REPORT

Port of Leith Outer Berth Development

Approach Channel Deepening Supplementary Environmental Impact Assessment Report

Client: Forth Ports Limited

Reference: PC4514-RHD-YY-XX-RP-EV-0017

Status: Final/01

Date: 8 December 2023

FORTH PORTS SCOTLAND

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Acronym	Acronym description
AL	Action Level
AON	Apparently Occupied Nests
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BAP	Biodiversity Action Plan
BHD	Back-hoe Dredger
BoCC	Birds of Conservation Concern
BPEO	Best Practicable Environmental Option
BTO	British Trust for Ornithology
CD	Chart Datum
CEDA	Central Dredging Association
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CES	Coastal East Scotland
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CV	Coefficient of Variation
DBT	Dibutyltin
DDV	Drop-Down Video
DECC	Department of Energy and Climate Change
EC	European Commission
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
EPS	European Protected Species
ES	East Scotland
ESR	Environmental Scoping Report
FCS	Favourable Conservation Status
FeAST	Feature Activity Sensitivity Tool
GES	Good Environmental Status
GPP	Guidance for Pollution Prevention
GPS	Global Positioning System
HES	Historic Environment Scotland

Acronym	Acronym description
HRA	Habitats Regulations Appraisal
IAMMWG	Inter-Agency Marine Mammal Working Group
IEMA	Institute of Environmental Management & Assessment
JNCC	Joint Nature Conservation Committee
MarESA	Marline Evidence Based Sensitivity Assessment
MarLIN	Marine Life Information Network
MAU	Marine Analytical Unit
MD-LOT	Marine Directorate Licensing Operations Team
MF	Moray Firth
MOD	Ministry of Defence
MPA	Marine Protected Area
MS	Marine Scotland
MT	Mud Transport
MU	Management Unit
MWR	Marine Works Regulations
nm	nautical mile
NMFS	National Marine Fisheries Service
NMP	National Marine Plan
NS	North Sea
OFFSABC	Outer Firth of Forth and St Andrews Bay Complex
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAC	Pre-Application Consultation
PAH	Polycyclic Aromatic Hydrocarbons
PAN	Planning Advice Note
PCB	Polychlorinated Biphenyls
PMF	Priority Marine Features
PPG	Pollution Prevention Guidance
PSA	Particle Size Analysis
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
rms	root mean square
SAC	Special Area of Conservation

Acronym	Acronym description
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
sEIA	Supplementary EIA
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single Strike Sound Exposure Level
SEPA	Scottish Environmental Protection Agency
SNH	Scottish Natural Heritage
SPA	Special Protected Area
sRIAA	Supplementary Report to Inform Appropriate Assessment
SSC	Sea Mammal Research Unit
SSSI	Site of Special Scientific Interest
TBT	Tributyltin
THC	Total Hydrocarbon Content
TSHD	Trailer Suction Hopper Dredger
TTS	Temporary Threshold Shift
VC	Vibrocore
WeBS	Wetland Bird Survey
WFD	Water Framework Directive
WODA	World Organisation of Dredging Associations
ZoI	Zone of Influence

1 Introduction

1.1 Proposed Amendments to the Outer Berth Development

Forth Ports Limited ("Forth Ports") is improving the Outer Berth at the Port of Leith ("the Port") to support the offshore renewable energy industry. In December 2022, Marine Licences were granted by Marine Scotland's Licensing Operations Team (now known as the Marine Directorate Licensing Operations Team (MD-LOT)) for improvement works to the Outer Berth (MS-00009818) as well as the disposal of associated dredged material (MS-00009819). An Environmental Impact Assessment (EIA) was undertaken on the Outer Berth development (herein referred to as "the Outer Berth EIA") and an EIA Report produced to support the licence applications (Royal HaskoningDHV, 2022).

The current water depth of the Leith approach channel (between -6.5m Chart Datum (CD) and -7.0m CD) significantly limits the tidal window during which deep-drafted vessels can access the Outer Berth and, on some neap tides, access is not possible at all. Given this, the increased water depth required by the evolving offshore renewables industry and limited vessel availability, Forth Ports is proposing to deepen the approach channel to the Port of Leith. The deepening of the approach channel would not change the number of vessel movements to the Outer Berth as described in the Outer Berth EIA Report. Instead, its purpose is to increase the frequency and length of the tidal window when deeper drafted vessels can access the Outer Berth.

The proposed deepening would increase the depth of the approach channel to -9.0m CD and extend the offshore extent, from the current maintenance dredge limit to the -9.0m CD contour within the Firth of Forth. The Outer Berth berth pocket, most of which will have been deepened to -9.0m CD as part of the consented Outer Berth development, would be repositioned northwards, increased in size, and deepened to -13.0m CD. The footprint of the proposed deepening can be seen in **Figure 1-1**.

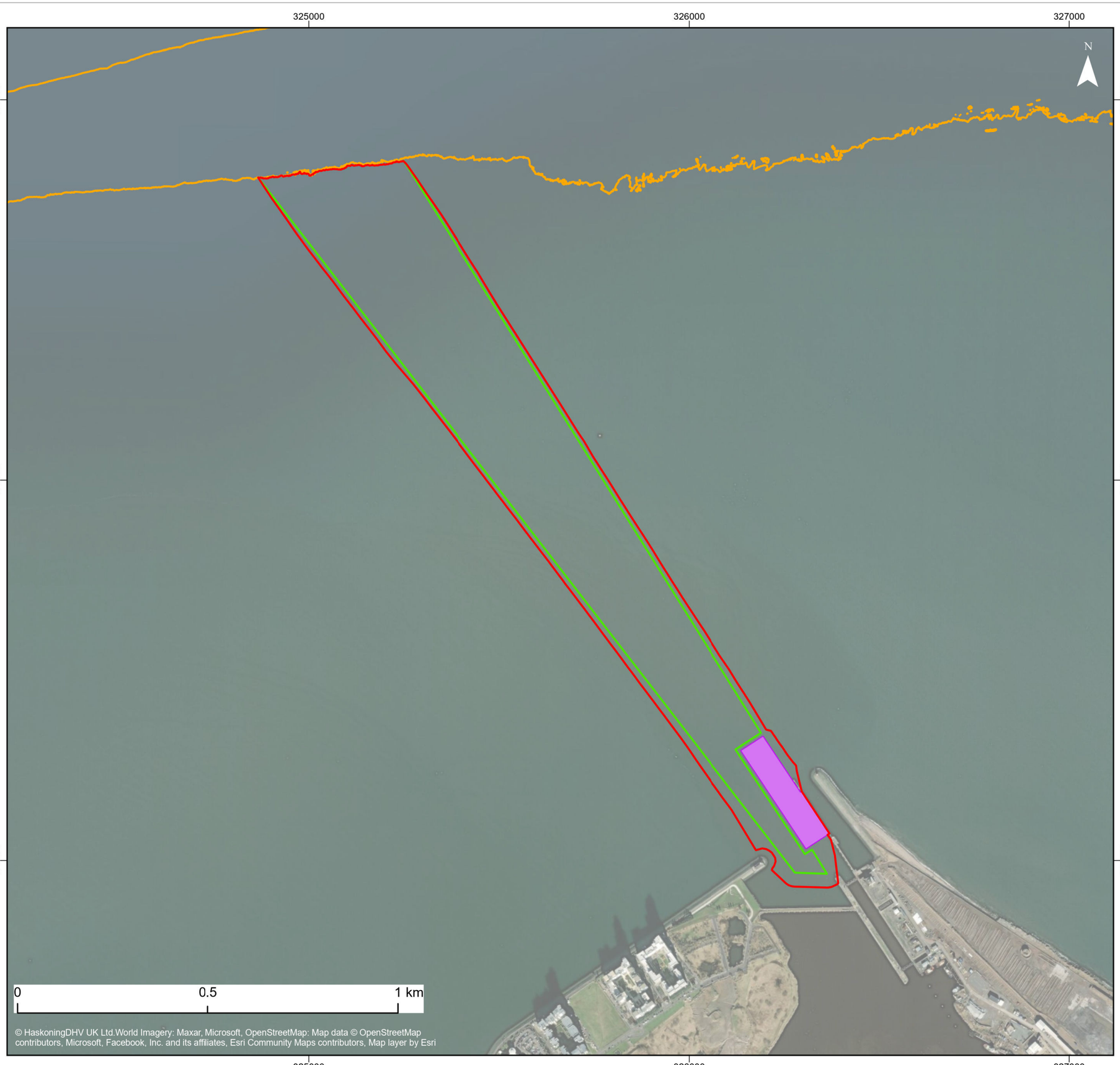
It is anticipated that the dredge and disposal activities would be completed within approximately four months, with approximately 1,300,000m^3 of material removed, approximately 1,410,000m^3 including a 0.25m over-dredge allowance. Disposal would be at Narrow Deep B Spoil Disposal Ground (FO038), as confirmed by the Best Practicable Environmental Option (BPEO) assessment submitted as part of the licence variation application.

In order to ensure the stability of the Eastern Breakwater following the repositioning and deepening of the berth pocket, a short retaining wall approximately 45m in length will be installed between the dredge pocket and the toe of the breakwater, as indicated in **Figure 1-2**.

To summarise, the 'Proposed Scheme' comprises the following elements:

- Deepening of the approach channel to -9.0m CD;
- Deepening of the Outer Berth berth pocket to -13.0m CD;
- Disposal of dredge material at Narrow Deep B Spoil Disposal Ground (FO038); and
- Installation of an approximately 45m retaining wall at the toe of the Eastern Breakwater.

Further detail of the Proposed Scheme is provided in **Chapter 3**.



Legend

- Dredge Area including slopes
- -9mCD Approach Channel
- -13mCD Berth Pocket
- -9mCD contour

Client: Forth Ports Limited	Project: Port of Leith Outer Berth: Approach Channel Deepening

Title: Footprint of the Proposed Deepening at the Port of Leith

Figure: 1.1

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Co-ordinate system: British National Grid

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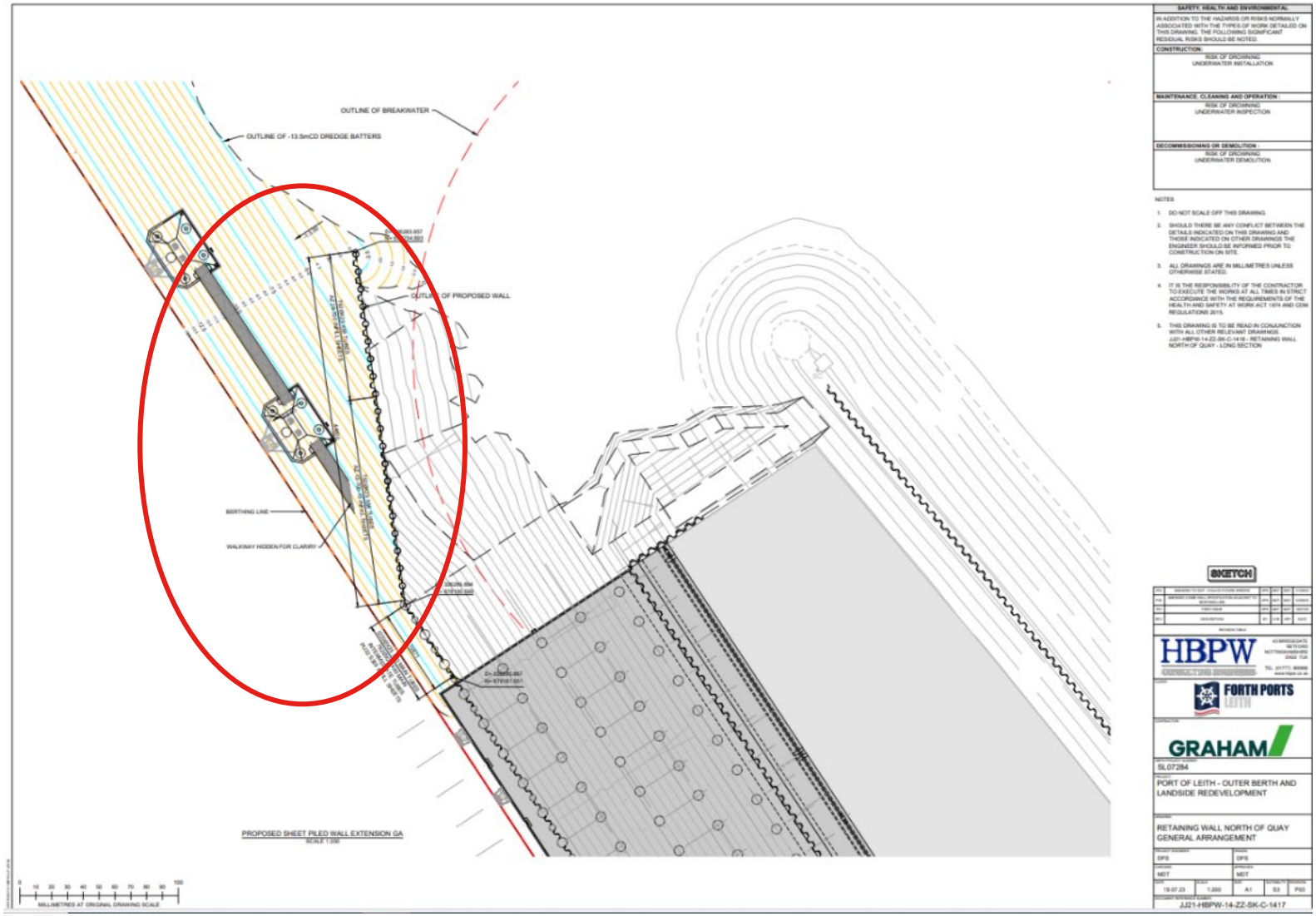

Figure 1-2 Proposed retaining wall extending north west of the Outer Berth (circled in red)

1.2 Requirement for Environmental Impact Assessment

The Outer Berth development was confirmed an EIA Development by MD-LOT under Schedule 2 Section 10(g) of the Marine Works (EIA) (Scotland) Regulations 2017 (as amended) ('the MWRs'), as:

"*Construction of harbours and port installations, including fishing harbours (unless included in Schedule 1).*"

Given the Proposed Scheme forms part of an EIA Development, its environmental effects, either alone or cumulatively with the Outer Berth development, are considered to have the potential to give rise to significant environmental effects. It has therefore been determined that the Proposed Scheme is also an EIA Development, and this supplementary EIA (sEIA) Report has been produced in support of applications to vary the Outer Berth development's Marine Licences.

1.3 Changes to the Proposed Scheme Since Scoping

An Environmental Scoping Report (ESR) was submitted to MD-LOT in June 2023, (Royal HaskoningDHV, 2023) and the Scoping Opinion received in September 2023 (**Appendix 1-1**). Further consideration of the types of vessels being used by the offshore renewables industry has identified that the approach channel to the Port of Leith needs to be deepened by an additional 1m to provide safe under-keel clearance for the required access the Outer Berth.

The following changes therefore have been made to the design of the Proposed Scheme since issuing of the ESR:

- Target depth in the approach channel has been increased from -8.0m CD (plus 0.25m over-dredge) to -9.0m CD (plus 0.25m over-dredge) and extended to the -9m CD contour, from the -8m CD contour;
- Target depth in the Outer Berth berth pocket has increased from -12.0m CD (plus 0.25m over-dredge) to -13.0m CD (plus 0.25m over-dredge); and
- The volume of dredged material requiring disposal has increased from *c.*575,000m^3 (*c.*695,000m^3 including over-dredge) to *c.*1,300,000m^3 (*c.*1,410,000m^3 including over-dredge).

It is anticipated that the capital dredge would now take approximately four months to complete, compared to the previously anticipated approximately three months.

1.3.1 Implications of Proposed Changes on the EIA

Within this sEIA Report, the above changes have been considered by:

- The numerical modelling (hydrodynamic and sediment dispersion); and
- Assessment of dredge and disposal activities.

As the proposed changes in dredge depth do not introduce any new activities to that considered by the environmental scoping exercise, there are no changes to the required surveys/studies and assessments set out in the ESR and confirmed by the Scoping Opinion. The proposed changes do however affect the scope of the following surveys, the specifications of which were presented in the ESR:

- Sediment sampling survey (Appendix C of the ESR); and
- Benthic ecology survey (Appendix D of the ESR).

Additional samples were proposed and approved by MD-LOT (see **Section 8**). As such, the sediment survey met the requirements of MD-LOT as is therefore sufficient to inform an assessment of the offshore disposal of the dredged material.

The proposed increase in dredge depth to -9m CD and berth pocket to -13m CD would extend the approach channel to the -9m CD contour, an increase of approximately 37,600m^2, and increase the width of the channel slightly as a result of the required side slopes, in particular towards the entrance to the port. The proposed scope of the benthic ecology survey included samples near to the -8m CD contour as well as further into the Firth of Forth, outside of the dredge footprint; however, within the expected Zone of Influence (ZoI) of potential effects as a result of the deepening of the approach channel (see **Figure 1-3**). The extension to the proposed dredge footprint is therefore within the envelope of sample sites, as shown on **Figure 1-3**. Given this, the very small increase in dredge footprint and the ubiquitous nature of the benthic habitats throughout the local area within the Firth of Forth, as determined from the 2021 EUSeaMap benthic mapping project (see Section 4.6.1 of the ESR), the benthic ecology survey is considered to remain suitable to assess the potential effects of the increased dredge depth on benthic ecology.

1.4 Marine Licencing

A request for a marine construction licence and marine disposal licence is being sought from MD-LOT to permit the installation of the short retaining wall and disposal of the dredged material associated with the Proposed Scheme. The dredging activity would be undertaken under Forth Port's powers conferred by the Forth Ports Authority Order Confirmation Act 1969.

1.5 Description of Study Area

The study area considered in this sEIA Report is the ZoI over which direct and indirect potential impacts of the Proposed Scheme may occur. This varies by effect/impact and receptor and takes into account the construction of the retaining wall, the dredging activity, and disposal at Narrow Deep B Spoil Ground. The maximum extent of the Proposed Scheme's ZoI is considered to relate to potential disturbance effects on coastal/marine birds and marine fauna (namely estuarine fish and marine mammals) and is described in the relevant sections of this sEIA Report.

1.6 Approach to the Supplementary EIA

The marine elements (i.e. the dredging and marine construction works) of the Outer Berth development (i.e. those with the potential for cumulative effects with the Proposed Scheme) will be completed before works related to the Proposed Scheme begins. As such, the presence of the marine elements of the Outer Berth development form part of the baseline upon which the Proposed Scheme has been assessed.

This sEIA Report is supplementary to the Outer Berth EIA Report and is supported by the assessments undertaken as part of the Outer Berth EIA Report, which has been issued alongside this sEIA Report. The EIA methodology applied is consistent with that presented in the Outer Berth EIA Report.

The Marine Works Regulations (MWRs) require an EIA Report to be prepared by competent persons. This report has been compiled by Royal HaskoningDHV, who prepared the original the Outer Berth EIA Report. Royal HaskoningDHV is a corporate member of the Institute of Environmental Management & Assessment (IEMA) (number 0001189). Royal HaskoningDHV is also a Corporate Registered Assessor for EIA under IEMA's voluntary EIA Quality Mark scheme, through which EIA activity is independently reviewed (on an annual basis) to ensure it delivers excellence in areas including EIA management, team capabilities, regulatory compliance, content, presentation and improving practices.

Legend

- Proposed Benthic Survey Station Locations
- DDV or ROV video sample transects
- Dredge Area
- Maintenance Dredge Area
- -8mCD contour
- -9mCD contour

Client: Forth Ports Limited	Project: Proposed Deepening of the Leith Approach Channel - Benthic Ecology Survey Specification

Title: Proposed Benthic Ecology Survey Station and Transect Locations

Figure: 1-3

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1.7 Structure of the Supplementary EIA Report

This sEIA Report is structured as follows:

Chapter 1 provides an introduction to the Proposed Scheme, the requirement for EIA and approach to the request for a variation to the Outer Berth development Marine Licences.

Chapter 2 details the need for the Proposed Scheme and the potential associated benefits.

Chapter 3 provides a project description for the Proposed Scheme, including information on the construction methodology, an overview of the operational phase and a description of the alternatives considered.

Chapter 4 provides an overview of the environmental/consenting legislation of relevance to the Proposed Scheme, this sEIA Report and the variation application.

Chapter 5 describes the approach taken in producing this sEIA Report, including the Cumulative Impact Assessment (CIA).

Chapter 6 outlines the consultation undertaken in relation to the Proposed Scheme.

Chapters 7 to 12 set out the environmental assessment of the Proposed Scheme. These sections summarise the baseline described in the Outer Berth EIA and provide any updated information of relevance. Potential impacts that could arise as a result of the Proposed Scheme are identified (where they materially differ from those set out in the Outer Berth EIA) and, where appropriate, mitigation measures are defined. The predicted residual impacts (i.e. those potential impacts remaining, assuming the recommended mitigation measures are implemented) are also set out in each chapter.

Chapter 13 presents the CIA for the Proposed Scheme in combination with other projects and plans.

Chapter 1 provides a summary of the potential impacts, any mitigation measures proposed (excluding those built into the design of the Proposed Scheme) and the residual impacts predicted.

Chapter 15 provides a list of references used in the compiling of this sEIA Report.

2 Need for the Proposed Scheme

As described in the Outer Berth EIA Report, the Outer Berth development, currently under construction at the Port, is a key component in Scotland's economic recovery and energy transition plans, and in the achievement of Scotland's net zero carbon emissions targets. It represents a £50m private sector investment that will see the creation of a bespoke, riverside marine berth capable of accommodating the world's largest offshore wind installation vessels.

To summarise, the Outer Berth development will:

- Make a major contribution to Scotland achieving its 70% reduction by 2030 and 2045 net zero targets, as defined in the Climate Change (Scotland) Act 2009 (as amended) and Climate Change (Emissions Reduction Targets) (Scotland) Act 2019;
- Secure the Firth of Forth as the driver for Scotland's green energy transition as envisaged in Scotland's National Marine Plan (NMP) 2015 and adopted in the 2020 Sectoral Marine Plan for Scotland to support and facilitate growth of offshore wind renewable energy;
- Support the Forth Green Freeport's strategically located tax and customs sites which aim to reindustrialise central Scotland, bringing up to 50,000 high-quality green jobs by increasing trade and supporting the growth of businesses across the Firth of Forth;
- Help spearhead Edinburgh's and Scotland's Covid-19 recovery plan in-line with the green recovery policy including the Covid Recovery Strategy 2021;
- Support up to 1,000 high quality, long term direct jobs and about 2,000 indirect jobs; and
- Further underpin the position of Scotland's Central Belt as a leading area of engineering and manufacturing skills and capabilities.

The Proposed Scheme is necessary to ensure that the Outer Berth can accommodate the deeper-drafted vessels that are becoming ever more prevalent in the construction of offshore renewable energy installations.

3 Description of the Proposed Scheme

3.1 Construction Phase

3.1.1 Dredging and Disposal

To deepen the approach channel to -9.0m CD and the Outer Berth berth pocket to -13.0m CD would require the removal of approximately 1,300,000m^3 of sediment (approximately 1,410,000m^3 of sediment including a 0.25m over-dredge allowance).

It is anticipated that the majority of dredging would be undertaken by a Trailer Suction Hopper Dredger (TSHD). In areas where the water depth is greater than 4.0m CD, it is likely that a medium TSHD with a hopper capacity of approximately 4,500m^3 would be employed (production rate of approximately 83,960m^3 per week). At shallower depths a smaller TSHD with a hopper capacity of approximately 1,500m^3 would be employed (production rate of approximately 25,680m^3 per week). It is anticipated that the TSHDs may work concurrently. In the berth pocket and proximity to the Port of Leith, the TSHD would be supported by a plough vessel to remove sediment from corners and level out ridges.

A breakdown of sediment types and estimated percentage breakdown of the material arising are presented in **Table 3-1**.

Table 3-1 Estimated sediment fractions of material to be dredged as part of the approach channel deepening

Sediment Type	Sediment Fractions (%)	
	Medium TSHD	Small TSHD
Silt/Clay	64	82
Fine Sand	20	17
Medium Sand	3	1
Coarse Sand	3	0
Gravel/Cobble	10	0

It is possible that some areas may also require the use of a Back-hoe Dredger (BHD), particularly within areas difficult for a TSHD to access or where rock or consolidated sediment is present. If a BHD would be used, it is expected that the BHD would work in place of one of the TSHDs. Given that the production rate of a BHD is below that of a TSHD, and would be working with rock or consolidated sediment, the resultant sediment plume would be smaller than that of the TSHD. To provide a worst-case assessment, the sediment dispersion modelling (see **Chapter 7: Coastal Processes**) has been based on all of the material being dredged by TSHD.

The BHD would excavate rock with the bucket, including ripping. Should the sediment be too hard to remove using this method, a hydraulic breaker would be attached. The typical underwater noise source level generated by a hydraulic breaker is 175.1 dB 1 µPa SPLRMS @ 1m[1] (Royal HaskoningDHV, 2019). The underwater noise source level for the TSHD is 186 dB 1 µPa SPLRMS @ 1m (see Appendix 10-1 of the Outer Berth EIA Report), the use of a TSHD. Consequently, in terms of underwater noise, the use of TSHD provides the worst-case scenario.

[1] *Using a 4.2 tonne, 10.4 kJ hydraulic hammer*

The dredged arisings would be transported to Narrow Deep B Spoil Disposal Ground (FO038) within the TSHD (or support barge in the case of material from BHD). Over the course of the dredge/disposal campaign, it is anticipated that there would be in the region of 800 round trips to the disposal site and dredge/disposal activities would take approximately four months.

3.1.2 Installation of the Retaining Wall

The retaining wall would comprise a short sheet piled structure, effectively forming an extension to the sheet piled wall that forms the face of the Outer Berth development. It would be installed below mean low water initially by vibratory piling and completed by percussive piling, as required. Installation would most likely take place from land-based plant working from the Outer Berth. To get access for a crane, there may be a requirement for some minor infilling, depending on the size of the crane to be used. The infill would either be removed following completion of piling or suitably protected with rock armour and left in-situ. The retaining wall would be approximately 45m in length.

3.1.3 Anticipated Construction Programme

The dredging programme would be dependent on the dredging equipment scenario(s) employed (e.g. method, capacity); however, it is anticipated that the dredge would be completed within approximately four months. Installation of the retaining wall would take around 12 weeks and may be carried out concurrently with the dredging.

3.2 Operational Phase

3.2.1 Change in Vessel Access to the Outer Berth

The Proposed Scheme would not change the number of vessel movements to the Outer Berth. Instead, its purpose is to increase the frequency and length of the tidal windows when deeper drafted vessels can access the Outer Berth.

3.2.2 Predicted Increase in Maintenance Dredging Requirements

Historic annual dredging volumes over the last two decades (2001 to 2020) have ranged up to 48,000m^3, with an average of 20,000m^3. Upon completion of the consented Outer Berth development (the baseline for the Proposed Scheme), the baseline maintenance dredge requirement for the entire channel is predicted to increase by 22% (Royal HaskoningDHV, 2022). This will equate to an annual predicted average dredge volume of about 24,000m^3. These volumes can be used as a proxy for the rate of sediment transport and deposition in the existing approach channel, and in combination with the change in its dimensions following the Proposed Scheme can be used to estimate the future maintenance dredging requirement.

The removal of about 1,410,000m^3 of sediment means that the accommodation space in the future channel compared to the existing channel would increase by this volume. Using the bathymetries of the approach channel and the areas to either side of the channel, the existing accommodation space in the approach channel (excluding the berth pocket) is estimated to be 365,000m^3. The existing accommodation space in the berth pocket (to -9.0m CD) is 54,000m^3, therefore the total existing accommodation space across the approach channel and berth pocket is 419,000m^3.

The removal of 1,410,000m^3 of sediment means that the accommodation space would increase from about 419,000m^3 to about 1,829,000m^3. This equates to an increase in accommodation space compared to the existing of about 337%. Using the baseline average maintenance dredging volume of 24,000m^3 and an increase in accommodation space of 337% means the estimated future average maintenance dredging requirement would be about 105,000m^3 with a maximum of up to approximately 197,000m^3.

The marine licence being made for the Proposed Scheme will not include for this maintenance dredging; consequently, maintenance dredging has not been assessed within this sEIA Report.

3.3 Consideration of Alternatives

3.3.1 Do-Nothing Scenario

The do-nothing scenario would mean that the Outer Berth development would have a reduced capacity or be unable to receive the larger drafted vessels on which the offshore energy sector is becoming increasingly reliant. This would likely make the Port unviable to support the offshore renewables industry, thereby hindering:

- Scotland achieving it 2045 net zero targets;
- Scotland's green energy transition; and
- Scotland's Covid-19 recovery plan.

In addition, the significant economic and employment benefits associated with the Outer Berth development would not be realised. Consequently, the do-nothing scenario has been discounted.

Given the design of the channel has been dictated by the requirements of the vessels that would visit the Outer Berth, no alternatives to the channel design are possible.

3.4 Embedded Mitigation

In addition to the measures set out in the following chapters to avoid or mitigate any adverse effects that could arise as a result of the Proposed Scheme, Forth Ports is committed to the use of best practice techniques and due diligence regarding construction projects. The following pollution prevention guidelines are relevant to the Proposed Scheme and will be adhered to during dredging/disposal and construction:

- Guidance for Pollution Prevention (GPP) 1: Understanding your environmental responsibilities - good environmental practices;
- GPP 5: Works and maintenance in or near water;
- PPG 6: Working at construction and demolition sites;
- Pollution Prevention Guidance (PPG) 7: Safe storage - The safe operation of refuelling facilities;
- GPP 8: Safe storage and disposal of used oils;
- GPP 13: Vehicle washing and cleaning (April 2017);
- GPP 21: Pollution incident response planning; and
- GPP 22: Dealing with spills.

4 Relevant Legislation

This section of the sEIA Report provides details on the overarching legislative framework for the proposed works. Additional legislation specific to an environmental topic is described in the relevant chapters.

4.1 Enabling Legislation

4.1.1 Marine (Scotland) Act 2010

Part 4 of the Marine (Scotland) Act 2010 provides a framework for the marine licensing system for those 'licensable marine activities' undertaken within Scottish waters below Mean High Water Springs. The Scottish Ministers are the licensing authority for most matters in Scottish inshore and offshore waters with MD-LOT responsible for issuing licences on their behalf.

Installation of the retaining wall would be classed as a licensable activity under paragraph (1)5 of Section 21 of the Marine (Scotland) Act:

"*To construct, alter or improve any works within the Scottish marine area either (a) in or over the sea, or (b) on or under the seabed*."

Similarly, offshore disposal of dredged material would be classed as a licensable activity under paragraph (1)1 of Section 21 of the Act:

"*To deposit any substance or object within the Scottish marine area, either in the sea or on or under the seabed, from…a vehicle, vessel, aircraft or marine structure*."

As such, a request for variations to the Outer Berth development's Marine Licences is being sought from MD-LOT.

The dredging required for the Proposed Scheme would be undertaken under Forth Ports' powers as statutory harbour authority and as such does not require a Marine Licence (however, as the dredging required is a capital dredge, this sEIA Report includes an assessment of the potential effects of the dredging activity).

4.2 EIA Legislation

4.2.1 The Marine Works (EIA) (Scotland) Regulations 2017

Following the EIA screening, MD-LOT determined that the Outer Berth development classified as an EIA Development under Schedule 2, paragraph 10(g) of the MWRs:

"*Construction of harbours and port installations, including fishing harbours*."

Given the Proposed Scheme forms part of an EIA Development, its environmental effects, either alone or cumulatively with the Outer Berth Development, are considered to have the potential to give rise to significant environmental effects. It has therefore been determined that the Proposed Scheme is also an EIA Development.

This sEIA Report fulfils the requirements of an EIA report as set out in Section 6 and Schedule 4 of the MWRs.

4.3 Other Relevant Legislation and Policy

4.3.1 Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013

Section 23 of the Marine (Scotland) Act 2010 details requirement for a Pre-Application Consultation (PAC). The process and approach to the PAC is detailed in the Marine Licensing (PAC) (Scotland) Regulations 2013.

The activities associated with the Proposed Scheme do not fulfil the criteria listed in the MD-LOT guidance document *Guidance on Marine Licensable Activities Subject to Pre-Application Consultation*[2], hence there is no requirement for PAC to be undertaken on the Proposed Scheme.

4.3.2 Conservation (Natural Habitats, &c.) Regulations 1994, as amended

In Scotland, the Habitats Directive is translated into specific legal obligations by the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. These regulations ("the Habitats Regulations") transpose the Habitats and Birds Directives into Scottish legislation.

The Habitats Regulations place an obligation on 'competent authorities' to carry out an appropriate assessment of any proposal likely to affect a designated site, to seek advice from NatureScot and not to approve an application that would have an adverse effect on a designated site unless certain conditions are met (where there are no alternative solutions, the plan or project can only proceed if there are imperative reasons of over-riding public interest and if the necessary compensatory measures can be secured).

A Habitats Regulations Appraisal (HRA) has also been undertaken on the Proposed Scheme and a Supplementary Report to Inform Appropriate Assessment (RIAA) accompanies the Marine Licence variation applications.

4.3.3 UK Marine Policy Statement 2011

The UK Marine Policy Statement sets out a framework for preparing Marine Plans and taking decisions affecting the marine environment. It aims to achieve a shared vision by the UK Administrations of having "*clean, healthy, safe, productive and biologically diverse oceans and seas*". The Marine Statement sets out the following high level marine objectives:

- Promote sustainable economic development;
- Enable the UK's to move towards a low-carbon economy, in order to mitigate the causes of climate change and ocean acidification and adapt to their effects;
- Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species, and our heritage assets; and
- Contribute to the societal benefits of the marine area, including the sustainable use of marine resources to address local social and economic issues.

[2] https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/02/marine-licensing-applications-and-guidance/documents/guidance/guidance-on-activities-subject-to-pre-application-consultation/guidance-on-activities-subject-to-pre-application-consultation/govscot%3Adocument/Guidance%2Bon%2Bactivities%2Bsubject%2Bto%2Bpre-application%2Bconsultation.pdf

It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning, considering:

- Marine ecology and biodiversity;
- Air quality;
- Noise;
- Ecological and chemical water quality and resources;
- Seascape;
- Historic environment;
- Climate change adaptation and mitigation; and
- Coastal change and flooding particularly.

The Marine Policy Statement identifies 'Ports and shipping' and 'Energy production and infrastructure development' as key activities taking place within the marine environment, and that they are essential contributors to the economic and social well-being of the UK. Securing the UK's energy objectives and providing key transport infrastructure between land and sea, while protecting the environment, is defined as a priority for marine planning. The Proposed Scheme is aligned with these objectives.

4.3.4 Scotland National Marine Plan

Scotland's NMP was published by the Scottish Government in March 2015. The plan covers the management of both Scottish inshore waters (out to 12 nautical miles (nm)) and offshore waters (12 to 200nm), setting out the Scottish Government's policies for the sustainable development of Scotland's seas (MSD, 2015).

The plan promotes an ecosystem-based approach, putting the marine environment at the heart of the planning process to promote ecosystem health, resilience to human induced change and the ability to support sustainable development and use. It adopts the guiding principles of sustainable development, which also ensures that any individual policy, plan, or activity is carried out within environmental limits.

Chapter 4 of the NMP sets out the General Planning Principles necessary to achieve sustainable development. Details of how the Proposed Scheme supports these principles, both of itself and as a component of the Outer Berth development, is presented in **Table 4-1**.

Table 4-1 Assessment of the Proposed Scheme against the NMP General Planning Principles

General Planning Principle	Policy context	How does the Proposed Scheme comply with the Policy?
GEN 1 General Planning Principle	There is a presumption in favour of sustainable development and use of marine environment when consistent with the policies and objectives of this plan.	The Proposed Scheme would support renewable energy projects through enhancement of the Port's ability to accommodate vessels associated with the offshore renewable energy industry.
GEN 5 Climate change	Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	By supporting the Port of Leith's ability to accommodate vessels associated with the offshore renewable energy industry, the Proposed Scheme will consequently support Scotland's renewable energy ambitions (full details in the Outer Berth EIA).

General Planning Principle	Policy context	How does the Proposed Scheme comply with the Policy?
GEN 7 Landscape/ seascape	Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape, and visual impacts into account.	All permanent elements of the Proposed Scheme are located below water hence would not affect landscape/seascape character or the visual setting. This was confirmed in the Proposed Scheme's Scoping Opinion (**Appendix 1-1**).
GEN 8 Coastal processes and flooding	Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.	The Proposed Scheme has been assessed using hydrodynamic modelling to and shown no significant effects on coastal processes (**Chapter 7**). Coastal flooding was scoped out of further assessment of the Outer Berth scheme EIA Report, and therefore was scoped out of assessment of the Proposed Scheme as per the ESR and confirmed in the Scoping Opinion (**Appendix 1-1**).
GEN 9 Natural heritage	Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area.	The Proposed Scheme would have minor to negligible, not significant in EIA terms, impacts on natural heritage (**Chapters 9** to **12**).
GEN 10 Invasive non-native species	Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	The Proposed Scheme is located within an operational port and would follow best practices to avoid the introduction or spread of invasive non-native species as carried out currently.
GEN 11 Marine litter	Developers, users, and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.	The Proposed Scheme is located within an operational port and would follow best practices to manage marine litter as carried out currently.
GEN 12 Water quality and resource	Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.	The Proposed Scheme would have minor adverse, not significant in EIA terms, impacts on water quality (**Chapter 8**).
GEN 13 Noise	Development and use in the marine environment should avoid significant adverse effects of man-made noise.	With adherence to standard best practice measures, the proposed development would not result in significant adverse noise impacts to the marine environment during construction (**Chapters 0 to 12**). The Proposed Scheme will have no impact on operational noise.
GEN 14 Air quality	Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.	The Proposed Scheme is not anticipated to alter the operational vessel activity as assessed in the EIA Report for the Outer Berth scheme and air quality impacts have been scoped of this EIA Report. This was confirmed in the MD-LOT scoping opinion (**Appendix 1-1**).
GEN 21 Cumulative impacts	Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.	The CIA is reported in **Chapter 13** of this sEIA Report.

5 EIA Methodology

5.1 Introduction

This section sets out the approach for the assessment of potential impacts which has been adopted within this sEIA Report. The approach is consistent with that employed for the Outer Berth EIA; however, has been reproduced in the sections below for ease of reference. This chapter presents:

- The EIA process followed for the Proposed Scheme;
- The approach adopted to define the baseline environment (details are provided for each topic considered in the relevant chapters);
- The generic approach employed to assessing potential impacts, including the evaluation of significance (relevant chapters detail where a different approach has been adopted for a specific topic);
- The generic approach taken to the derivation of mitigation measures and the assessment of residual impacts; and
- The approach taken to the assessment of potential cumulative impacts.

5.2 EIA Guidance

This EIA has been undertaken in accordance with the requirements of the MWRs and has considered key legislation, guidance, and advice, including *inter alia*:

- Chartered Institute of Ecology and Environmental Management (CIEEM) *Guidelines for Ecological Impact Assessment in the UK and Ireland* (CIEEM, 2018); and
- IEMA Guidelines for Environmental Impact Assessment (IEMA, 2017).

Where additional guidance has been considered, it has been described in the relevant topic chapter.

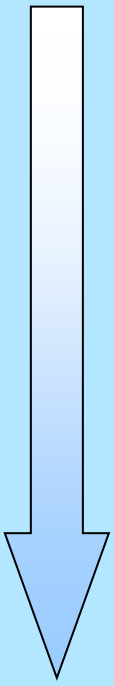
5.2.1 The EIA Process

In accordance with Schedule 4 of the MWRs, this sEIA Report includes such information as is reasonably required to assess the likely significant environmental effects of the Proposed Scheme and which the applicant can reasonably be required to compile, including:

- A description of the Proposed Scheme comprising information on its site, design, size, and other relevant features of the development (**Chapter 3**);
- A description of the likely significant effects of the Proposed Scheme on the environment (**Chapters 7** to **13**);
- A description of any features of the Proposed Scheme, or measures envisaged to avoid, prevent, or reduce and, if possible, offset likely significant adverse effects on the environment (**Chapters 7** to **13**);
- A description of the reasonable alternatives studied by the developer, which are relevant to the Proposed Scheme and its specific characteristics, and an indication of the main reasons for the option chosen, considering the environmental effects of the development on the environment (**Section 3.3**); and
- A non-technical summary of the above.

EIA is a process that systematically examines and assesses the potential impacts of a project on the environment. The process is outlined in **Table 5-1**.

Table 5-1 The EIA process

Stage	Task	Aim/objective	Work/output (examples)
Screening report	Screening	To formally confirm route for EIA and lead responsible authority.	Appropriate level of information on proposals and approach.
Scoping study (optional)	Scoping	To identify the potentially significant direct and indirect impacts of the Proposed Scheme.	Preliminary consultation with key consultees. Targets for specialist studies (e.g., bird survey).
EIA 	Consultation	Consult with statutory and non-statutory organisations and individuals with an interest in the area and the Proposed Scheme.	Local knowledge and information.
	Primary data collection	To characterise the existing environment.	Background data including existing literature and specialist studies.
	Specialist studies	To further investigate those environmental parameters which may be subject to potentially significant effects.	Specialist reports.
	Impact assessment	To evaluate the existing environment, in terms of sensitivity. To evaluate and predict the impact (i.e., magnitude) on the existing environment. To assess the significance of the predicted impacts.	Series of significant adverse and beneficial impacts.
	Mitigation measures	To identify appropriate and practicable mitigation measures and enhancement measures.	The provision of solutions to minimise adverse impacts as far as possible. Feedback into the design process, as applicable.
	EIA Report	Production of the EIA Report in accordance with EIA guidance.	EIA Report.

The approach adopted for in this sEIA Report is summarised in the following sections. It should be noted that these stages may overlap; for example, iterative design changes may be made considering emerging findings of the EIA process to prevent or reduce the significance of a potential impact.

5.3 Screening

As described in **Section 1.1**, the Proposed Scheme forms part of the wider Outer Berth development, which was categorised under Schedule 2, Section 10(g) of the MWRs as:

"Construction of harbours and port installations, including fishing harbours (unless included in Schedule 1)."

Given the Proposed Scheme forms part of an EIA Development, it has therefore been determined that the Proposed Scheme is also an EIA Development and rescreening for EIA was not considered necessary, as agreed with MD-LOT and in accordance with Part 2, Section 7 of the MRWs:

"If no screening opinion has been adopted by the Scottish Ministers, the submission…of a report referred to by the applicant as an EIA report…will determine for the purpose of these Regulations whether proposed works would be an EIA project.".

5.4 Scoping

The scope of this sEIA Report has been informed by the EIA Scoping Opinion issued by MD-LOT in September 2023 (see **Appendix 1-1**). The topics to be assessed are as follows:

- Coastal processes;
- Marine water and sediment quality;
- Marine benthic ecology;
- Fish and shellfish ecology;
- Ornithology;
- Marine mammals; and
- Cumulative impacts.

5.5 Supplementary EIA Report

This sEIA Report is supplementary to the Outer Berth EIA Report and is supported by the information obtained and assessments undertaken as part of the Outer Berth EIA Report, which has been issued alongside this sEIA Report.

5.5.1 Baseline Environment

The term 'baseline environment' is used to describe the nature, scale, condition, and other relevant information to provide a detailed description of a given environmental receptor that falls within the scope of this sEIA report. Within this report, the description of the baseline environment consists of the following aspects:

- The spatial location and extent of the environmental features or receptors;
- A description of the environmental features or receptors and their character;
- The context of the environmental features or receptors in terms of rarity, function, and population at the local, regional and national level;
- The sensitivity of the environmental features or receptors in relation to physical, chemical or biological changes; and
- The value of the environmental features or receptors (e.g. designated status).

Details on the studies and surveys that have been undertaken to inform the baseline environment and to inform the required assessments are provided in the relevant technical chapters; however, to summarise, the following have been undertaken:

- Hydrodynamic modelling to predict changes in current speed and direction as a result of the Proposed Scheme (see **Chapter 7**);
- Sediment dispersion modelling to predict changes in suspended sediment concentrations in the water column associated with dredge and disposal activities (see **Chapter 7**);
- Geophysical survey to provide physical information of the sediments to be dredged (see **Appendix 5-1**);
- Sediment sampling and analyses to characterise the chemical and physical properties of the sediment to be dredged (see **Appendix 8-2**); and

- Benthic ecology survey (comprising grab samples and Drop-Down Video (DDV) transects) to characterise the marine benthic communities within the dredge footprint and surrounding seabed (see **Appendix 9-1**).

In addition, the following studies and surveys were undertaken to inform the Outer Berth EIA Report and which are relevant to the assessment of the Proposed Scheme:

- Underwater and above water noise modelling; and
- The ornithological surveys of the Port and surrounding environment, comprising:
    - Twice-monthly estuarine bird counts within the impounded dock system and nearby coastal/offshore locations between March 2021 and March 2022;
    - Twice monthly tern colony counts during May to July 2021 (inclusive), denoting the number of Apparently Occupied Nests (AON) at Imperial Dock Lock Leith Special Protected Area (SPA); and
    - Twice monthly tern flight behaviour surveys during May to July 2021 (inclusive).

5.5.2 Impact Identification

As per the Outer Berth EIA, the assessment set out herein has used the conceptual 'source-pathway-receptor' model wherever applicable. The model identifies potential impacts resulting from the proposed activities on the environment and sensitive receptors within it. This process provides an easy-to-follow assessment route between impact sources and potentially sensitive receptors ensuring a transparent impact assessment. The aspects of this model are defined as follows:

- Source - the origin of a potential impact (i.e. an activity, such as disposal of dredged material, and a resultant effect, such as increased suspended sediment levels at the disposal site);
- Pathway - the means by which the effect of the activity could impact a receptor (e.g. for the example above, changes to water quality in the receiving environment); and
- Receptor - the element of the receiving environment that is impacted (this could either be a component of the physical, ecological or human environment, e.g. for the above example, species living on or in the watercourses affected).

Where a different approach has been necessary to reflect the specific assessment requirements of a particular topic, this is described in the corresponding technical chapter.

5.5.3 Assessing the Significance of Potential Effects

5.5.3.1 Determining Receptor Value and Sensitivity

The characterisation of the existing environment helps to determine the receptor sensitivity in order to assess the potential impacts upon it.

Receptor value considers whether, for example, the receptor is rare, has protected or threatened status, has importance at a local, regional, national or international scale and, in the case of biological receptors, whether the receptor has a key role in the ecosystem function.

The ability of a receptor to adapt to change, tolerate, and/or recover from potential impacts is key to assessing its sensitivity to the impact under consideration. For ecological receptors, tolerance could relate to short term changes in the physical environment; for human environment receptors, tolerance could relate

to impacts upon community. The time required for recovery is an important consideration in determining receptor sensitivity.

The overall receptor sensitivity is determined by considering a combination of value, adaptability, tolerance and recoverability. This is achieved through applying known research and information on the status and sensitivity of the feature under consideration coupled with professional judgement and past experience.

Expert judgement is particularly important when determining the sensitivity of receptors. For example, an Annex II species (under the Habitats Directive) would have a high inherent value, but may be tolerant to an impact or have high recoverability. In this case, sensitivity should reflect the ecological robustness of the species and not necessarily default to its protected status. Example definitions of the different sensitivity levels for a generic receptor are given in **Table 5-2.**

Table 5-2 Generic definitions of receptor 'sensitivity' classifications

Sensitivity	Definition
High	Receptor has very limited or no capacity to avoid, adapt to, tolerate or recover from the impact.
Medium	Receptor has limited capacity to avoid, adapt to, tolerate or recover from the impact.
Low	Receptors has some capacity to avoid, adapt to, tolerate or recover from the impact.
Negligible	Receptor can generally avoid, adapt to, tolerate or recover from the impact.

The definitions of sensitivity given within each chapter are relevant to that particular EIA topic and are clearly defined by the assessor within the context of that assessment.

In addition, for some assessments the value of a receptor may also be an element to add to the assessment where relevant, for instance if a receptor is designated or has economic value. Example definitions of the value levels for a generic receptor are given in **Table 5-3**.

Table 5-3 Generic definitions of receptor 'value' classifications

Value	Definition
High	Internationally/nationally important from a conservation, ecological or economic perspective (for example, features of an international or national designation).
Medium	Regionally important from a conservation, ecological or economic perspective (for example, features of a regional designation).
Low	Locally important from a conservation, ecological or economic perspective.
Negligible	Not considered to be important (for example, common and/or widespread with little or no ecological or economic importance).

The terms 'high value' and 'high sensitivity' are not necessarily linked within a particular impact and it is important not to inflate impact significance specifically because a feature is 'valued'. For example, a receptor could be of high value (e.g. an Annex I habitat) but have a low or negligible physical/ecological sensitivity to an effect.

5.5.3.2 Determining Magnitude of Impact

In order to predict the level and significance of an effect, it is necessary to establish the magnitude of impact, as well as the probability of an impact occurring through consideration of:

- Scale or spatial extent of an impact (with regard to receptor populations etc.);
- Duration (short-, medium- or long-term or permanent);

- Likelihood of impact occurrence;
- Frequency of impact occurrence; and
- Nature of change relative to baseline conditions.

5.5.3.3 Evaluation of Significance

The matrix presented in **Table 5-4** was used to provide transparency to the assessment process presented in the Outer Berth EIA Report. The assessment presented herein maintains this approach. It should be noted that assessments may be modified based on the application of expert judgement – this is detailed in the relevant chapters where applicable.

Table 5-4 Potential effect matrix based on the magnitude of impact and the sensitivity of the receptor

Receptor sensitivity	Magnitude of impact							
	High	Medium	Low	Negligible	Negligible	Low	Medium	High
High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
Low	Moderate	Minor	Negligible	Negligible	Negligible	Negligible	Minor	Moderate
Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Descriptions of the approach to assessment of potential effects and the interpretation of significance levels are provided within the relevant chapters of this EIA. This approach ensures that the definition of impacts is transparent and specific to each topic under consideration. Example definitions of the significance levels for a generic receptor are given in **Table 5-5**.

Table 5-5 Definitions of effect significance

Potential effect	Definition
Major	Fundamental, permanent/irreversible changes, over the whole receptor, and/or fundamental alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are well in excess of the natural range of variability, and likely to occur some distance away from the development area.
Moderate	Considerable, permanent/irreversible changes, over the majority of the receptor, and/or discernible alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are in excess of the natural range of variability but may be largely restricted to the development area. Change occurs throughout the associated project development phase.
Minor	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are similar to, but occasionally in excess of, the natural range of variability. Change occurs intermittently during associated project development phase and is likely to be restricted to the development area.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or a slight alteration to key characteristics or features of the particular receptor's character or distinctiveness.

For the purposes of EIA, 'major' and 'moderate' potentially effects are deemed to be 'significant', while 'minor' and 'negligible' effects are deemed 'not significant'.

For each topic within this sEIA, best practice methodology (based on the latest available guidance) has been followed, which may augment the assessment framework presented above. In all cases the specific approach taken to assess impacts is described within each technical chapter.

5.5.4 Mitigation

Where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, mitigation measures have been proposed and discussed with the relevant authorities in order to avoid, prevent or reduce impacts to acceptable levels.

For the purposes of this EIA, two types of mitigation are defined:

- Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA (see **Section 3.4**); and
- Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts.

5.5.5 Residual Impacts

Following initial assessment, if the impact does not require additional mitigation (or none is possible) the residual impact will remain the same. However, if additional mitigation measures are identified, impacts are re-assessed, and all residual impacts clearly described.

5.5.6 Assumptions and Limitations

The EIA process requires an EIA Report to provide an indication of any difficulties (technical deficiencies or lack of expertise) encountered during the assessment process. Any such assumptions or limitations are identified within the relevant topic chapter, where appropriate.

5.6 Cumulative Impact Assessment

5.6.1 Impact Inter-Relationships

This sEIA Report has given due consideration to the potential for different residual impacts to have a combined impact on sensitive receptors. The objective is to identify where the accumulation of impacts on a single receptor, and the relationship between those impacts, potentially gives rise to a need for additional mitigation. Inter-relationships have been assessed within the relevant sections of the topic chapters of the sEIA Report.

5.6.2 Cumulative Impacts with the Consented Outer Berth Development

The marine elements of the Outer Berth development (i.e. those with the potential for cumulative impacts with the Proposed Scheme) would be completed by the time the construction works for the Proposed Scheme begins. As such, the presence of the Outer Berth development forms part of the baseline upon which the Proposed Scheme has been assessed.

5.6.3 Cumulative Impacts with Other Projects/Developments

In line with IEMA's *Guidelines for Environmental Impact Assessment* (IEMA, 2017), cumulative impacts are defined as:

"…the impacts on the environment which result from incremental impacts of the action when added to other past, present and reasonably foreseeable future actions."

There is no legislation that outlines how CIA should be undertaken; however, Schedule 4, Section 6 of the MWRs require the consideration of *"direct effects and any…cumulative…effects of the works."* Guidance on CIA is provided in a number of good practice documents (e.g. the European Commission, 1999). This guidance is not prescriptive, but rather suggests various approaches which may be used, depending on their suitability to the project (for example the use of matrices, expert opinion, consultation, spatial analysis and carrying capacity analysis).

With respect to 'past' projects, a useful ground rule in CIA is that the environmental impacts of schemes that have been completed should be included within the environmental baseline; as such, these impacts will be accounted in the EIA process and, generally, can be excluded from the scope of CIA. However, the environmental impacts of recently completed projects may not be fully manifested and, therefore, the potential impacts of such projects are taken into account in the CIA.

In line with established practice, the CIA is limited to those plans and projects for which there is sufficient information available to allow assessment of potential effects. In the absence of publicly available information (usually in the form of consent applications) or a defined 'scheme', it is not possible to undertake a proper consideration of cumulative effects (i.e. if proposals are speculative or where assumptions regarding the potential impacts may be contentious).

An assessment of the cumulative impacts of the Proposed Scheme with other projects is provided in **Chapter 13** of this report.

6 Consultation

6.1 Introduction

The following sections outline the EIA consultation that has been undertaken to inform this sEIA. It has been confirmed with MD-LOT[3] that there is no requirement for a PAC event to be carried out on Proposed Scheme.

6.2 Statutory Consultation

A Scoping Opinion was requested of MD-LOT to confirm the scope of the sEIA Report. Statutory consultation was undertaken by MD-LOT as part of that scoping request and used to inform their Scoping Opinion, issued in September 2023 (see **Appendix 1-1**). **Table 6-1** summarises responses provided by consultees and where there are addressed, as required, in the sEIA Report.

Table 6-1 Summary of the scoping responses and where they are addressed in the sEIA Report.

Consultee	Comment	Where comment is addressed
Scottish Ministers	Sediment transportation has been scoped in for further assessment due to potential short term increases in suspended sediment concentrations during dredging activity of the approach channel and berth pocket and potential changes in seabed level. The content and approach must include a plume dispersion model linked to the hydrodynamic model outputs that will predict increases in suspended sediment concentrations due to the dredging process and the subsequent thickness and distribution of deposition on the seabed from the plume. Bathymetry has been scoped out as hydrodynamic modelling indicates that no further assessment is required.	Plume dispersion modelling has been used to predict increases in Suspended Sediment Concentrations (SSC) and the description of approach can be found in **Chapter 0**.
	Marine sediment and water quality has been scoped in and advised that a sediment sampling campaign is conducted prior to commencing dredging. With the results of this sampling presented within the sEIA Report along with an assessment of any predicted impacts.	Sediment sampling results can be found summarised in **Chapter 8.5** and **Appendix 8-3**.
	Potential ornithological impacts scoped in for further assessment are visual disturbance to birds caused by the increase in vessel activity at the deposit site and changes in water quality and prey availability as a result of the sediment plume arising from dredging. Previous concerns raised by NatureScot in relation to the impacts of using the Narrow Deep deposit site on the conservation objectives of the Outer Firth of Forth and St Andrews Bay Complex Special Protection Area should be considered.	These potential impacts have been considered in **Chapter 11.7**.
	Direct loss of benthic habitat/communities within the proposed dredge footprint, the release of contaminants during dredging and deposit and smothering of benthic communities as a result of the deposition of suspended sediment during dredging and deposit have been scoped in for further assessment in the sEIA Report.	These potential impacts have been considered in **Chapter 9**.
	Underwater noise during dredging activity, the potential for increased suspended sediment concentration during dredging and deposit and release of contaminants during dredging and deposit have been scoped in for further assessment in the sEIA Report.	These potential impacts have been considered in **Chapter 10.6; Chapter 11.7; Chapter 12.6**.

[3] *Confirmed via email communication dated July 2023 with MD-LOT*

Consultee	Comment	Where comment is addressed
	The potential for auditory injury and/or behavioural impacts from underwater noise during dredging works has been scoped in for further assessment in the sEIA Report. In addition, changes in water quality and prey availability as a result of sediment plume from dredging is also scoped in for further assessment. Any mitigation measures that are relevant to the Proposed Scheme must be included in the sEIA Report.	These potential impacts have been considered in **Chapter 10.6; Chapter 11.7; Chapter 12.6**.
	Scottish Ministers agree with the proposed approach and the list of projects to be included.	The list of projects can be found in **Chapter 13**.
	Where topics were scoped out of the sEIA Report, if relevant mitigation was identified in the 2022 EIA Report, this should be included in the sEIA Report.	**Noted**
	Marine archaeology and cultural heritage can be scoped out of further assessment but a geoarchaeological method statement and Protocol for Archaeological Discoveries will be produced.	**Noted**
Historic Environment Scotland (HES)	The Proposed Scheme will not result in significant impacts on its interests and therefore marine archaeology and cultural interests could be scoped out of the sEIA Report. HES welcomed the proposed consultation with it regarding the geotechnical method statement and the Protocol for Archaeological Discoveries should archaeological remains be identified during the dredging process.	**Noted**
Edinburgh City Council	Support was given for the proposed approach.	**Noted**
Marine Coastguard Agency	It is noted that the Port of Leith are responsible for the safety of shipping and navigation during the construction work and during the operational phase of the berth. The Marine Coastguard Agency would expect to see the works carried out in accordance with the Port Marine Safety Code and its Guide to Good practice. The port's Marine Safety Management System should be updated to incorporate the additional works. The Marine Coastguard Agency would expect any works below the MHWL to be subject to appropriate marine licensing conditions under the Marine Scotland Act 2010 and/or Marine and Coastal Access Act 2009.	**Noted**
Northern Lighthouse Board	Northern Lighthouse Board are content with the proposed sEIA scope and will respond in full to the Marine License application or variation.	**Noted**
NatureScot	Agree with the topics scoped into the EIA and the approach to assessments, which largely follow those carried out for the Outer Berth project EIA. It will be useful to summarise or refer to this information within the EIA document also, to keep all the information together for ease of reference.	**Noted.** The Outer Berth EIA report has been referenced where appropriate.
Scottish Environment Protection Agency (SEPA)	Based on the information provided, it appears that this application falls below the thresholds for which SEPA provide site specific advice.	**Noted**
Scottish Water	Scottish Water has no objection to this planning application; however, the applicant should be aware that this does not confirm that the Proposed Scheme can currently be serviced.	**Noted**
Ministry of Defence (MOD)	Following a review of the notification, the MOD Safeguarding confirm they have no objections to this activity however, it is requested that the Developer notifies our team at DIO-Safeguarding-Offshore@mod.gov.uk once all work is complete.	**Noted**

Consultee	Comment	Where comment is addressed
North and East Coast Regional Inshore Fisheries Group	The North and East Coast Regional Inshore Fisheries Group have no comments to make on this application.	**Noted**
Scottish Fishermen's Federation	Scottish Fishermen's Federation submits a nil response on this occasion.	**Noted**
Royal Yachting Association	The Royal Yachting Association Scotland agrees that tourism and recreation should be scoped out of the EIA.	**Noted**
MD-LOT	MD-LOT are content that commercial fisheries can be scoped out of the EIA. MD-LOT agree with the proposed approach of the assessment in regards to physical environment and coastal processes.	**Noted**, see **Chapter 7** for further assessment of the potential effects on coastal processes.
Marine Analytical Unit (MAU)	The report suggests to scope out socio-economics. The MAU agrees with this assessment.	**Noted**

7 Coastal Processes

7.1 Introduction

This chapter of the sEIA Report considers the potential effects of the Proposed Scheme in relation to coastal processes and details the assessment of the potential impacts during the construction and operational phases of the Proposed Scheme. The effects of the Proposed Scheme on both bedload processes (sediment particles transported in contact with the bed) and suspended sediment processes (sediment particles transported in suspension) are considered. Mitigation measures are described, if required, and a discussion of the residual impacts provided where significant impacts were identified.

7.2 Legislation, Policy and Guidance

Table 7-1 describes the relevant policy and guidance used to inform the assessment of potential impacts on coastal processes for the Proposed Scheme. The overarching policy and legislation driving this development are described in **Chapter 4** of this report.

Table 7-1 Summary of Relevant Policy and Guidance for Coastal Processes

Relevant policy or guidance	Relevance to the assessment
The Marine Policy Statement (HM Government, 2011) provides the high-level approach to marine planning and general principles for decision making that contribute to achieving this vision. It also sets out the framework for environmental, social, and economic factors that need to be considered in marine planning.	The key reference is in Section 2.6.8.6 which states: *"…Marine plan authorities should not consider development which may affect areas at high risk and probability of coastal change unless the impacts upon it can be managed. Marine plan authorities should seek to minimise and mitigate any geomorphological changes that an activity or development will have on coastal processes, including sediment movement."*
Scotland's National Marine Plan (Scottish Government, 2015) details strategic policies for the sustainable development of Scotland's marine resources out to 200 nautical miles.	Policy GEN 8 Coastal process and flooding states: Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding. Paragraph 4.36 states: Marine planners and decision makers should also be satisfied that activities and developments will be resilient to risks from coastal change and flooding over their lifetime and will not have an unacceptable impact on coastal change. They should seek to ensure that any geomorphological changes that an activity or development bring about in coastal processes, including sediment movement and wave patterns, are minimised, and mitigated, bearing in mind the potential impact on commercial interests such as fisheries and conservation of the natural environment and key coastal heritage sites. Developments which may affect areas at high risk and increase the probability of coastal change should not be permitted unless the impacts upon the area can be managed effectively.
National Planning Framework	Scotland's 4th National Planning Framework (Scottish Government, 2023) includes the following ambitions relevant to the marine environment at Leith: Policy 2 Climate mitigation and adaptation states: Development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible. Development proposals will be sited and designed to adapt to current and future risks from climate change. Development proposals to retrofit measures to existing developments that reduce emissions or support adaptation to climate change will be supported. Policy 10 Coastal development states:

Relevant policy or guidance	Relevance to the assessment
	Development proposals in developed coastal areas will only be supported where the proposal does not result in the need for further coastal protection measures taking into account future sea level change; or increase the risk to people of coastal flooding or coastal erosion, including through the loss of natural coastal defences including dune systems, and is anticipated to be supportable in the long-term, taking into account projected climate change.
Planning Policy Scotland	Planning policy for Scotland is set out in the document Scottish Planning Policy (Scottish Government, 2014). The planning policy document outlines the Scottish Government's approach to facilitating the delivery of the aims set out in the National Planning Framework. The relevant points within the policy relating to this chapter are: Conserve and enhance protected sites and species, taking account of the need to maintain healthy ecosystems and work with the natural processes which provide important services to communities. Promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way. Seek benefits for biodiversity from new development where possible, including the restoration of degraded habitats and the avoidance of further fragmentation or isolation of habitats.

7.3 Consultation

To inform this sEIA Report, a Scoping Opinion was requested from MD-LOT, which was issued in September 2023 (**Appendix 1-1**). Comments regarding coastal processes were received from MD-SEDD (Marine Directorate Science, Evidence, Data and Digital).

Table 7-2 Coastal processes consultation

Consultee	Date/Document	Comment	Responses/where addressed in the sEIA report
Scottish Ministers	Scoping Opinion – September 2023	Sediment transportation has been scoped in for further assessment due to potential short term increases in suspended sediment concentrations during dredging activity of the approach channel and berth pocket and potential changes in seabed level. The content and approach must include a plume dispersion model linked to the hydrodynamic model outputs that will predict increases in suspended sediment concentrations due to the dredging process and the subsequent thickness and distribution of deposition on the seabed from the plume. Bathymetry has been scoped out as hydrodynamic modelling indicates that no further assessment is required.	Assessment of potential increases in suspended sediment concentration has been undertaken using sediment dispersal modelling linked to hydrodynamic model outputs and found in Section 0
MD-SEDD	Scoping Opinion – September 2023	MD-SEDD are with the content and approach to the assessment of coastal processes proposed in the Scoping Report and advise that this must be included in the Supplementary EIA Report.	Noted. Section 0 sets out the assessment methodology used as part of this assessment.

7.4 Assessment Methodology

7.4.1 Hydrodynamic and Sediment Dispersion Modelling

Given the linkages that exist between coastal processes and a range of sensitive receptors over various spatial and temporal scales, it is vital that potential changes in these processes due to the Proposed Scheme are assessed robustly, but in a manner that is proportionate to the risks which are presented. The greatest risk concerns change to tidal current velocities and, in turn, morphological changes (bed shear stresses) to the seabed. The enlarged approach channel would result in changes to bathymetry, which in turn, may change tidal currents. These changes could potentially affect the sediment transport mechanisms and/or seabed morphology, the scale of which would be dependent upon the scale of the proposed change and the local physical conditions. Potential changes in these parameters due to the Proposed Scheme have been assessed using a hydrodynamic model to predict tidal current velocities and bed shear stresses. The model software used for this study was MIKE3-Flow Model, a three-dimensional hydrodynamic model developed by DHI.

Capital dredging would increase SSCs and deposition on the seabed and therefore plume dispersion modelling, linked to the hydrodynamic model outputs, was completed. To do this, the MIKE3-Flow Model model was coupled with the MIKE Mud Transport (MT) module to simulate sediment release, dispersion and deposition in 3D. The model predicts increases in SSC due to the dredging and disposal activities and the subsequent thickness and distribution of deposition on the seabed from the plume. The model was run for both sediment disturbance due to dredging and due to disposal at the designated disposal site.

Waves did not require modelling because they are relatively small across the approach channel and within the lee of the eastern breakwater. Changes to them caused by the Proposed Scheme would therefore be very small, and it was considered that there is a low level of risk of adverse effects. Although the final pattern of seabed change will be determined by the balance between settling (accretion) and the erosional forces created by local wind-generated waves, the proportionate approach to assessment of waves is a conceptual understanding and the use of expert judgement, without the need for numerical modelling.

This proposed combination of approaches is considered proportionate to the perceived risks to the surrounding environment. The combination of numerical modelling (hydrodynamic and sediment plume) and conceptual analysis (waves) provides the required inputs to the assessment of changes to hydrodynamics and coastal processes associated with the Proposed Scheme and for consequential effects, for example on benthic ecology.

7.4.2 Description of the Proposed Scheme used in the Modelling

The baseline bathymetry (including the consented Outer Berth development, which will have been completed prior to the deepening of the approach channel) is a gradually deepening seabed from the coast to -8m CD offshore, intersected by the existing approach channel (deeper than -7m CD but shallower than -8m CD) and berth pocket oriented north-northwest to south-southeast in the lee of the eastern breakwater and dredged to a depth of -9m CD as part of the consented Outer Berth development (**Figure 7-1**). The Proposed Scheme bathymetry would be an extension of the baseline approach channel (**Figure 7-2**). The depth would increase to -9m CD across a wider section of the seabed. The berth pocket would be deepened to -13m CD.

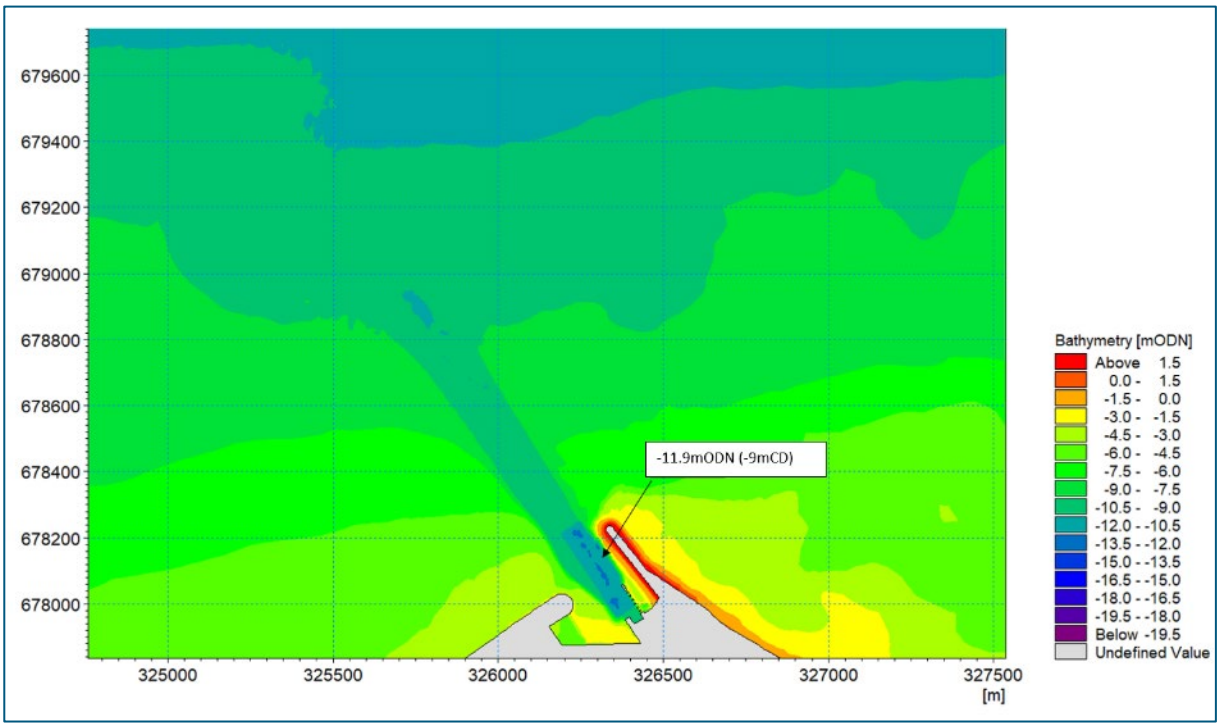


Figure 7-1 Baseline bathymetry of the Port of Leith approach channel and berth pocket (including the consented outer berth works)

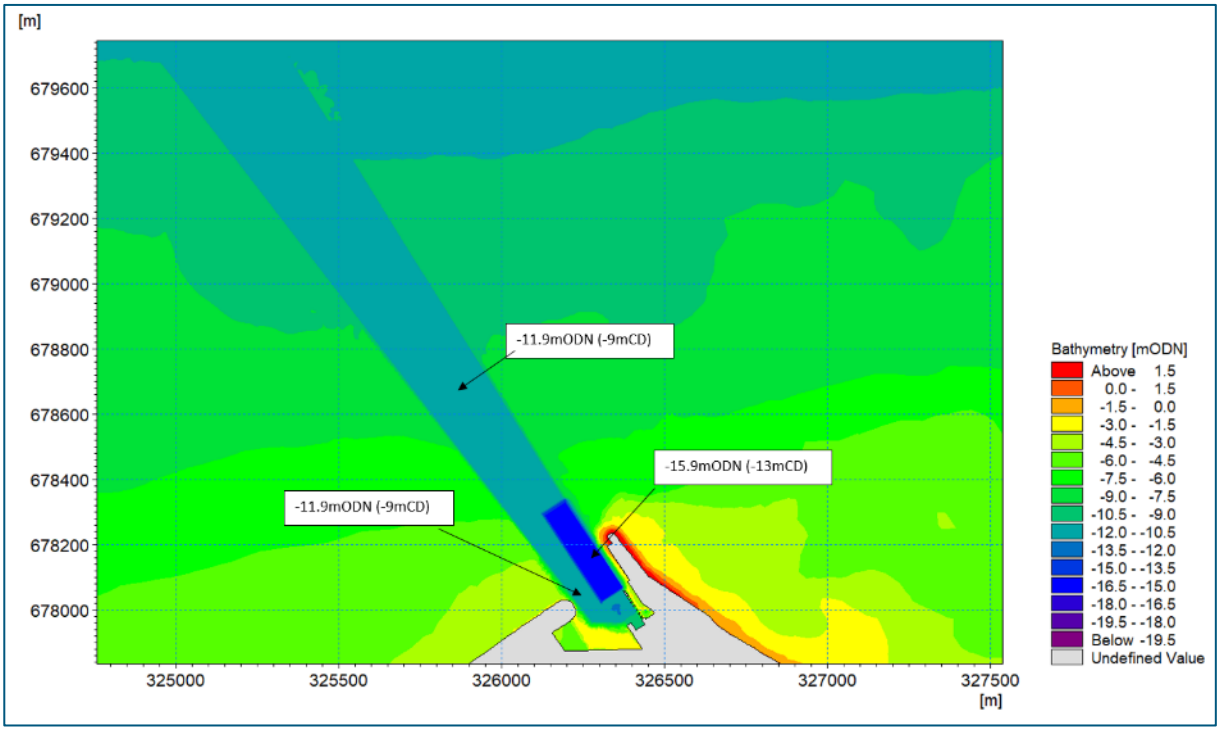


Figure 7-2 Proposed Scheme bathymetry of the Port of Leith approach channel and berth pocket

For the purposes of modelling, it has been assumed the capital dredge would be carried out by two TSHDs working simultaneously. A medium sized TSHD (vessel load of around 2,700m^3) would dredge in deeper areas including the approach channel to -9m CD and along the berth pocket to -13m CD. This TSHD would remove approximately 1,300,000m^3 of sediment. A smaller TSHD (vessel load of around 900m^3) would

dredge in the remaining shallower areas removing approximately 162,000m^3. The total dredging volume would be approximately 1,410,000m^3.

The proposed dredging would take approximately four months to complete with an anticipated 96 hours per week operational time. The TSHDs would transport the dredged sediment approximately 5km east-northeast to the disposal site at Narrow Deep B Spoil Disposal Ground (FO038). Each cycle was anticipated to take 137 minutes for the medium sized TSHD and 149 minutes for the small TSHD. For both TSHDs, the model operates with limited overflow, and it was assumed that the mass of sediment resuspended by the drag head per m^3 of dredged sediment will be 15kg/m^3. The model adopts this 'S-factor' of 15kg/m^3 based on the CIRIA guidelines (CIRIA, 1999). The model was simulated for 5.5 months (16 July 2022 to 1 January 2023) which considers the full dredging period and additional time after the dredging has finished to allow the sediment plume to disperse (six weeks) under spring-neap tidal variations.

Two sediment fractions are adopted in the modelling, one for sediment to be dredged by the medium sized TSHD and one for the small TSHD (**Table 7-3**). Sediment release rates for dredging and disposal input to the model were:

- Medium sized TSHD Dredging: 3.63kg/s;
- Medium sized TSHD Disposal: 7,200kg/s (assuming 1.6 Tonnes Dry Solids);
- Small TSHD Dredging: 1.11kg/s; and
- Small TSHD Disposal: 2,400kg/s (assuming 1.6 Tonnes Dry Solids).

Table 7-3 Sediment fractions used in the modelling

Sediment type	Medium TSHD Sediment %	Small TSHD Sediment %
Silt/Clay	64	82
Fine Sand	20	17
Medium Sand	3	1
Coarse Sand	3	0
Gravel/Cobble	10	0

As a worst-case scenario for sediment plume dispersion, a spatially and time constant wave climate was applied. Considering the dredgers that would be in operation, this wave climate is a 1m significant wave height, five second wave period and 60°N incident direction. The addition of waves in the model prolong sediment in suspension in the water column, as a conservative approach for sediment plume dispersion.

7.5 Baseline Physical and Sedimentary Environments

This section provides an overview of the key information from the assessment of the existing coastal processes environment. The approach taken has been to review existing relevant data and reports from Leith and surrounds, and formulate an understanding of the baseline coastal physical and sedimentary environments using expert-based assessment and judgement supported by the numerical modelling.

7.5.1 Tidal Currents and Bed Shear Stress

Regionally, tidal streams run approximately parallel to the coast and are east-northeast to west-northwest (into the Firth of Forth) during the flood tide and west to east (out of the Firth of Forth) during the ebb tide (British Geological Survey, 1986). Currents are relatively strong in mid-channel (enough to transport and erode fine sediment) but are weaker in the nearshore zone close to the Proposed Scheme.

FugroEMU (2013a) deployed four acoustic current profilers offshore from the Port of Leith for 30 days at the end of 2012/early 2013 to capture data on current speed and direction (**Figure 7-3)**. They showed that the tidal current floods in a west-southwest direction and ebbs in an east-northeast direction; however, the current speed and direction can be disturbed by non-tidal river discharge when the current direction on much of the flood tide can remain easterly (i.e. out of the Firth of Forth). The maximum recorded tidal current speed was 1.27m/s near the water surface at Site 1. Maximum near-bed tidal current speeds (potential driver of bedload sediment transport) reached 0.57m/s at Site 1 and 0.41m/s at Site 2. The statistics at Sites 1 and 2 closest to the outer berth are presented in **Table 7-4** and **Table 7-5**.

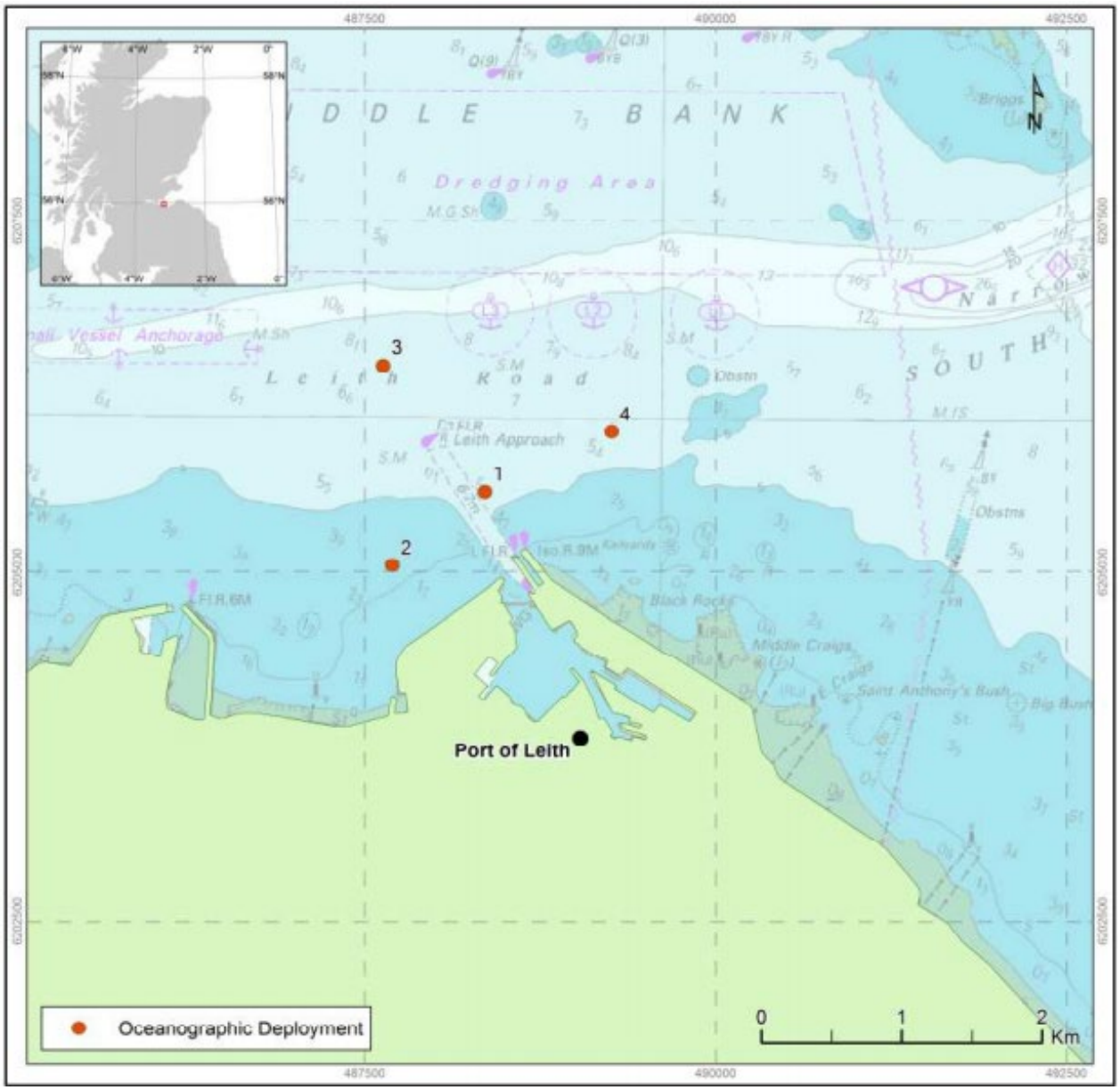


Figure 7-3 Locations of acoustic current profiler deployments in 2012 (FugroEMU, 2013a)

Table 7-4 Current statistics for Site 1 (FugroEMU, 2013a). Location is shown on Figure 7-3

Statistic	Depth-averaged	Surface (0-0.5m)	Mid (5.0-5.5m)	Near-bed (1.0-1.5m)
Maximum tidal current speed	0.70	1.27	0.71	0.57
Mean spring tide speed (m/s)	0.47	0.63	0.50	0.34
Mean neap tide speed (m/s)	0.25	0.40	0.25	0.18
Flood direction (°N)	246	247	248	240
Ebb direction (°N)	66	67	68	60

Table 7-5 Current statistics for Site 2 (FugroEMU, 2013a). Location is shown on Figure 7-3

Statistic	Depth-averaged	Surface (0-0.5m)	Mid (5.0-5.5m)	Near-bed (1.0-1.5m)
Maximum tidal current speed	0.49	0.72	0.46	0.41
Mean spring tide speed (m/s)	0.32	0.36	0.31	0.24
Mean neap tide speed (m/s)	0.17	0.22	0.15	0.13
Flood direction (°N)	255	265	251	245
Ebb direction (°N)	75	85	71	65

Arup (2007) indicated that an eddy forms in the approach channel at the end of the eastern breakwater, which peaks a couple of hours after high water and a couple of hours after low water. Measurements taken by the Port of Leith in July 1999 indicate a maximum current of 0.44m/s on the spring tide and 0.41m/s on the neap tide. The direction of these currents depends on location. About 100m from the end of the eastern breakwater the current flows 10°N and 190°N depending on the state of the tide, and at 300m from the end of the breakwater, the current flows approximately 310-320°N and 110-130°N depending on the state of the tide.

7.5.1.1 Spring Tide Flow Distribution

The predicted spring tide peak flood currents typically flow from east to west at speeds of 0.5-0.6m/s across the approach channel (**Figure 7-4**). Either side of the channel the velocities are slightly higher between 0.6m/s and 0.7m/s. The predicted velocities across the channel are slower because the water is deeper (**Figure 7-2**). There are local complexities in the port basin where tidal currents are slower between the eastern and western breakwaters. Here, there is a predicted reversal in flow direction (west to east, up to 0.5m/s) along the coast west of the berth pocket, and a predicted south to north flow (up to 0.3m/s) adjacent to the berth pocket. Elsewhere, in the port basin, flows are predicted to be less than 0.1m/s.

The predicted spring tide peak ebb currents typically flow from west-southwest to east-northeast. Speeds reduce from 0.5-0.6m/s across the outer part of the existing approach channel to about 0.3m/s closer to the berth pocket (**Figure 7-5**). To the west of the channel, predicted velocities are like those across the outer channel and slightly higher (0.6-0.7m/s) to the east of the channel. Within the port basin and berth pocket, flows are predicted to be less than 0.1m/s. There is an increase in predicted current velocities to greater than 1.0m/s around the tip of the eastern breakwater.

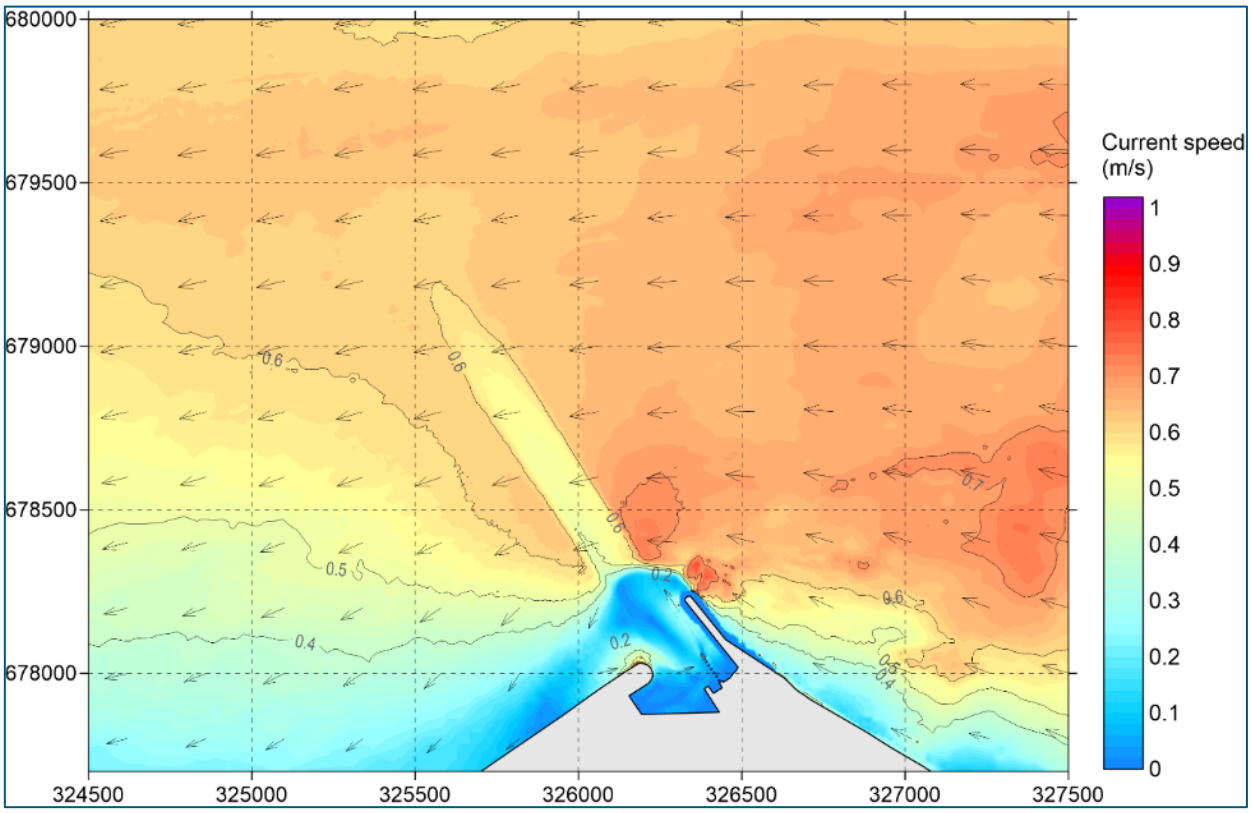


Figure 7-4 Predicted baseline spring tide peak flood currents

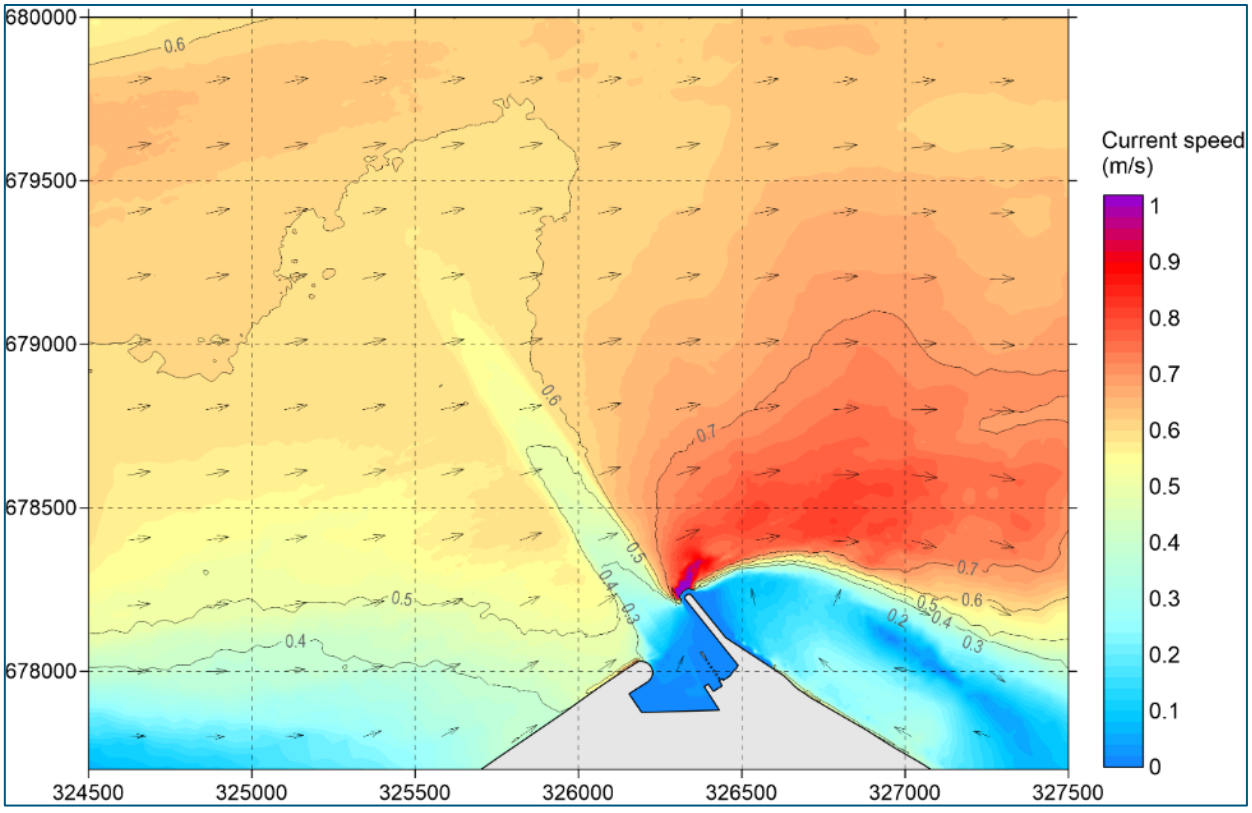


Figure 7-5. Predicted baseline spring tide peak ebb currents

7.5.1.2 Spring Tide Bed Shear Stress Distribution

The predicted spring bed shear stress on a peak flood tide is between 0.27N/m^2 and 0.50N/m^2 in the existing approach channel **(Figure 7-6)**. These values reduce to less than 0.18N/m^2 in the port basin and berth pocket. Either side of the approach channel, the bed shear stress is higher at 0.50-1.23N/m^2. For the peak spring ebb tide, bed shear stresses are generally lower than the flood tide predictions **(Figure 7-6)**. Bed shear stress is 0.27-0.50N/m^2 in the outer channel, reducing to 0.18-0.27N/m^2 in the central channel, and less than 0.18N/m^2 in the inner channel, port basin and berth pocket. In both cases, the bed shear stress magnitudes mimic the flow speed magnitudes, whereby lower current speeds are associated with lower bed shear stresses.

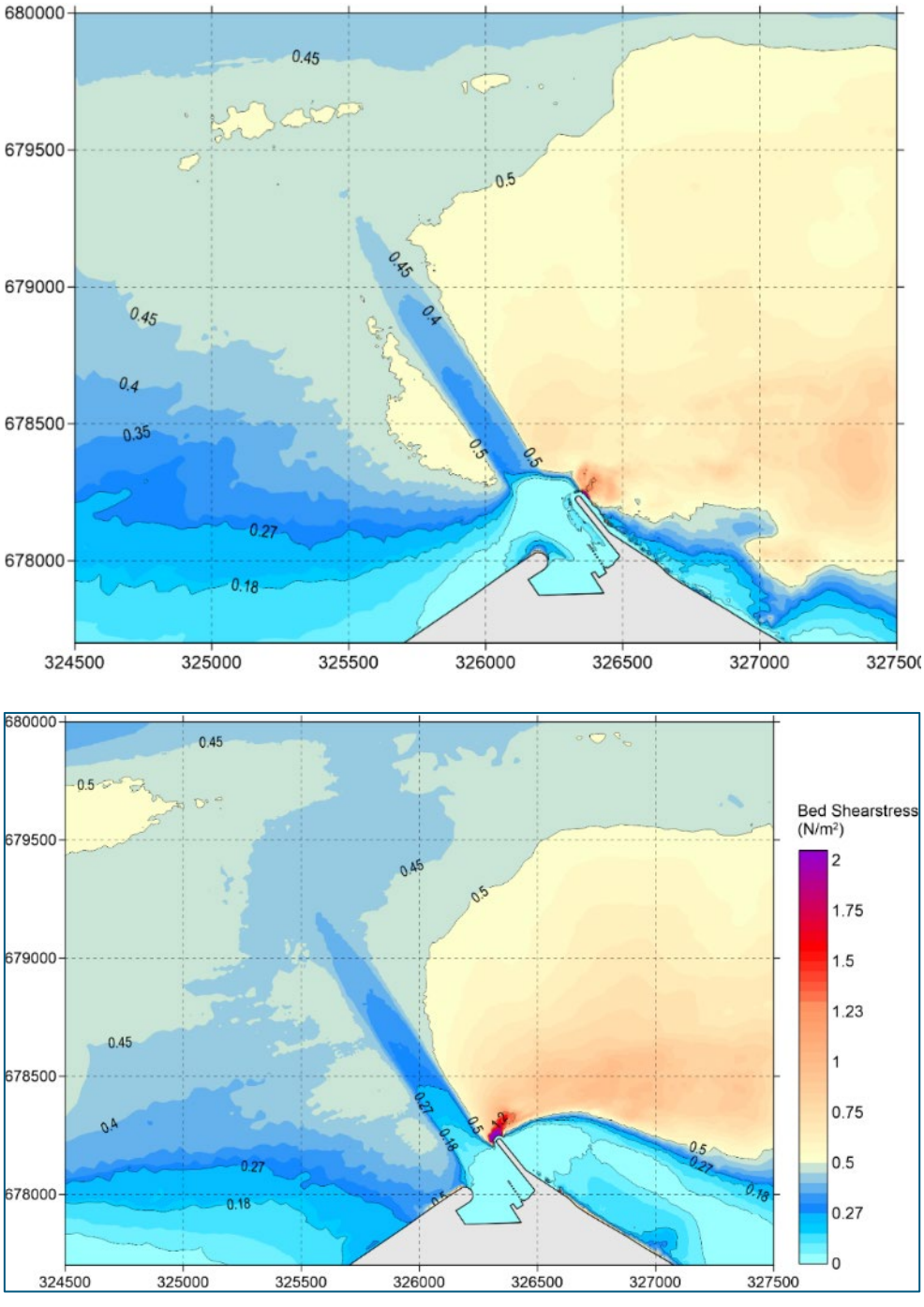


Figure 7-6 Predicted baseline spring tide peak flood bed shear stress (top) and spring tide peak ebb bed shear stress (bottom)

7.5.2 Waves

The predominant waves approach the Port of Leith coast from the east to east-northeast sector (from the North Sea). These waves drive longshore sediment transport to the west at the Proposed Scheme. The waves are composed of two distinct components (HR Wallingford, 2007). These are short period waves generated by winds blowing across the Firth of Forth and longer period swell waves generated further offshore modified (reduced) by the sheltering effects of the adjacent coast and refraction as they propagate through the Firth of Forth.

Using a hindcast dataset from 1987 to 2006, HR Wallingford (2007) showed that the nearshore wave conditions are relatively benign with fewer than 0.1% of significant wave heights predicted to be greater than 2m. The larger waves (significant wave heights greater than 1.2m) had peak periods less than seven seconds. Longer period waves do penetrate the site, with peak periods as high as 17 seconds, but the longest waves (periods greater than 12 seconds) tend to be associated with relatively small waves (significant wave heights less than 0.6m).

Wave data were collected at Site 3 (**Figure 7-3**) by FugroEMU (2013a). General statements on wave conditions were provided. Maximum significant wave heights during calm conditions were less than 0.5m. Three periods of elevated wave heights were recorded, during which significant wave heights increased to up to 1m with maximums between 1.25m and 2.9m.

7.5.3 Regional Sediment Distribution

FugroEMU (2013b) completed a grab sample survey in the nearshore around the Port of Leith between the 17 and 20 November 2012 and on 29 November 2012. The particle size distributions can be divided into three distinct areas (**Figure 7-7**). West of the approach channel (outside the entrance of Granton Harbour to the entrance channel of the Port of Leith), the dominant sediment is silt (less than 63 microns) with subordinate very fine to fine sand and gravel. They predominantly contain 0-6% gravel, 16-41% sand and 59-80% mud. To the east of the approach channel (offshore from the Port of Leith between the entrance channel and Black Rocks), silt is still dominant, but the percentage of gravel increases relative to sand. They predominantly contain 1-77% gravel, 19-98% sand and 1-48% mud. East of the Black Rocks, very fine to fine sand is dominant with subordinate gravel.

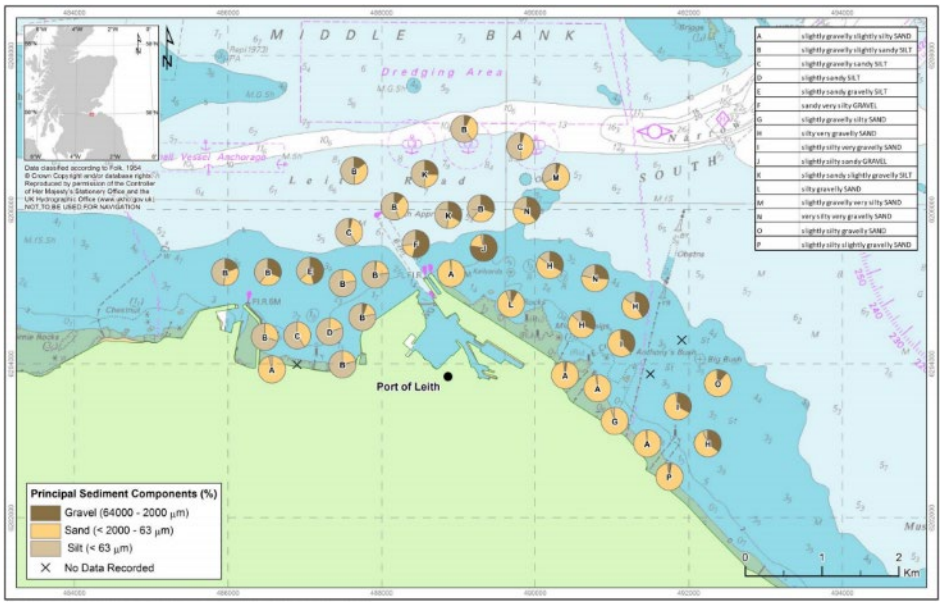


Figure 7-7 Location and sediment classifications at each of the grab samples recovered by FugroEMU (2013b) in November 2012

7.5.4 Outer Berth Sediment Distribution

Eight vibrocores were recovered by Dunelm (2021) in October 2021 at stations as part of the Outer Berth development (**Figure 7-9**). The recovered sequence composed Recent (mobile) sediment overlying diamicton. Subsamples for particle size analysis were taken at the surface, full recovery depth and at least one mid-depth layer. Where cores were less than 0.75m long, subsamples were taken at the surface and at full depth. Most of the samples taken from the Recent sediments are dominated by mud (56-81%) with sand comprising 19-39%, and gravel 0-5%. Dunelm (2023) collected a further 17 vibrocores in May 2022 at stations adjacent to the outer berth (**Figure 7-9**). Most of the samples taken from the Recent sediments are dominated by mud (46-99%) with sand comprising 1-54%, and gravel 0-4%.

7.5.5 Approach Channel Sediment Distribution

Causeway Geotech (2023) collected 14 vibrocores in August 2023 within the proposed dredge footprint of the approach channel (**Figure 7.8**). Subsamples for particle size analysis were taken from each station at the surface layer (0-0.15m), full-depth (limited by the glacial diamicton level) and at 0.5m intervals between. Five vibrocores (VC08-VC12) were terminated at scheduled depth. Six vibrocores (VC01-VC04, VC13 and VC14) met shallow refusal, no second attempt was made due to the material encountered at the bottom of the sampler (diamicton). Three vibrocores (VC05-VC07) met shallow refusal in predominately diamicton, except VC05 where refusal was met in dense sand (likely to be glacial sand). Most of the samples taken from the Recent sediments are dominated by mud (33-98%) with sand comprising 2-54%, and gravel 0-27%. The Recent sediments in the approach channel contain more gravel than those at the Outer Berth.

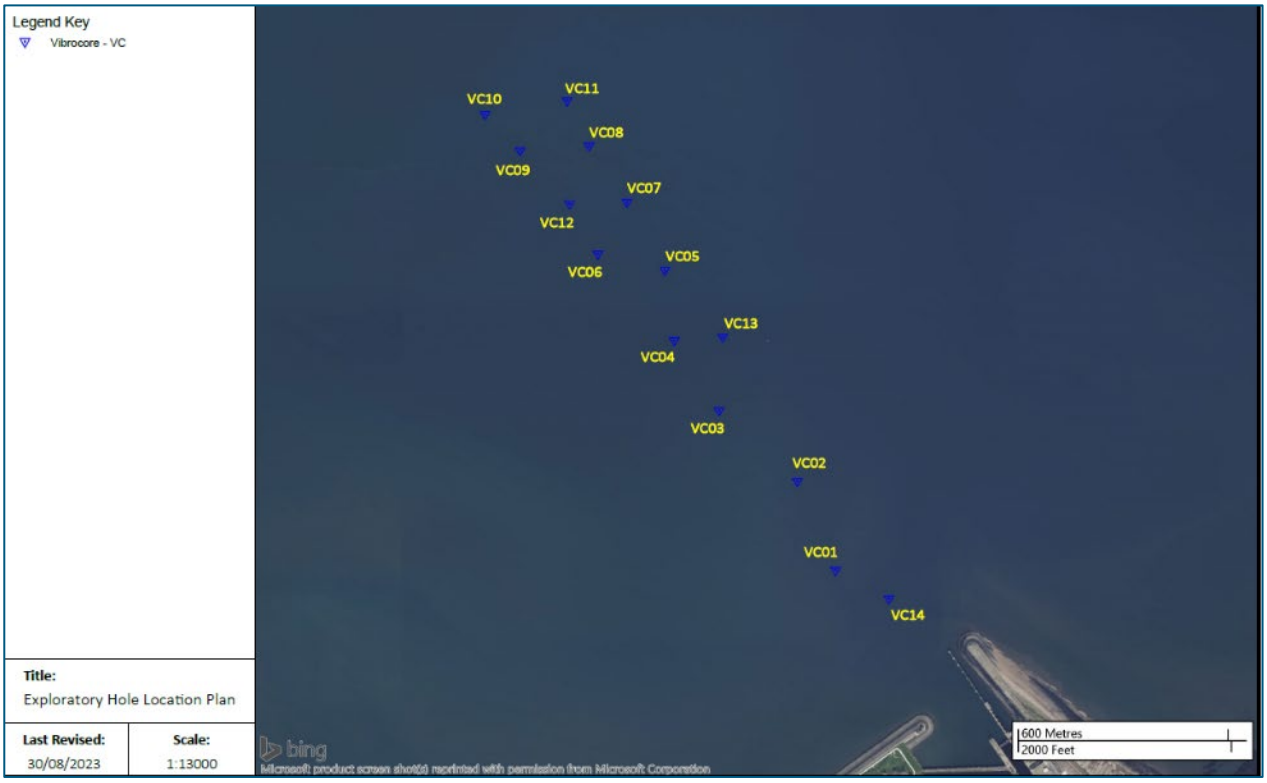


Figure 7-8 Locations of vibrocores collected in August 2023 in the dredge footprint of the approach channel (Causeway Geotech, 2023)

Figure 7-9. Locations of the eight vibrocores (VC01-VC08) collected in October 2021 in the outer berth (Dunelm, 2021) (left) and 17 vibrocores collected in the outer berth in May 2022 (Dunelm, 2023) (right)

7.5.6 Historic Maintenance Dredge Volumes in the Approach Channel

The Port of Leith is licensed to dispose of dredged sediment annually in the Narrow Deep Channel. Forth Ports provided maintenance dredge volumes from the approach channel and from within the dock area between 2001 and 2021. Between 2001 and 2017, the recorded volumes were the combined dredging of the approach channel and within the dock (**Table 7-6**), whereas between 2018 and 2021 the volumes are for the approach channel only (**Table 7-7**). Most of the deposition within the dock was derived from supply from Water of Leith, whereas the sediment removed from the approach channel was supplied by marine/coastal sediment transport. The predominance of silty sand in the approach channel suggests that the deposition mechanism could be a combination of deposition from suspension in the water column and deposition by sediment transport processes along the bed; however, the proportion deposited by each mechanism is not known.

Table 7-6 Annual maintenance dredge volumes from the approach channel and dock combined (data from Forth Ports)

Year	Volume (m^3)	Year	Volume (m^3)
2001	65,719	2010	23,574
2002	23,820	2011	21,597
2003	21,689	2012	0
2004	10,162	2013	0
2005	0	2014	25,930
2006	14,096	2015	18,966
2007	3,173	2016	47,957
2008	28,412	2017	0
2009	28,241	-	-
Average 2001-2017	**19,608**		

Table 7-7 Annual maintenance dredge volumes from the approach channel (data from Forth Ports)

Year	Volume (m^3)
2018	22,468
2019	6,780
2020	28,342
2021	8,523 (partial)
Average 2018-2020	**19,197**

The annual combined volumes (2001 to 2017) range from 0m^3 to 65,719m^3 with an average of 19,608m^3. The annual volumes dredged from the approach channel (2018 to 2020) range from 6,780m^3 to 28,342m^3 with an average of 19,197m^3. These volumes suggest that most of the sediment is removed from the approach channel with very small volumes from inside the dock; hence, the longer-term average volume of maintenance dredging from the approach channel has been about 20,000m^3/year. This dredging rate can be used as a proxy for the rate of sediment transport into the approach channel. The mix of mud, sand and gravel in the approach channel suggests that the deposition mechanism could be a combination of deposition from suspension in the water column and deposition by sediment transport processes along the bed.

Upon completion of the consented Outer Berth development (the baseline for the Proposed Scheme), the maintenance dredge requirement for the entire channel was predicted in the Outer Berth EIA Report to increase by 22% (Royal HaskoningDHV, 2022). This equates to an annual predicted baseline average volume of about 24,000m^3.

7.5.7 Bedload Sediment Transport

Ramsay and Brampton (2000) indicated that longshore transport of sediment is dominated by wave action from the North Sea which results in a net westerly movement of sediment along the southern coast of the Firth of Forth. The net rate of longshore sediment transport at and adjacent to the Port of Leith is low (Ramsay and Brampton, 2000; HR Wallingford, 2004). This is because along Leith Sands the coast is oriented approximately perpendicular to the predominant wave approach direction.

Sand has accreted along the outer face of the eastern breakwater since it was constructed. It is possible that some of the nourished sand from Portobello Beach is transported west along the coast to the Leith Sands frontage. A small volume of the bedload sediment from Leith Sands is transported around the end of the eastern breakwater and deposited in the approach channel (HR Wallingford, 2004). However, the limited volume suggests that there is not a large flux of wave-driven bedload sediment in a westerly direction across the port entrance. There will also be reversals of transport due to locally generated waves from the west.

7.5.8 Suspended Sediment Concentrations

FugroEMU (2013a) deployed four optical backscatter sensors offshore from the Outer Berth (at the same locations as the acoustic current profilers, **Figure 7-3**) to capture data on SSC. Wave data were also collected at Site 3 to assist in the quality control of the turbidity time series data. During calm wave conditions near-bed SSC of 10-50mg/l were recorded (**Figure 7-10**). This period was characterised by maximum wave heights less than 0.5m (at Site 3). During the first period of elevated wave heights, near-bed SSC increased to approximately 1,300mg/l, 1,100mg/l, 600mg/l and 200mg/l at Sites 1, 2, 3 and 4, respectively. During the second period of high waves, the SSC reached approximately 1,000mg/l at Sites 1, 2 and 3 whilst at Site 4 the concentration peaked at around 700mg/l. During the third period SSC peaked at 500mg/l at Sites 1, 2 and 4, and 200mg/l at Site 3.

The data shows that re-suspension of sediment from the seabed resulting in very high SSC above ambient conditions is caused by increased wave heights. After the sediment is elevated into the water column by this process, it is transported past the eastern breakwater by tidal currents on the flood tide and by wave induced flows (typically during easterly weather, HR Wallingford, 2004). On the flood tide it is likely that a large-scale eddy forms in the lee of the eastern breakwater (Arup, 2007) that traps some of the suspended sediment that bypasses the eastern breakwater allowing it to settle and deposit in the inner approach channel and Outer Berth (ERM, 2021).

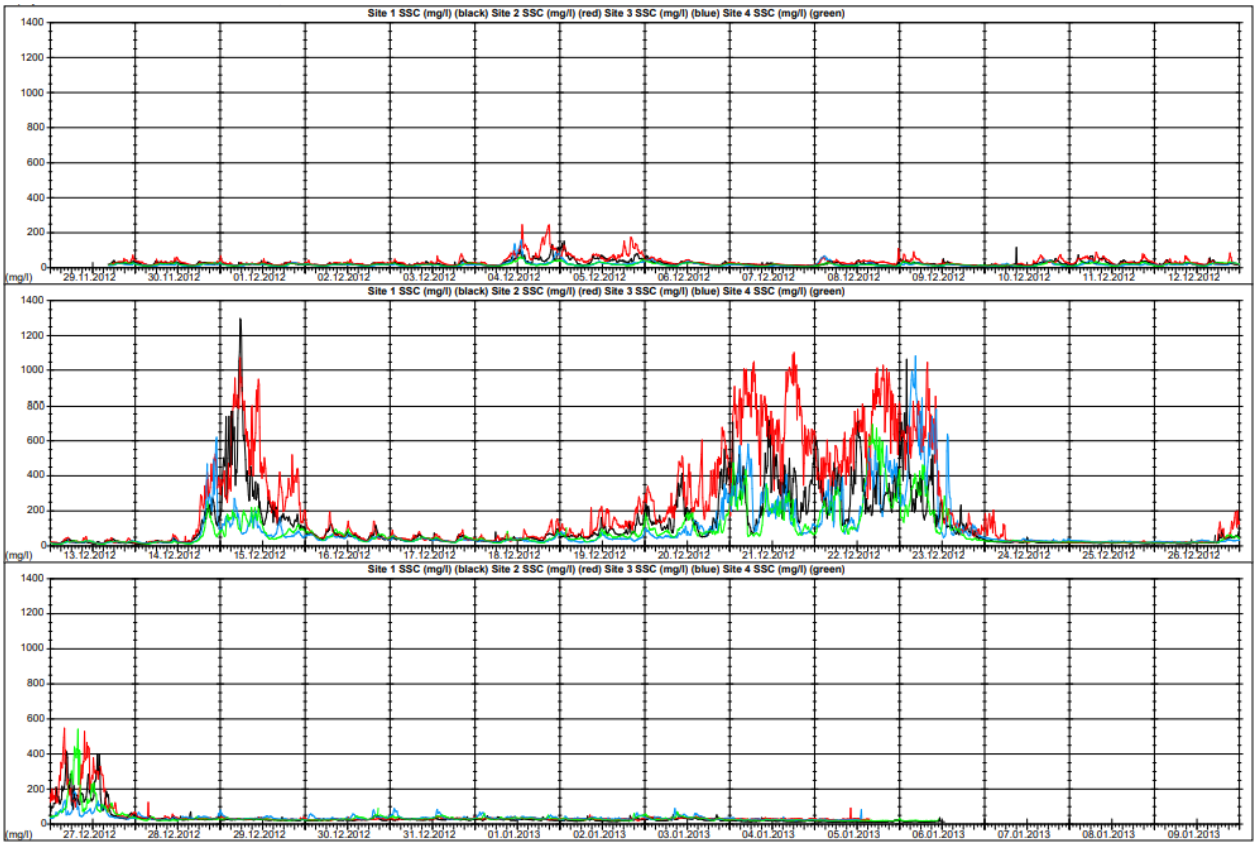


Figure 7-10 Suspended sediment concentrations at Sites 1 (black), 2 (red), 3 (blue) and 4 (green) between 29 November 2012 and 6 January 2013 (FugroEMU, 2013a)

7.6 Prediction of Potential Significant Effects During the Construction Phase

7.6.1 Changes in Suspended Sediment Concentrations due to Capital Dredging of the Approach Channel and Berth Pocket

Seabed sediments would be disturbed leading to short term increases in SSC during capital dredging of the approach channel and berth pocket, and sediment disposal. The mobilised sediment from these activities would be transported and dispersed by tidal currents (and waves) in suspension in the water column.

The results of the sediment plume modelling have been presented as plots showing predicted maximum SSC at any time throughout the simulation at the near bed, mid and surface water layers (**Figure 7-11**, **Figure 7-12** and **Figure 7-13**). The results show that the largest changes in SSC would be related to disposal activities. Predicted maximum SSC are highest in the bottom layer reducing through the water column to the sea surface. Concentrations could exceed 18,000 mg/l in the bottom layer directly over the disposal site reducing to less than 500mg/l in the surface layer. Maximum predicted concentrations also decline away from the disposal site along the tidal current directions to values less than 150mg/l about 5km east-northeast and 5km west-southwest from the centre of the site.

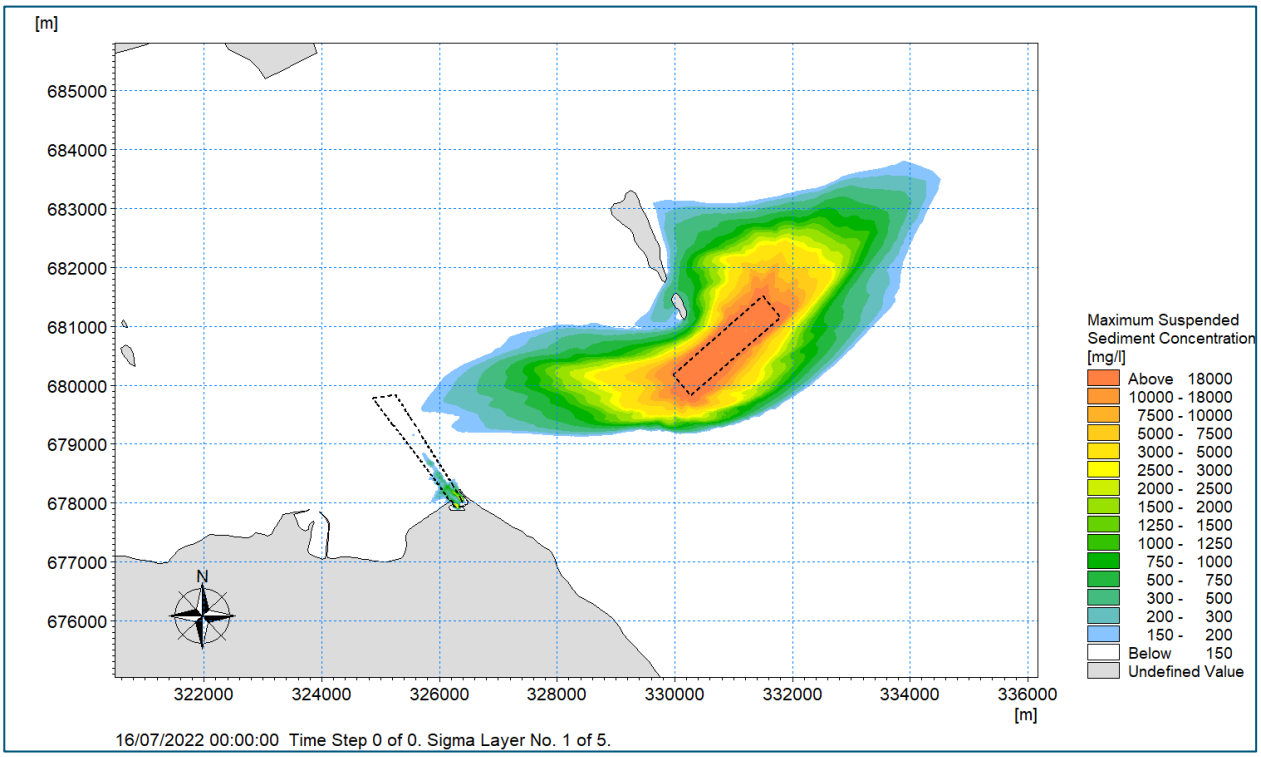


Figure 7-11 Maximum suspended sediment concentrations above ambient conditions in the bottom layer

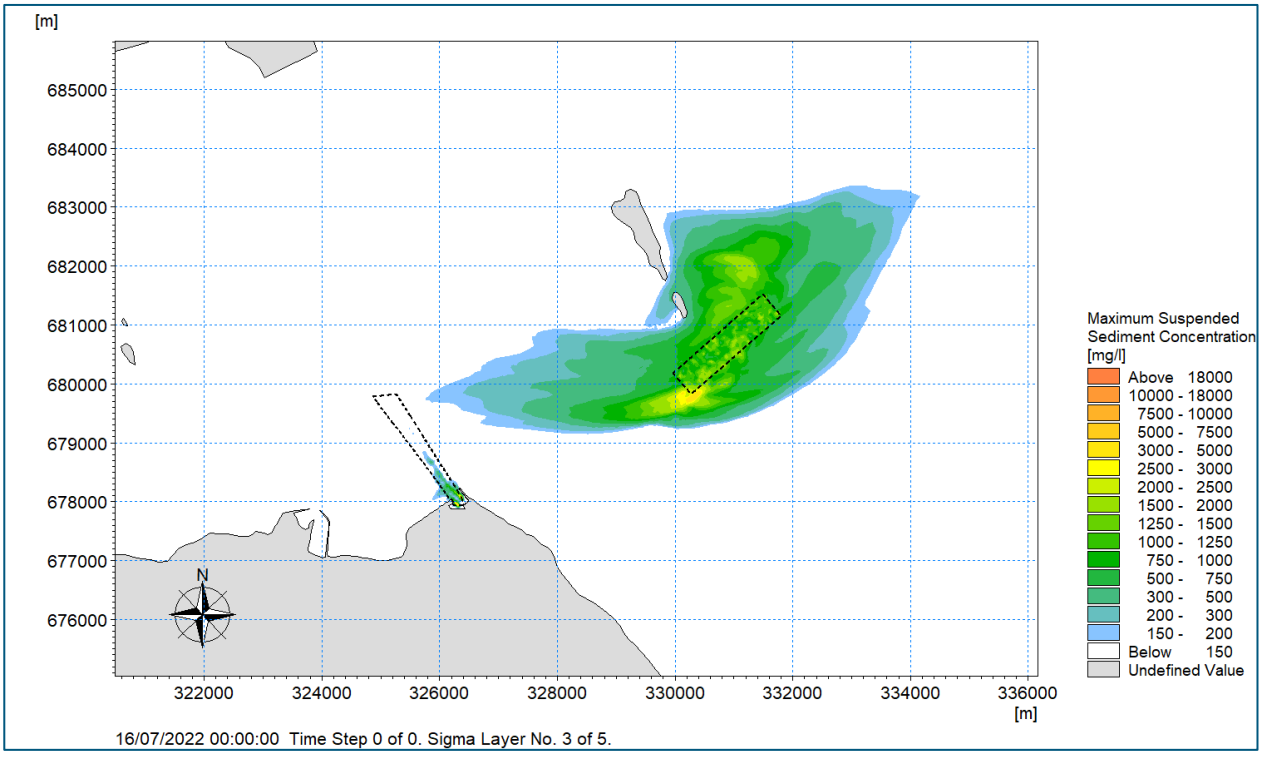


Figure 7-12 Maximum suspended sediment concentrations above ambient conditions in the mid layer

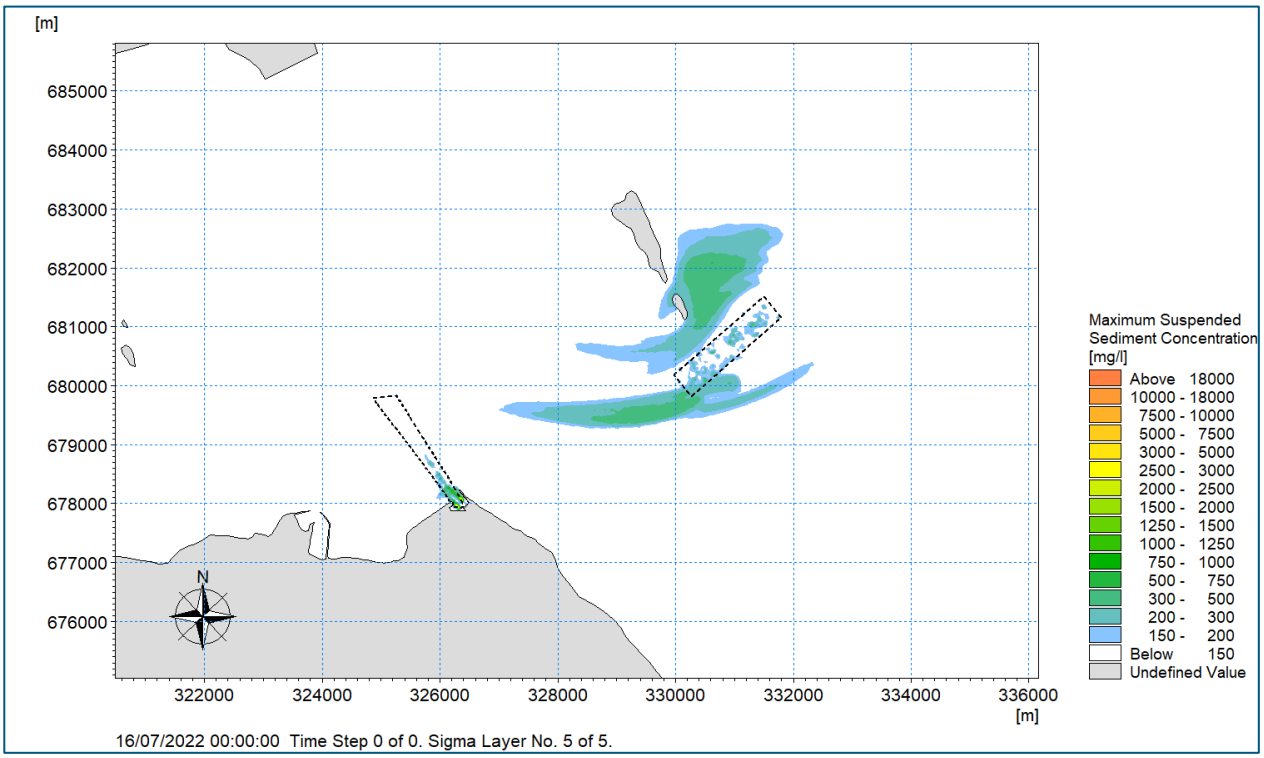


Figure 7-13. Maximum suspended sediment concentrations above ambient conditions in the surface layer

The model outputs from three selected sites (Points 1 to 3 on **Figure 7-14)** were analysed to predict the time series of SSC during the dredging and disposal activities, and after the cessation of activities, at:

- P1: the centre of the disposal site;
- P2: mid-way between the disposal site and the approach channel; and
- P3: the seaward end of the approach channel.

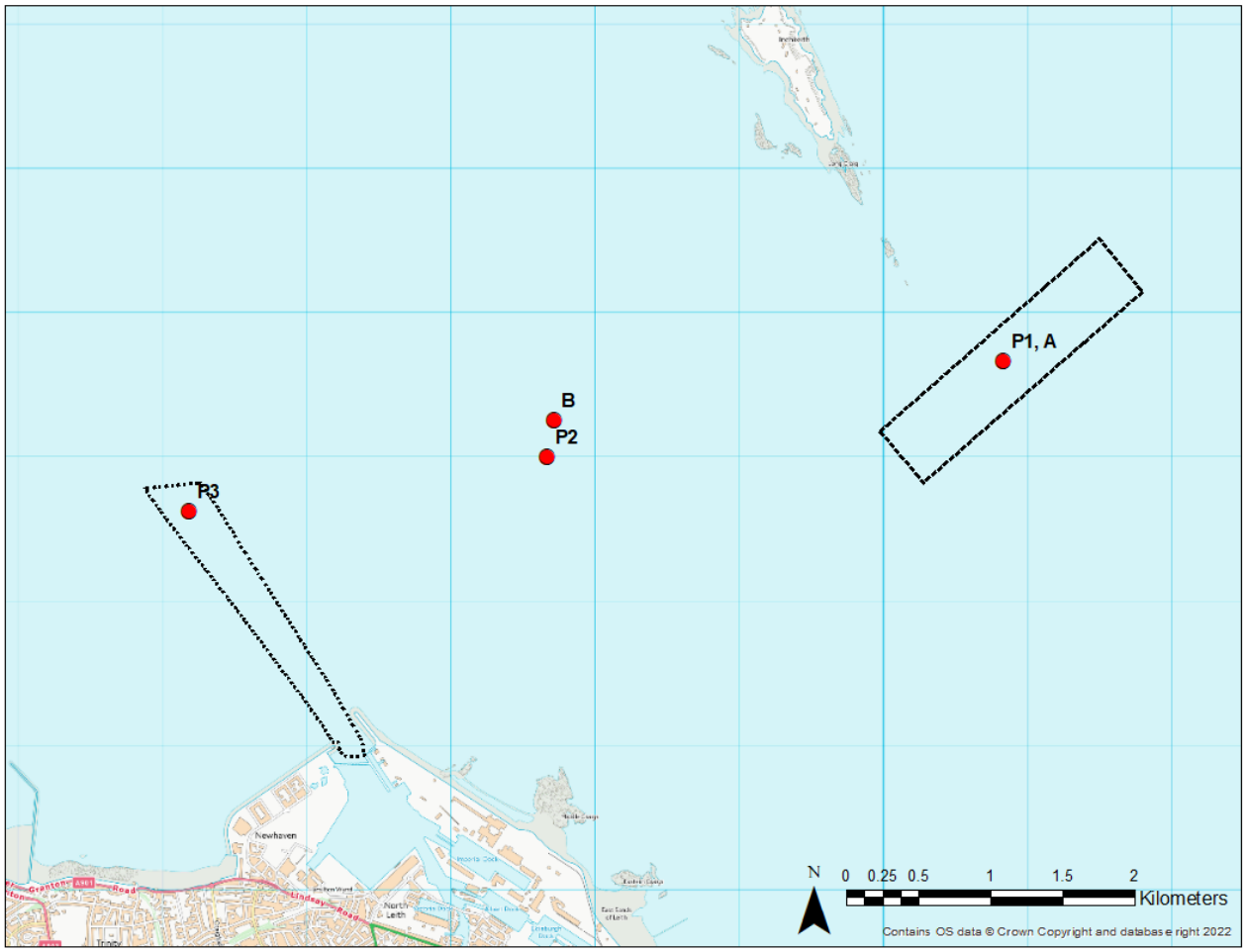


Figure 7-14 Location of points for time series analysis of suspended sediment concentrations (P1-P3) and seabed level (A and B)

Dredging and disposal would take place over approximately four months. The sediments suspended as a result of these activities have been predicted to disperse and decrease to within background levels in less than one hour after each phase of dredging and disposal activities ceases, including after all activities cease (**Figure 7-15, Figure 7-16** and **Figure 7-17**). The numerical modelling includes approximately seven vessel movements associated with dredge and disposal, therefore results in SSC elevated beyond background for approximately seven hours on the days of dredge and disposal operations.

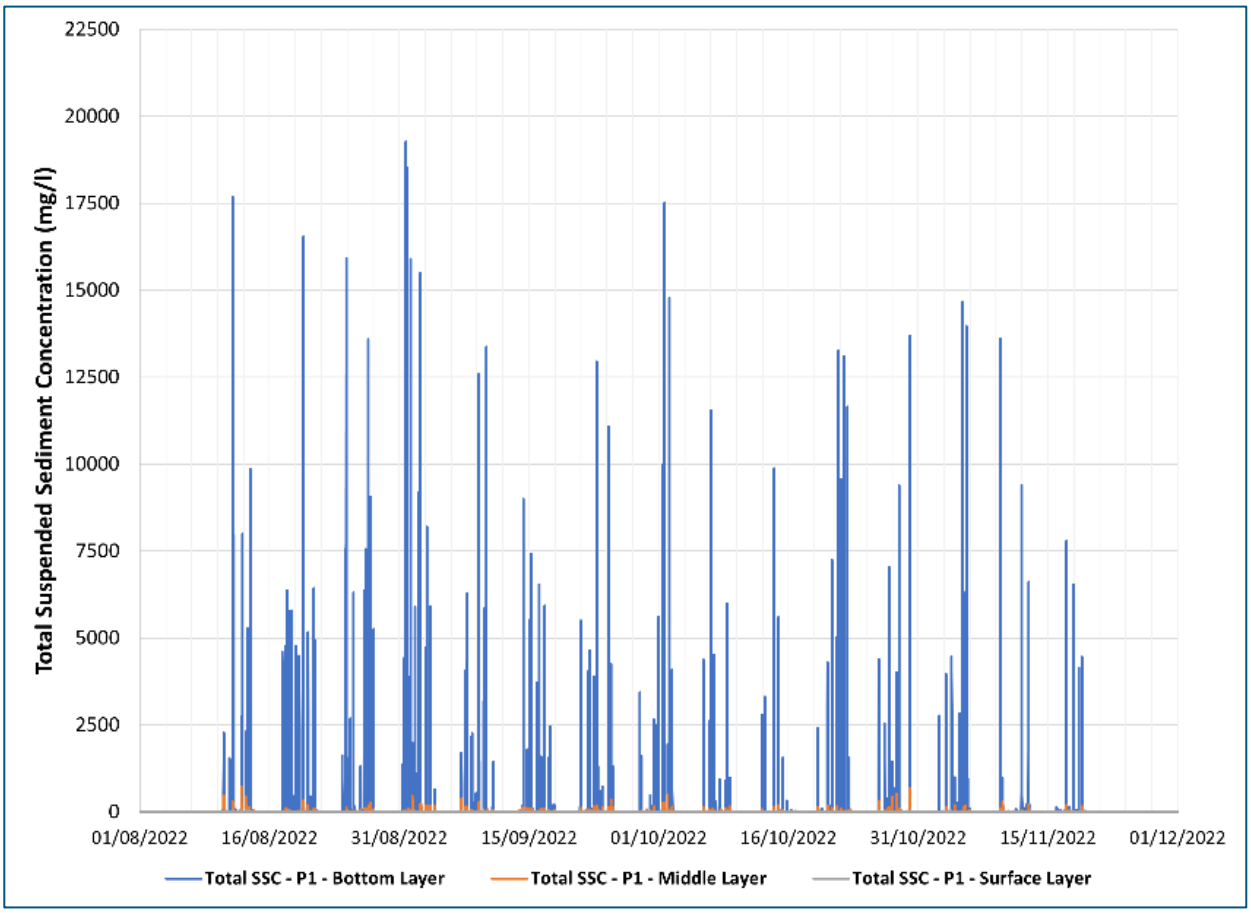


Figure 7-15 Time series of suspended sediment concentrations at P1, shown on Figure 7-14

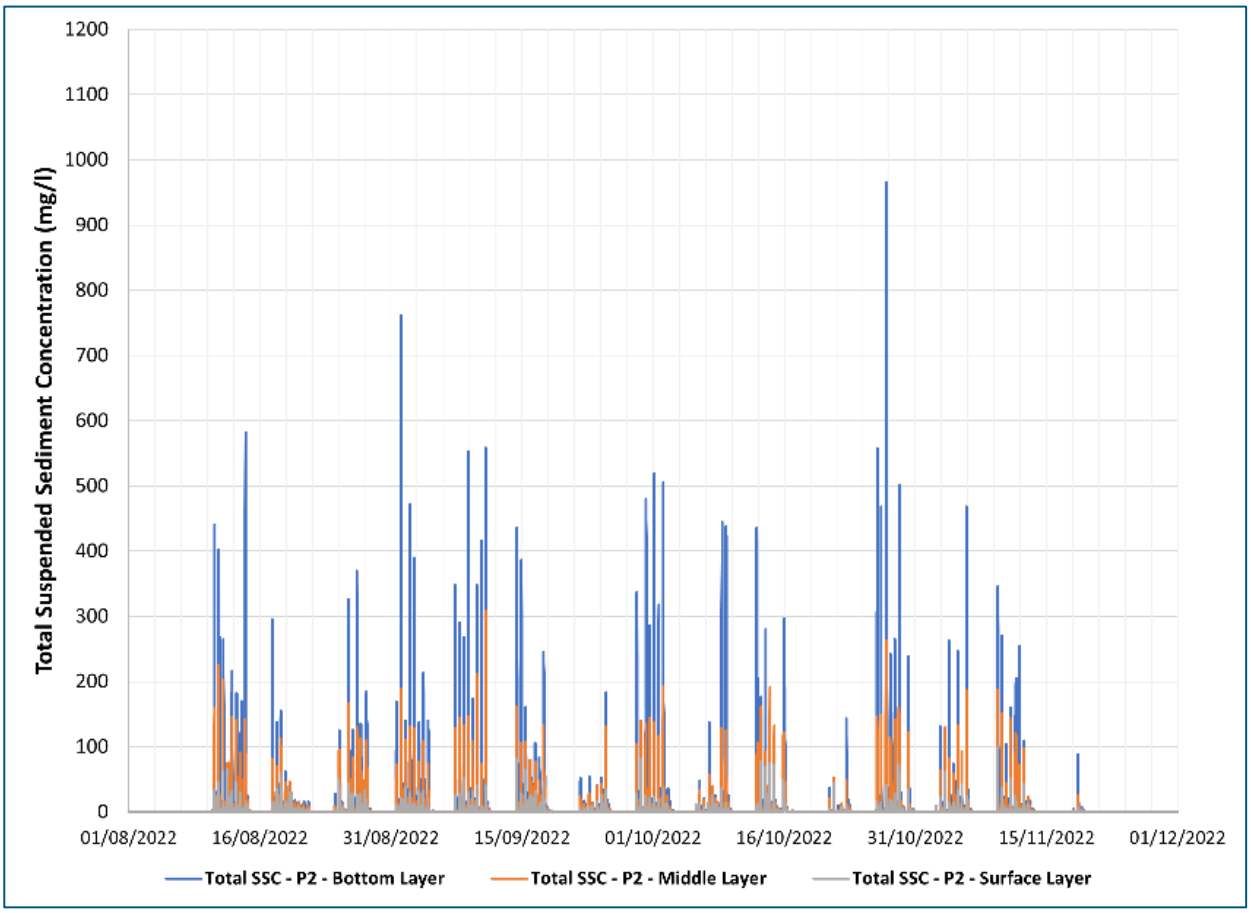


Figure 7-16 Time series of suspended sediment concentrations at P2, shown on Figure 7-14

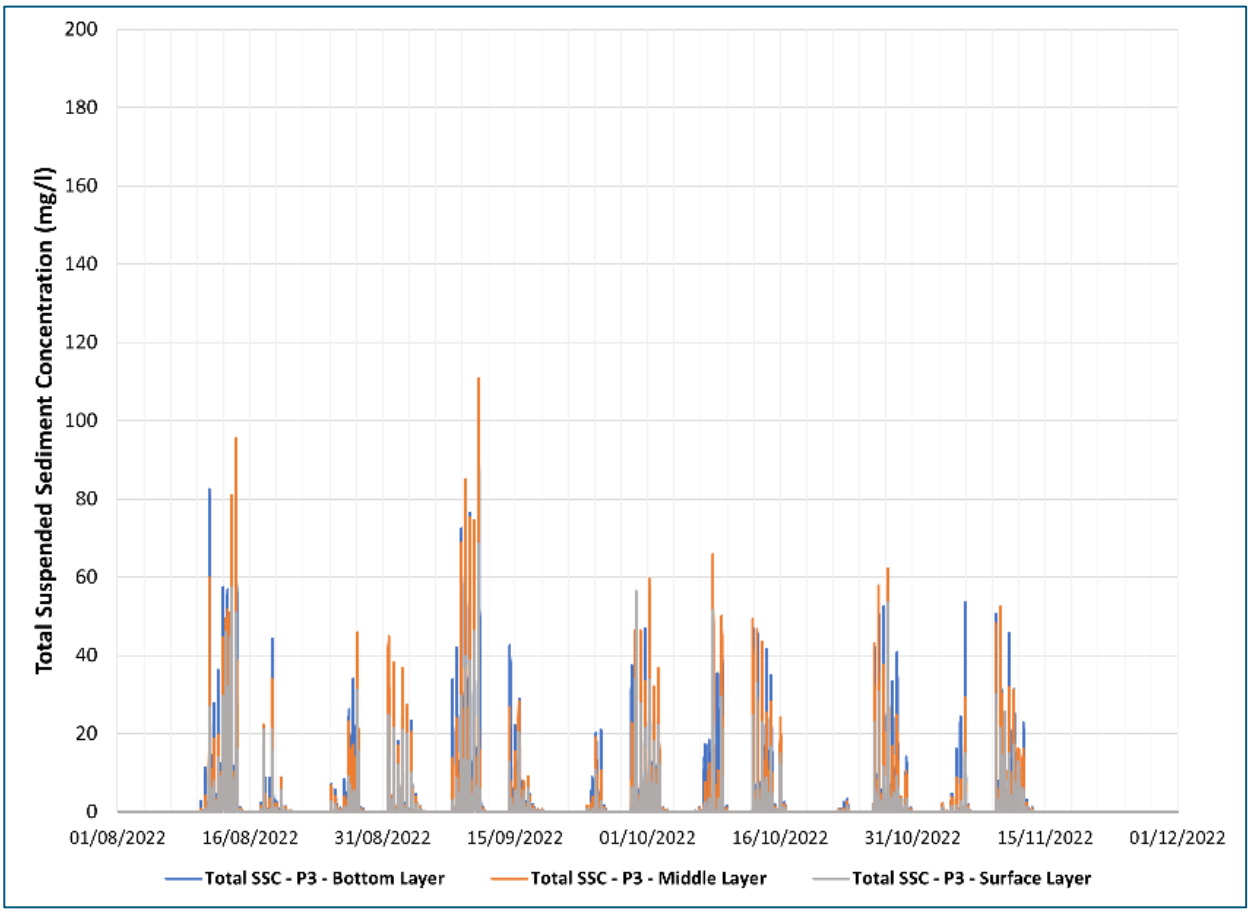


Figure 7-17 Time series of suspended sediment concentrations at P3, shown on Figure 7-14

7.6.1.1 Assessment of Impact Magnitude and Effect Significance

It is expected that increased SSC during the construction phase represent a reversible and short-term effect due to the rapid rate of dispersion. The environmental receptors for coastal processes are of low sensitivity given the open nature of the water (ability to disperse) and medium magnitude given the medium-term duration of construction activity and the reversibility of the impact. Consequently, the potential effect is assessed as being of **minor adverse** which is not considered significant in EIA terms, given the ambient SSC in the Firth of Forth (up to 1,300mg/l, FugroEMU, 2013a).

7.6.2 Changes in Seabed Level due to Capital Dredging of the Approach Channel and Berth Pocket

The increased SSC associated with capital dredging of the approach channel and berth pocket have the potential to deposit sediment and raise seabed elevation. **Figure 7-18** describes the predicted changes in seabed elevation due to the dredging and disposal activities. The largest changes occur directly over the disposal site where deposition of up to 1.9m has been predicted. Away from the disposal site, deposition thicknesses reduce to less than 0.1m about 3km northeast and 4km west-southwest from the centre of the site.

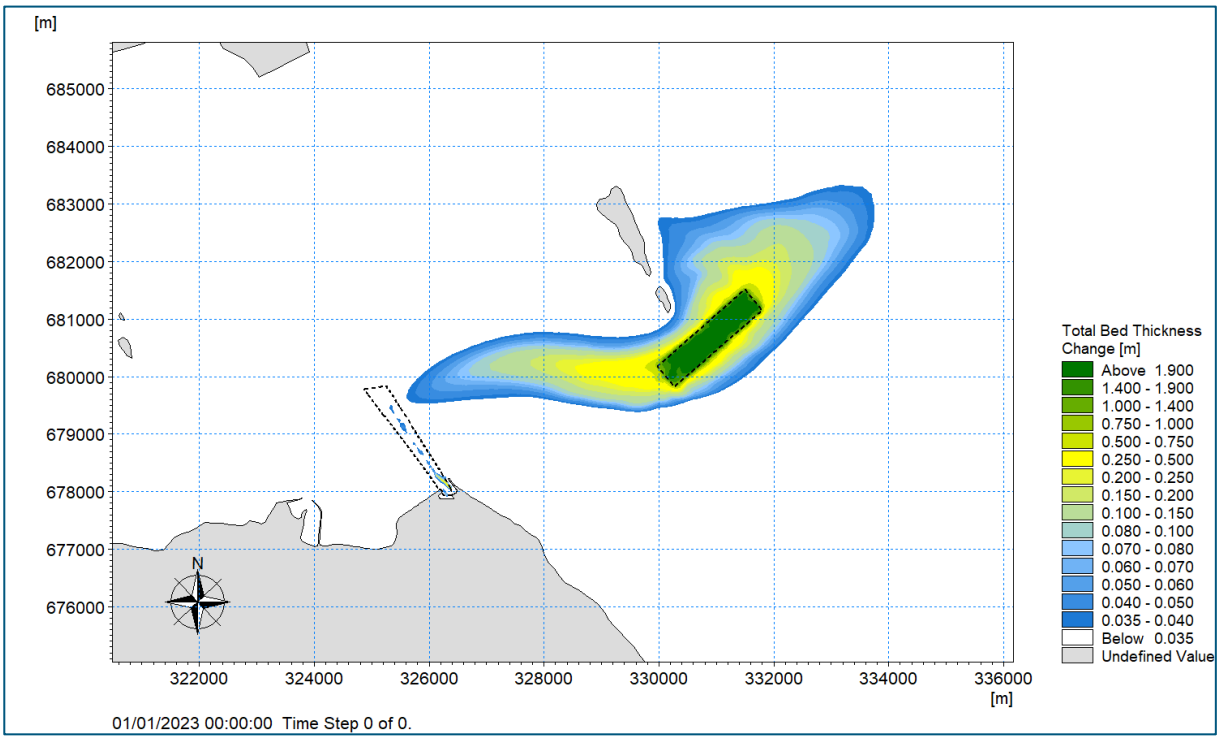


Figure 7-18 Predicted changes in seabed elevation due to deposition from the plume caused by dredging and disposal activities

Analysis of the time series of predicted deposition from the plume over the simulation period at two selected points (Points A and B in **Figure 7-14**) shows that the maximum deposition at the disposal site is about 2m (Point A) (**Figure 7-19**). At Point B, predicted deposition is less than 0.2m. These points were selected outside the dredged channel as it was assumed that the channel will continue to be dredged until the required depth is achieved and sediment deposition would not persist.

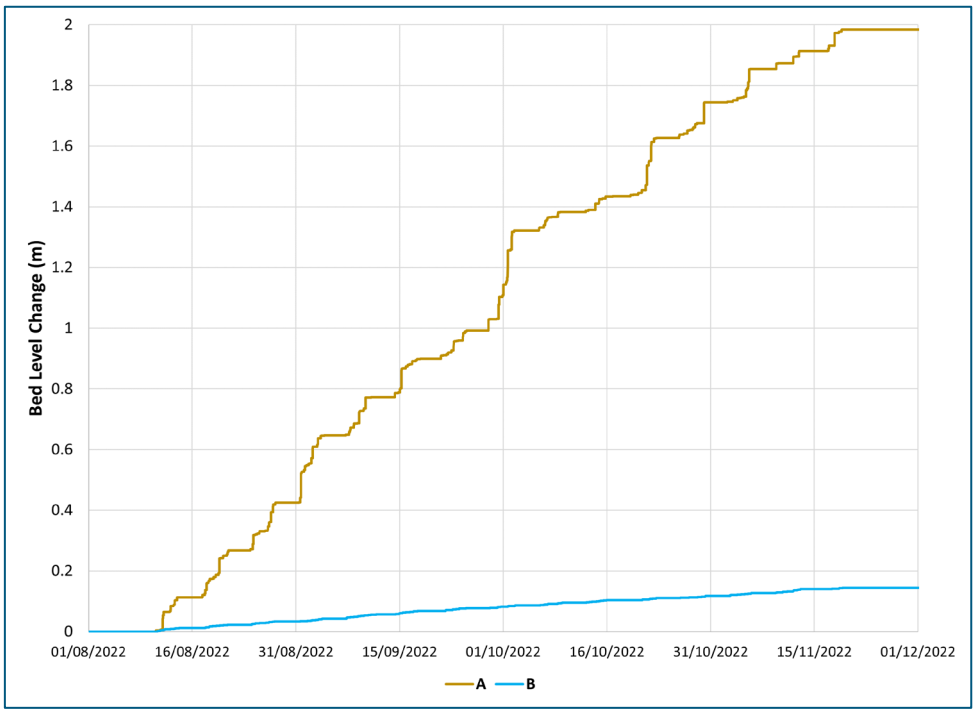


Figure 7-19 Time series of bed thickness change at the two selected points shown on Figure 7-14

7.6.2.1 Assessment of Impact Magnitude and Effect Significance

Based on the findings of the sediment dispersion modelling, predicted deposition from the plume generated from dredging and disposal would amount to a maximum of *c.*1.9m confined to the disposal site itself after the cessation of dredging. Predicted thickness would reduce away from the disposal site, which is to be expected given the dispersive nature of the disposal site location; however, after this cumulative deposition has ceased, the sediment would be continually re-suspended to gradually reduce the thickness. The longer-term outcome would be significantly reduced thicknesses once the sediment supply from dredging has ceased. The environmental receptors for coastal processes are beyond the footprint of seabed level change induced by the dredging and disposal. Consequently, the potential effect is assessed as being of **minor adverse** which is not significant in EIA terms.

7.7 Prediction of Potential Significant Effects During the Operation Phase

The enlarged approach channel and berth pocket would result in changes to bathymetry, which in turn may change tidal currents. These changes could potentially affect the sediment transport mechanisms and/or seabed morphology. Also, the berthing areas would potentially create a sink for deposition of fine sediment, and they may require maintenance dredging to maintain depth during the operational phase.

7.7.1 Changes to Tidal Currents due to the Presence of the Deepened Approach Channel and Berth Pocket

The baseline and Proposed Scheme layouts as shown in **Figure 7-1** and **Figure 7-2** were input to the hydrodynamic model to predict tidal currents (and bed shear stresses), and changes to them due to the changes in approach channel geometry.

7.7.1.1 Spring Tide Flow Distribution for the Proposed Scheme

For the Proposed Scheme, the general distribution of predicted spring tide peak flood currents is like the flow distribution for the baseline (**Figure 7-20**). The main change is the spatial extent of flows with velocities between 0.5m/s and 0.6m/s within the larger approach channel dimensions, and changes in the port basin and berth pocket due to its deepening. The general distribution of predicted spring tide peak ebb currents is also like the flow distribution for the baseline (**Figure 7-21**), apart from the spatial extent of similar flow velocities within the larger approach channel dimensions.

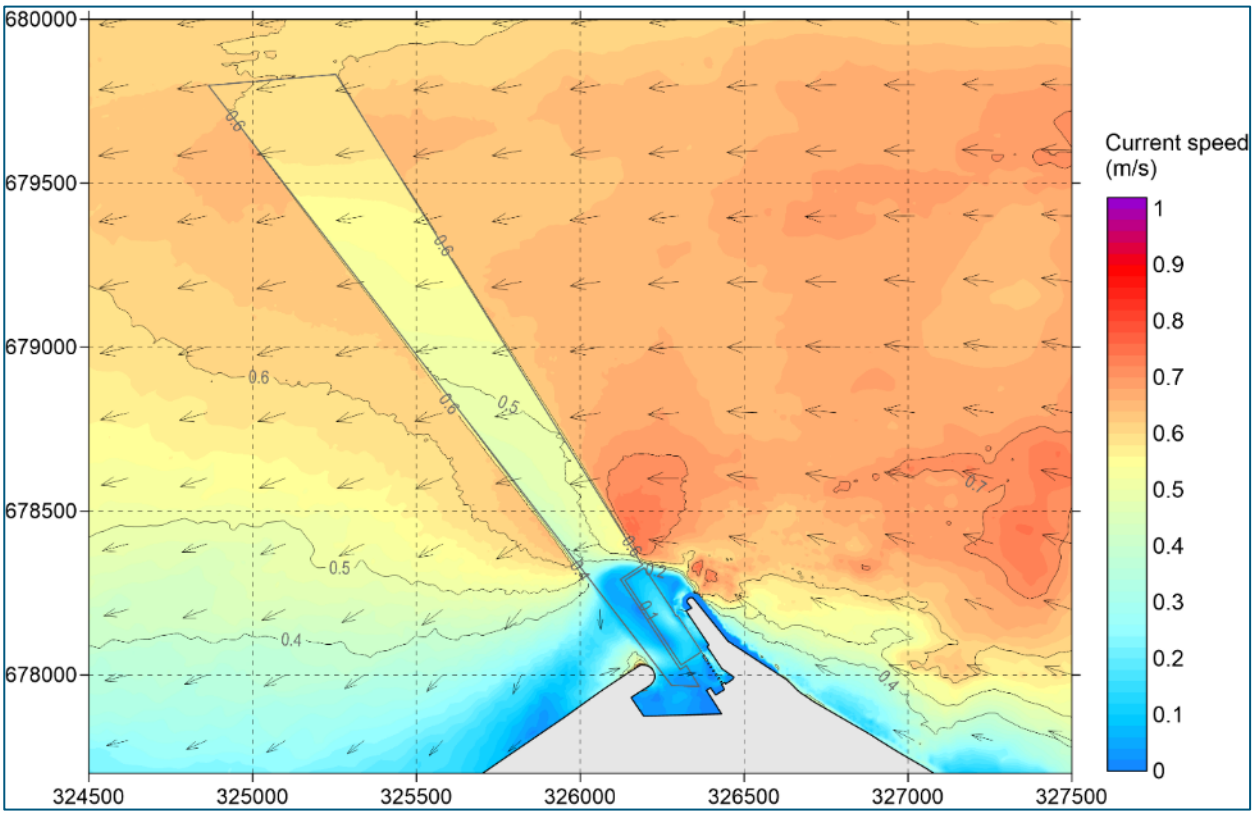


Figure 7-20 Predicted spring tide peak flood currents for the Proposed Scheme

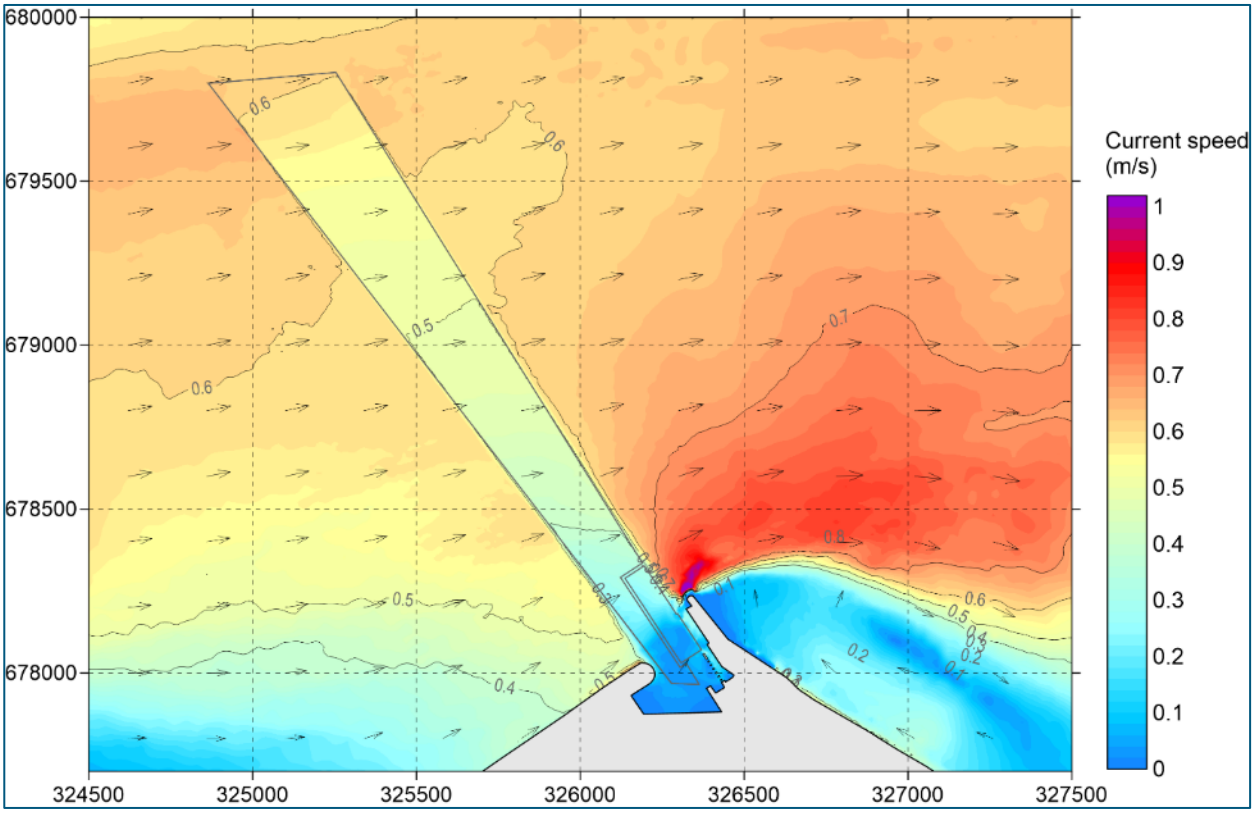


Figure 7-21 Predicted spring tide peak ebb currents for the Proposed Scheme

7.7.1.2 Changes in Spring Tide Flow Distribution

The predicted differences in overall flow distribution between the baseline and the Proposed Scheme are reflected in predictions of how tidal current flows would change with implementation of the larger approach channel. Most of the changes are predicted to be restricted to within the bounds of the future approach channel and are due to its increase in overall dimensions. Other changes occur within the port basin and parts of the deeper berth pocket.

Spring tide peak flood currents are predicted to reduce apart from small areas in the port basin (**Figure 7-22**). Speeds reduce mainly along the west side of the future approach channel, by 0.025-0.05m/s in the outer channel, 0.05-0.1m/s in the central part of the channel, and greater than 0.2m/s in the inner channel. Predicted changes to flows along most of the eastern side of the channel are less than 0.025m/s as would be those within the berth pocket. Within the port basin, the flows are predicted to both decrease (up to 0.1-0.15m/s) and increase (up to 0.05-0.1m/s).

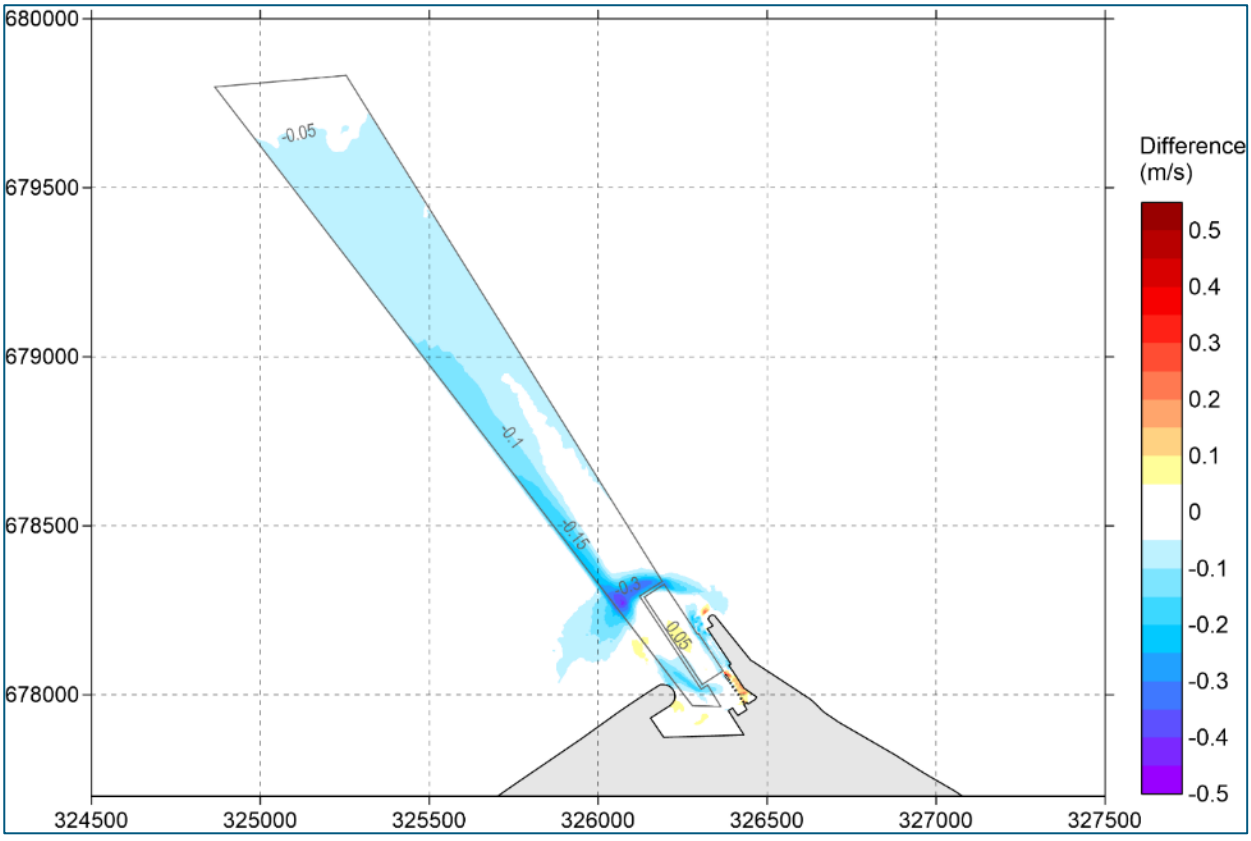


Figure 7-22 Predicted change in spring tide peak flood currents between the baseline and Proposed Scheme

A similar distribution of change has been predicted for the spring tide peak ebb currents, with the greatest changes along the west side of the future approach channel, although there would also be reductions (0.025-0.05m/s) along the east side of the central and inner channel which extend into the northern half of the berth pocket (**Figure 7-23**). There would be no significant changes to predicted flow speeds within the port basin.

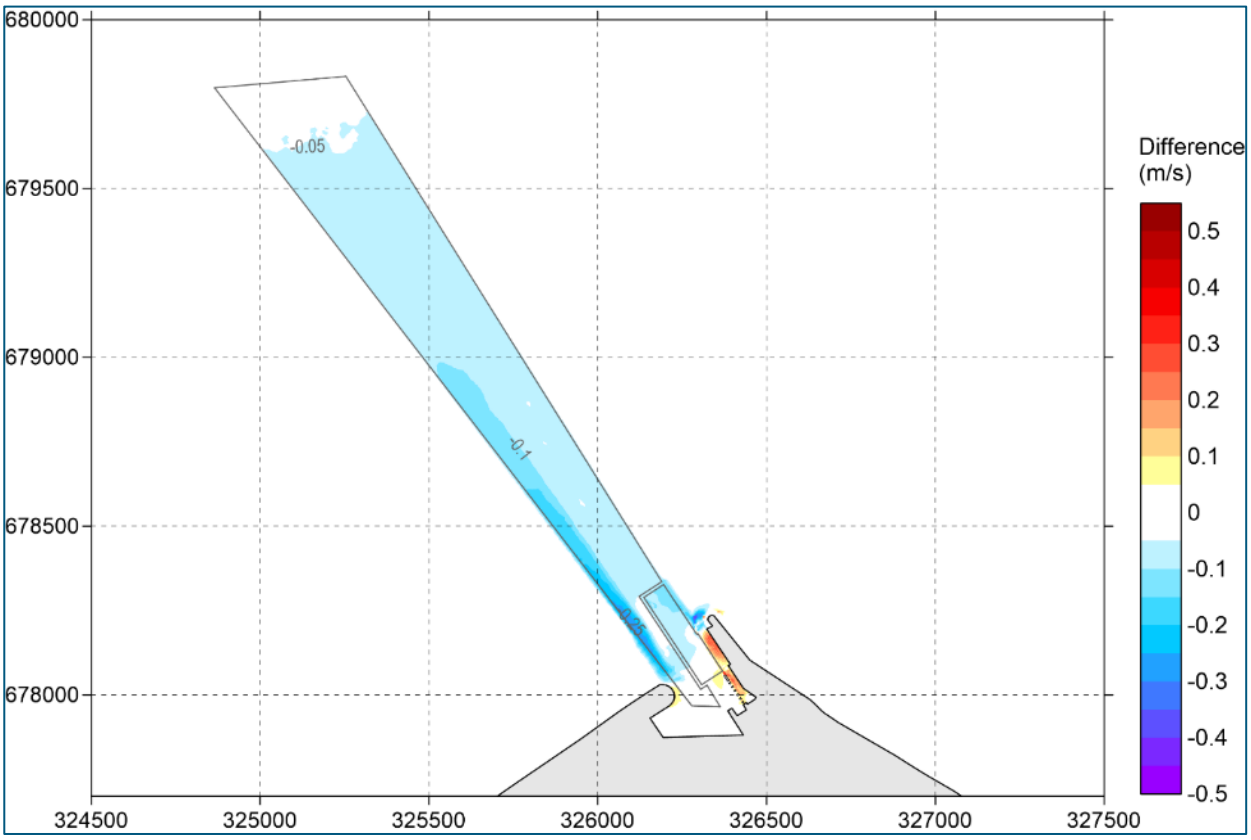


Figure 7-23 Predicted change in spring tide peak ebb currents between the baseline and the Proposed Scheme

These distributions of change are predicted to occur because the greatest change in water depth after dredging of the future approach channel is along its west side (**Figure 7-2**). The increase in water depth here would tend to reduce tidal current velocities. The bathymetry of the east side of the approach channel has only marginally been modified (slightly deeper), and so the predicted reduction in tidal current velocities is less. For both spring tide flood currents and spring tide ebb currents, the speeds would universally decrease across the Proposed Scheme approach channel compared to the baseline currents.

7.7.1.3 Assessment of Impact Magnitude and/or Effect Significance

The effects on tidal current velocities due to operation of the approach channel do not directly impact upon the environmental receptors for coastal processes. This is because the features are related to sedimentary processes operating on the seabed driven by tidal currents; hence, there would be **no effect** on the receptors associated with the changes in tidal currents. The effect on sediment transport and erosion/accretion patterns due to changes in tidal current velocities is assessed in **Section 7.7.2** below.

7.7.2 Changes to Sediment Transport and Erosion/Accretion Patterns due to the Presence of the Deepened Approach Channel and Berth Pocket

7.7.2.1 Spring Tide Bed Shear Stress Distribution

For the Proposed Scheme, the general distribution of predicted bed shear stress (for peak currents on both spring flood and spring ebb tides) is similar to the baseline bed shear stress distribution (**Figure 7-24** and **Figure 7-25**). The main change is the spatial extent of the bed shear stress magnitudes within the larger approach channel dimensions.

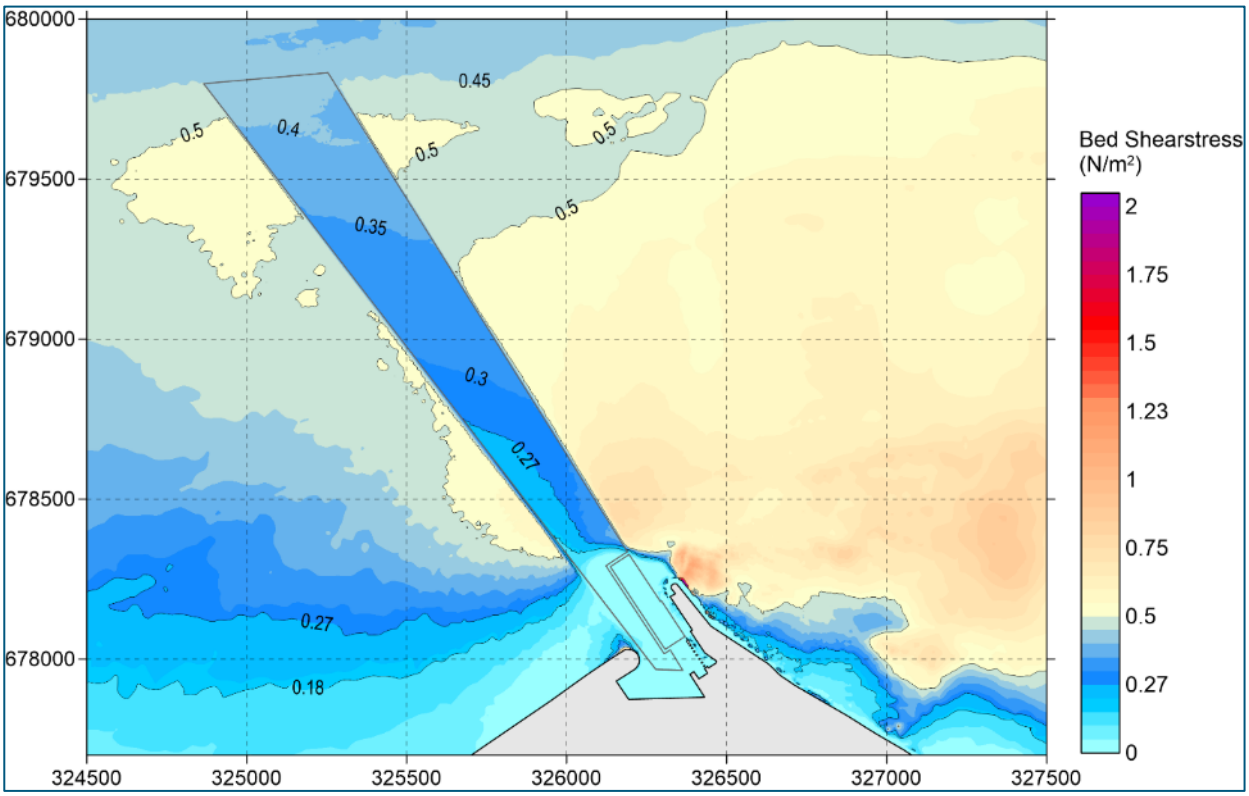


Figure 7-24 Predicted spring tide peak flood bed shear stress for the Proposed Scheme

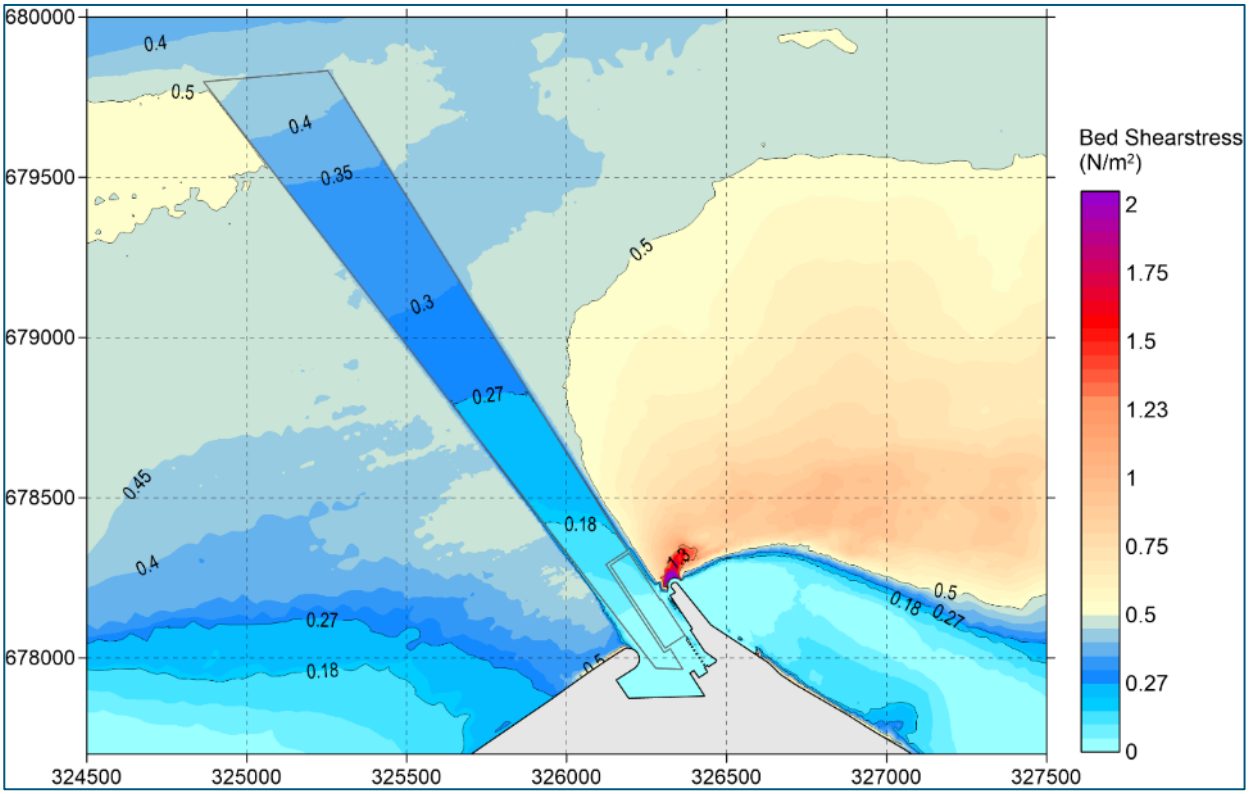


Figure 7-25 Predicted spring tide peak ebb bed shear stress for the Proposed Scheme

7.7.2.2 Changes in Spring Tide Bed Shear Stress Distribution

The predicted differences in overall bed shear stress distribution between the baseline and the Proposed Scheme are reflected in predictions of how bed shear stress would change with dredging of the larger approach channel. Most of the changes are restricted to within the bounds of the future approach channel and are due to reductions in tidal current flows driven by the increase in overall dimensions of the channel. Smaller changes occur within the port basin and parts of the deeper berth pocket.

The dominant predicted change in bed shear stress is for a reduction across the entire future approach channel with minor areas of increase outside the channel (**Figure 7-26** and **Figure 7-27**). For peak flows on both spring flood and ebb tides, the greatest reduction occurs along the west side of the inner channel (0.1N/m^2 to greater than 0.2N/m^2), mimicking the reduction in tidal current speeds in this area. Smaller reductions (0.025-0.1N/m^2) occur across the rest of the channel.

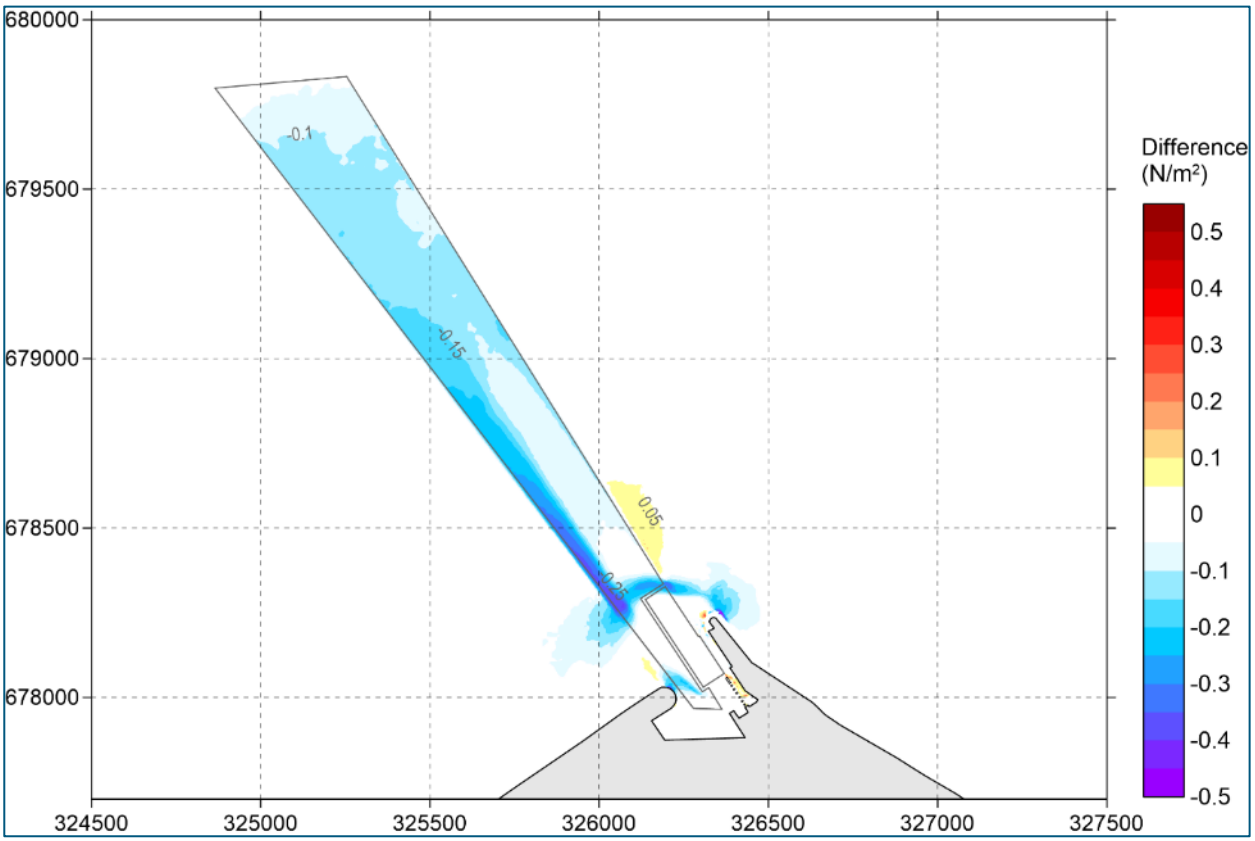


Figure 7-26 Predicted change in bed shear stress for spring tide peak flood currents between the baseline and Proposed Scheme

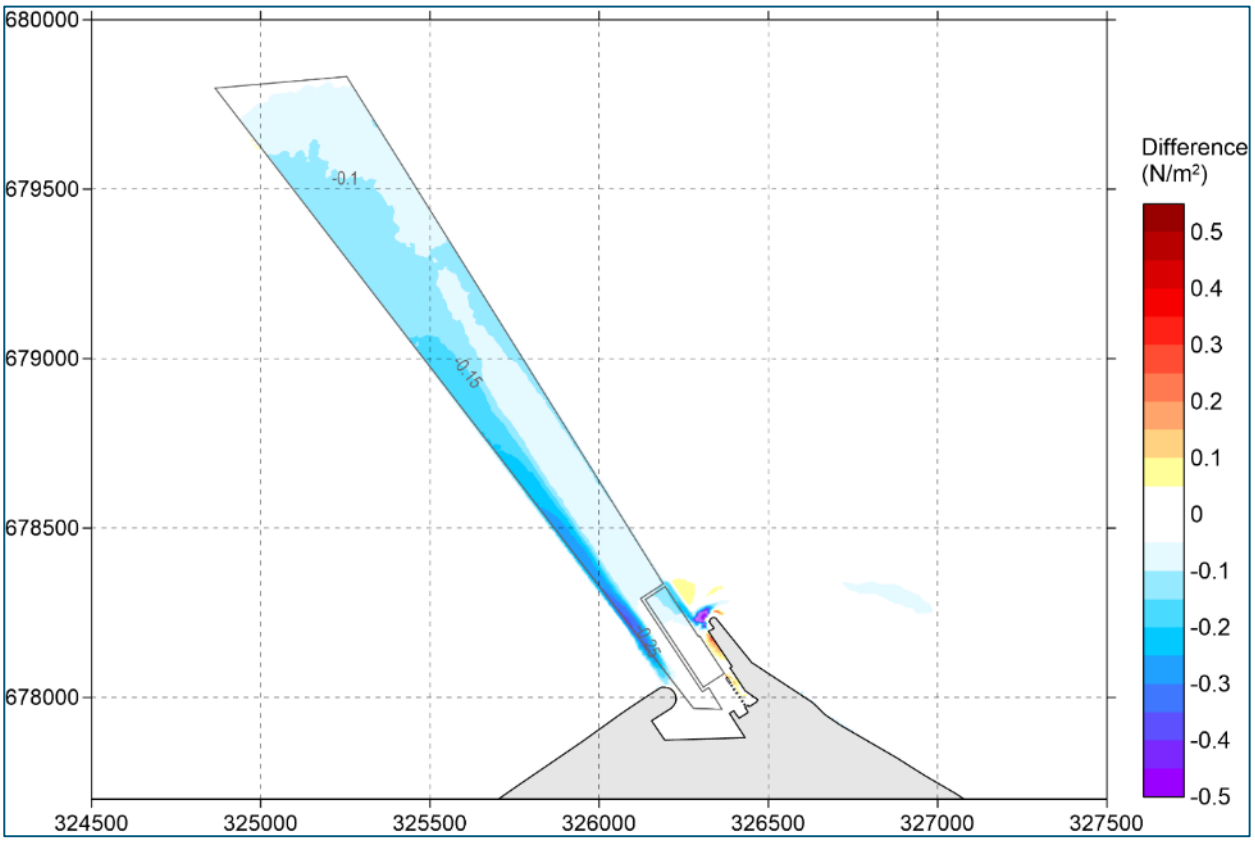


Figure 7-27 Predicted change in bed shear stress for spring tide peak ebb currents between the baseline and Proposed Scheme

7.7.2.3 Assessment of Impact Magnitude and Effect Significance

The predicted changes to bed shear stresses induced by the dredging of the approach channel are small, and the effect on sediment transport and deposition patterns would be small; however, transport of fine particles is sensitive to small changes in bed shear stresses, and it is likely that the predicted reduction of bed shear stresses within the approach channel would lead to an enhancement in accretion rate. The predicted reduction of 0.1N/m^2 to greater than 0.2N/m^2 could potentially lead to enhanced deposition of fine sediment in the approach channel. Hence, the potential effect on sediment transport and deposition patterns for the environmental receptors for coastal processes is **minor adverse** which is not significant in EIA terms.

7.8 Summary

Table 7-8 summarises the potential effects to coastal processes assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 7-8 Summary of potential effects

Potential Impact	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Construction					
Changes in Suspended Sediment Concentrations due to Capital Dredging of the Approach Channel and Berth Pocket	Low	Medium	Minor Adverse	None Required	Minor Adverse
Changes in Seabed Level due to Capital Dredging of the Approach Channel and Berth Pocket	Low	Medium	Minor Adverse	None Required	Minor Adverse

Potential Impact	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Operation					
Changes to Tidal Currents due to the Presence of the Approach Channel and Berth Pocket	N/A	N/A	No effect	None Required	No effect
Changes to Sediment Transport and Erosion/Accretion Patterns due to the Presence of the Approach Channel and Berth Pocket	Low	Medium	Minor Adverse	None Required	Minor Adverse

8 Marine Water and Sediment Quality

8.1 Introduction

This chapter of the sEIA Report considers the potential impacts of the Proposed Scheme on marine water and sediment quality. It describes the methods used to assess potential effects and the baseline conditions currently existing within the study area. The mitigation measures required to prevent, reduce or off-set any significant adverse impacts are presented together with the likely residual impacts after these measures have been adopted.

This chapter is supported by the following chapters and appendices:

- **Chapter 7: Coastal Processes;**
- **Appendix 8-1: Sediment Sampling Plan and MD-LOT's Approval;**
- **Appendix 8-2: Revised Sediment Sampling Plan and MD-LOT's Approval**; and
- **Appendix 8-3: Sediment Analyses Results.**

8.2 Legislation, Policy and Guidance

8.2.1 Legislation

Table 8-1 outlines legislation relevant to marine water and sediment quality.

Table 8-1 Summary of the key legislation relevant to marine water and sediment quality

Legislation	Relevance
Water Environment and Water Services Scotland Act 2003 (WEWS Act)	This act came into being from the Water Framework Directive (WFD) 2000/60/EC in Scotland. It commits Scotland to achieve good status of all water bodies by 2015 with the final deadline for meeting objectives being 2027. River basins comprise all transitional waters (estuaries) and coastal waters extending to 3nm seaward from the territorial baseline. Any proposed development within 3nm must have regard to the requirements of the WFD to ensure that all transitional and coastal water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. This in an overarching act which makes provisions for regulations on controlled activities and protected areas such as shellfish and bathing waters.
Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)	The Controlled Activities Regulations 2011 (and its amendments in 2013 and 2017) apply regulatory controls over activities which may affect Scotland's water environment. The regulations cover rivers, lochs, transitional waters (estuaries), coastal waters, groundwater, and groundwater dependent wetlands. All activities with potential to affect the water environment require to be authorised under the Controlled Activities Regulations. The level of authorisation required is dependent on the anticipated environmental risk posed by the activity to be carried out and a licence is required to be obtained.
Water Environment (Shellfish Water Protected Areas: Environmental Objectives etc.) (Scotland) Regulations 2013	The Shellfish Waters Directive was repealed in 2013 and was replaced by this legislation in 2013. The objectives of this regulation are to prevent the deterioration of water quality within a shellfish water protected area and protect and improve each protected area to achieve good water quality by 2015. To help achieve this these regulations also put in place a monitoring and measures programmes for each shellfish water.
Bathing Waters (Scotland) Amendment Regulations 2012	Previously designated under the Bathing Water Directive (76/160/EEC), these waters are now covered by the revised Bathing Water Directive (2006/7/EC) and are protected areas under WFD. This directive is transposed into Scottish law through the Bathing Waters (Scotland) Amendment Regulations 2012.

8.2.2 Policy and Plans

The following sections cover the main planning policy and guidance relevant to marine water and sediment quality.

8.2.2.1 Scotland's National Marine Plan

GEN 12 Water Quality and Resource of Scotland's NMP states:

"Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply."

8.2.2.2 MARPOL Convention

The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The Convention covers all the technical aspects of pollution from ships, except the disposal of waste into the sea by dumping, and applies to ships of all types, although it does not apply to pollution arising out of the exploration and exploitation of seabed mineral resources.

8.2.3 Best Practice and Guidance

This impact assessment takes account of the following guidance:

- IEMA, EIA Guidance;
- Scottish Environment Protection Agency (SEPA) (2017) Land Use Planning System; and
- SEPA Guidance Note 13.

8.2.3.1 Marine Scotland's Action Levels for the Disposal of Dredged Material

The characterisation of the contaminants found within sediments is established through the use of recognised guidelines and Action Levels (AL), in this case the MS's ALs (**Table 8-2**).

Table 8-2 Marine Scotland's Action Levels

Contaminant	Units	AL1	AL2
Arsenic (As)	mg/kg	20	70
Cadmium (Cd)		0.4	4
Chromium (Cr)		50	370
Copper (Cu)		30	300
Mercury (Hg)		0.25	1.5
Nickel (Ni)		30	150
Lead (Pb)		50	400
Zinc (Zn)		130	600
Tributyltin (TBT) and Dibutyltin (DBT)		0.1	0.5
ICES 7 Polychlorinated Biphenyls (PCB)	ug/kg	20	180
Acenaphthene		100	None
Acenaphthylene			
Anthracene			

Contaminant	Units	AL1	AL2
Fluorene			
Naphthalene			
Phenanthrene			
Benzo[a]anthracene			
Benzo[b]fluoranthene			
Benzo[k]fluoranthene			
Benzo[a]pyrene			
Benzo[g,h,i]perylene			
Dibenzo[a,h]anthracene		10	
Chrysene		100	
Fluoranthene			
Pyrene			
Indeno [1,2,3-cd] pyrene			
Total Hydrocarbons (THC)	mg/kg	100	

The majority of the material assessed against these standards arises from dredging and disposal activities as part of MD-LOT's marine licensing process for disposal of material to sea, but they are also considered a good way of undertaking an initial risk assessment with respect to determining risks to water quality from marine activities like dredging and disposal as part of EIA.

8.3 Consultation

A sediment sampling plan request was submitted to MD-LOT on 9 May 2023 to seek approval on the suggested sediment sampling locations and analysis. The agreed sediment sampling plan and MS's approval can be seen in **Appendix 8-1**. Following further updates to the dredge depth, increasing the volume of material, an additional note was submitted to MD-LOT on the 31 October 2023 to seek confirmation that the proposed revised sediment sampling was suitable to inform the assessment of potential effects during dredging and disposal activities. This note and MD-LOT's approval is provided in **Appendix 8-2**.

Responses received during the EIA scoping process relevant to marine water and sediment quality (**Table 8-3**) have been taken into account when undertaking the assessment presented in this chapter.

Table 8-3 Marine water and sediment quality consultation

Consultee	Date/Document	Comment	Response/where addressed in the sEIA Report
Scottish Ministers	Scoping Opinion – September 2023	Marine sediment and water quality has been scoped in and advised that a sediment sampling campaign is conducted prior to commencing dredging. With the results of this sampling presented within the sEIA Report along with an assessment of any predicted impacts.	Sediment sampling results can be found summarised in **Chapter 8.5** and **Appendix 8-3.**

8.4 Assessment Methodology

8.4.1 Baseline Environment

8.4.1.1 Data Sources – Desk Study

Desk-based sources consulted included:

- SEPA's website and tools including the Water Environment Hub - https://www.sepa.org.uk/datavisualisation/water-environment-hub/;
- Scotland's Environment Web – Map - https://map.environment.gov.scot/sewebmap/;
- Scotland Government website - https://www.gov.scot/policies/water/protected-waters/;
- Best Practicable Environmental Option Report for Port of Leith Maintenance Dredge Disposal; and
- Marine Licence Application (ERM, 2021).

8.4.1.2 Data Sources – Site Specific Surveys

A site-specific sampling was undertaken between 5 and 8 May 2022 and 28 and 29 August 2023 during which sediment samples were taken for the following chemical and physical analysis:

- Trace metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn);
- Organotins (TBT and DBT);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- ICES 7 PCBs; and
- Particle Size Analysis (PSA).

Both sets of samples were analysed by SOCOTEC and the results were received on the 22 June 2022 and 21 September 2023 and are presented in **Appendix 8-3** and summarised in **Section 8.5.3**. It should be noted that there is a formatting error in the template used to display these figures which has resulted in some values being highlighted as exceeding AL2 values when they are not.

8.4.2 Study Area

The study area for this topic comprises the likely maximum extent over which potentially significant environmental impacts of the Proposed Scheme may occur. This was informed by sediment dispersion modelling of the dredging and disposal activities, which have been based on the maximum predicted extent over which effects of the sediment plume are predicted to occur.

8.4.3 Impact Assessment Methodology

General methodology for EIA is discussed in **Section 5.5**. The following sections describe the methodology used to assess the potential impacts of the Proposed Scheme on marine water quality, taking into account sediment quality, in more detail.

8.4.3.1 Sensitivity of Receptor

The definition of sensitivity of the receptor for impact assessment is the same as that defined in **Section 5.5.3**, and depends on a combination of value, adaptability, tolerance, and recoverability.

The composite criterion for sensitivity used for water quality combines value (a measure of the receptors importance) with sensitivity. In some instances, the inherent value of a receptor is recognised by means of

designation (such as a bathing or shellfish water) and the 'value' element of the composite criterion recognises and gives weight in the assessment to that designation.

8.4.3.2 Magnitude of Impact

The magnitude of the impact has been assessed according to the impact extent, duration, reversibility, timing (critical seasons) and frequency. Where impacts are anticipated to occur, their magnitude has been determined as per the criteria stated in **Table 8-4**.

Table 8-4 Definitions of magnitude levels

Magnitude	Definition
High	Major or long-term change (over more than one year) to one or more water quality parameter.
Medium	Noticeable or medium-term change (over a full season) to one or more water quality parameter, for example, one Bathing Water season (one summer).
Low	Small or short-term change (over a matter of days or weeks, or less than one spring tide cycle) to one or more water quality parameter.
Negligible	No detectable change to water quality or change is within natural variation.

8.5 Baseline Environment

A review of marine sediment and water quality information was undertaken to inform this sEIA. The following information was identified:

- The approach channel is within the Kinghorn to Leith Docks coastal water body (ID: 200041) which, as reported in the Outer Berth EIA Report, continues to hold a chemical status of 'Pass', an ecological status of 'Good' and an overall status of 'Good';
- There are no Bathing Waters (designate under the Bathing Waters (Scotland) Regulations 2008 (as amended4)) within 2km of the dredge footprint;
- There are no Shellfish Waters within the Firth of Forth under The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2013; and
- Sediment quality data available from the dredge footprint following a sediment sampling campaigns undertaken in May 2022 and August 2023.

8.5.1 WFD Waterbody Classification

The Proposed Scheme is within the Kinghorn to Leith Docks coastal water body (ID: 200041), which has an overall status of Good, a chemical status of Pass and an ecological status of Good[9]. The water body is expected to maintain this status in 2027. Full classification details of this waterbody are provided in **Table 8-5.**

Table 8-5 2012 Classification status of Kinghorn to Leith Docks coastal water body (ID: 200041)

Parameter	Status	Confidence of Class
Overall Status	*Good*	*High*
Macro-invertebrates	*Good*	*High*
Alien species	*High*	*Low*
Morphology	*Good*	*Medium*

[4] *https://www.legislation.gov.uk/ssi/2008/170/contents/made*

Parameter	Status	Confidence of Class
Specific pollutants	*Pass*	*High*
Macroalgae	*Good*	*High*
Dissolved Inorganic Nitrogen	*High*	*Medium*
Dissolved Oxygen	*High*	*High*

8.5.2 Suspended Sediment Concentration

SSC data, from backscatter sensors deployed by FugroEMU (2013), were presented in the Outer Berth EIA Report and are summarised in **Section 7.6.1** of this sEIA Report. Baseline suspended sediment levels – typical of an estuarine environment – were highly variable, with ambient levels of around 10-50mg/l. The data shows that re-suspension of sediment from the seabed resulting in very high suspended sediment concentrations above ambient conditions is caused by increased wave heights. These concentrations are between 200mg/l to 1,300mg/l. The backscatter sensors were deployed within close proximity to (and therefore are representative of) the approach channel and surrounding marine areas and are considered to be valid for the proposed dredging.

After the sediment is elevated into the water column by this process, it is transported past the eastern breakwater by tidal currents on the flood tide and by wave induced flows (typically during easterly weather, HR Wallingford, 2004). On the flood tide it is likely that a large-scale eddy forms in the lee of the eastern breakwater (Arup, 2007) that traps some of the suspended sediment that bypasses the eastern breakwater allowing it to settle and deposit in the inner Approach Channel and outer berth (ERM, 2021).

8.5.3 Sediment Quality

8.5.3.1 Overview

Across both sampling campaigns, vibrocore (VC) samples were taken from 27 locations within the proposed dredge footprint at three depths: surface, mid and bottom of the cores. Cores were vibrated through the soft-surface sediments until refusal. Samples were sent for chemical and physical analysis and the results are presented in **Appendix 8-3**. Note, no samples were recovered from station VCN11A. A summary is presented in the sections below.

8.5.3.2 Particle Size Analysis

PSA results show that the sediment present within dredge footprint is comprised of mixed sediments with the majority of samples comprised of a high proportion of sand and silt.

8.5.3.3 Metals and Organotins

Concentrations of seven metals, cadmium, chromium, copper, mercury, nickel, lead and zinc were found at levels marginally exceeding AL1. AL2 was exceeded in the mid-core sample taken from VC02 within the approach channel, which also contained elevated levels of nickel. Mercury and cadmium were also recorded at levels exceeding AL2 in seven and four samples, respectively, within the proposed berth pocket. There was one exceedance of AL1 for organotins (TBT) in the max-depth (-2.18m CD) sample taken from NVC06 located in the south east extent of the dredge, to the south of the berth pocket.

8.5.3.4 PAHs and THC

Levels of the majority of PAH congeners were found to be above AL1 in many of the samples. It is apparent that contamination levels decrease with increasing distance from the outer berth. There is no AL2 for PAHs.

8.5.3.5 PCBs

Levels of the sum total of ICES 7 PCB congeners were found to be higher than AL1 in nine samples and exceeding AL2 in NVC04.

8.5.3.6 Average for the Total Dredge Area

Given the small number of exceedances of AL2, averages across the dredge area have been presented to provide a more representative assessment of risk to the marine environment (**Table 8-6**). When averaged, all metals are present at levels below AL1. Whilst many of the PAHs exceed AL1, when averaged the majority of these exceedances are considered to be marginal. Average levels of ICES 7 PCBs do not exceed AL1.

Table 8-6 All parameters averaged over total dredge area (AL1 exceedance in dark blue)

Parameter	Unit	Average
Gravel (>2mm) (%)	%	7.32
Sand (63-2000 µm) (%)	%	24.65
Silt (<63 µm) (%)	%	68.03
Arsenic	mg/kg	6.1
Cadmium	mg/kg	0.31
Chromium	mg/kg	32.3
Copper	mg/kg	21
Mercury	mg/kg	0.23
Nickel	mg/kg	23.8
Lead	mg/kg	27.5
Zinc	mg/kg	64.8
DBT	mg/kg	0.006
TBT	mg/kg	0.007
Acenaphthene	ug/kg	43.1
Acenaphthylene	ug/kg	16.1
Anthracene	ug/kg	100
Benzo(a)anthracene	ug/kg	203
Benzo(a)pyrene	ug/kg	208
Benzo(b)fluoranthene	ug/kg	218
Benzo(ghi)perylene	ug/kg	205
Benzo(k)fluoranthene	ug/kg	113
Chrysene	ug/kg	233

Parameter	Unit	Average
Dibenzo(ah)anthracene	ug/kg	32
Fluoranthene	ug/kg	407
Fluorene	ug/kg	70.7
Indeno(1,2,3-c,d)pyrene	ug/kg	153
Naphthalene	ug/kg	89.1
Phenanthrene	ug/kg	314
Pyrene	ug/kg	433
THC	mg/kg	219.34
Sum of ICES 7 PCB congeners	ug/kg	9.36

8.6 Prediction of Potential Significant Effects During the Construction Phase

Potential impacts to marine water and sediment quality during construction phase of the Proposed Scheme include:

- Potential release of contamination during dredging and disposal.

8.6.1 Deterioration in Water Quality due to Release of Sediment-Bound Contaminants

Dredging and disposal activities have the potential to adversely impact water quality due to the potential release of contaminants adsorbed to sediment particles; however, it should be noted that much of the material to be dredged for this project is Glacial till and mudstone which does not contain anthropogenic derived contaminants.

Sediment samples indicate that, when averaged, the sediment to be dredged does not contain significantly elevated concentrations of contaminants. There are a number of contaminants which, when averaged, still exceed AL1 but none exceed AL2 (**Table 8-6**). These results are in line with the historic data collected between 1993 – 2020 where a few metals and most of PAHs were found to be above AL1 within Port of Leith and the Narrow Deep B disposal ground (reported on in the Outer Berth EIA Report).

Relevant to the assessment of potential risk to the marine environment associated with contaminant release are the results of dispersion modelling (presented in **Section 7.6**), which predict that the sediment plume would remain localised to the dredging locations and peaks in SSC would only be short-term returning to baseline within an hour. At the disposal site, the plume extent is predicted to be larger but restricted to the seabed and mid-layer. Peaks in SSC are also predicted to be short term and return to baseline within a matter of hours. Therefore, if any contamination is released during dredging or disposal, the rapid dispersion is likely to dilute any release quickly and a return to baseline conditions would be expected within an hour. Plume predictions are also likely to be exaggerated given that the dredging and disposal activity is likely to require dredge and disposal of soft and hard material rather than all the soft material in one event.

The receptor sensitivity is also considered to be low given the open nature of the water, absence of shellfish and bathing waters. Given the reversibility of the impact, the magnitude of impact is also assessed to be low; therefore, the potential effect is of **negligible**.

Mitigation measures
No mitigation is required.

Residual effects
The residual impact is **negligible, which is not significant in EIA terms.**

8.7 Prediction of Potential Significant Effects During the Operation Phase

No impacts to marine water and sediment quality would occur during the operational phase. Maintenance dredging requirements at the port would increase; however, the potential effects arising from this activity will be less than that arising from the capital dredge. Any increase in maintenance dredge requirements will be assessed and managed through a variation to Forth Port's current maintenance licence for Leith.

8.8 Summary

Table 8-7 summarises the significance of the potential impacts to marine water and sediment quality assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 8-7 Summary of assessment

Potential effect	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Construction					
Deterioration in water quality due to release of sediment-bound contaminants	Low	Low	Negligible	None required	Negligible

9 Marine Ecology

9.1 Introduction

This chapter of the sEIA Report considers the potential impacts of the Proposed Scheme on benthic ecology and how this could affect priority habitats and/or protected/notable species. It describes the methods used to assess potential effects and the baseline conditions currently existing within the study area. The mitigation measures required to prevent, reduce or off-set any significant adverse impacts are presented together with the likely residual impacts after these measures have been adopted.

This chapter is informed by the following chapters from this sEIA Report:

- **Chapter 7: Coastal Processes**; and
- **Chapter 8: Marine Water and Sediment Quality**.

9.2 Legislation, Policy and Guidance

This section outlines relevant legislation, policy and guidance applicable to the sEIA Report of the potential effects on benthic ecology associated with the Port of Leith outer berth development.

9.2.1 Legislation

There are several different legislative instruments that are relevant to assess the potential impacts of the capital dredge to benthic ecology receptors.

9.2.1.1 International

- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979); and
- Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') 1992.

9.2.1.2 National

- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- Nature Conservation (Scotland) Act 2004 (as amended);
- Marine (Scotland) Act 2010; and
- Wildlife and Natural Environment (Scotland) Act 2011.

9.2.1.3 Scotland's National Marine Plan

Scotland's NMP was published by the Scottish Government in March 2015. The plan covers the management of both Scottish inshore waters (out to 12nm) and offshore waters (12 to 200nm), setting out the Scottish Government's policies for the sustainable development of Scotland's seas (MSD, 2015).

The plan promotes an ecosystem-based approach, putting the marine environment at the heart of the planning process to promote ecosystem health, resilience to human induced change and the ability to support sustainable development and use. It adopts the guiding principles of sustainable development, which also ensures that any individual policy, plan, or activity is carried out within environmental limits. Within Scotland's NMP Annex B are a set of Good Environmental Status (GES) indicators that must be met.

Within these, of relevance to the Proposed Scheme, are:

- "*Biological diversity is maintained and recovered where appropriate. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions (GES 1).*
- *All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (GES 4).*
- *Concentrations of contaminants are at a level not giving rise to pollution effects (GES 8).*"

Additionally, within Scotland's NMP General policy 9 (GEN 9) Natural Heritage "Development and use of the marine environment must:

a) Comply with legal requirements for protected areas and protected species.

b) Not result in significant impact on the national status of Priority Marine Features.

c) Protect and, where appropriate, enhance the health of the marine area."

9.2.1.4 Edinburgh Biodiversity Action Plan

The UK generated the UK Biodiversity Action Plan (BAP) in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets.

The sixth edition of the Edinburgh BAP (covering 2022-2027) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the importance of ensuring protected and priority species are reflected in plans, policies, strategies, projects and other activities, as appropriate.

9.2.2 Best Practice and Guidance

The impact assessment adheres to the following guidance and standards:

- CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine;
- CIEEM Guidelines for Ecological Report Writing (2nd Edition, December 2017);
- Environmental Impact Assessment Handbook (SNH, 2018);
- British Standard 42020:2013 –Biodiversity. Code of Practice for planning and development (British Standard, 2013);
- CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition) (CIRIA, 2010);
- Joint Nature Conservation Committee Marine Monitoring Handbook (2001);
- Planning Advice Note (PAN) 1/2013: Environmental Impact Assessment (Scottish Government, 2013);
- Scottish Biodiversity List (Biodiversity Scotland, undated);
- Planning Advice Note 60 (Planning for Natural Heritage) (Scottish Government, 2000);
- NatureScot website: guidance on protected species;
- (https://www.nature.scot/professional-advice/safeguarding-protected-areas-andspecies/protected-species) (SNH, 2019); and
- GB Non-native Species Secretariat (2015) Species Information.

9.3 Consultation

The comments received from the Scottish ministers on the EIA scoping process agreed with the proposed assessment approach for benthic ecology (**Table 9-1**). The scoping responses also called for the benthic ecology assessment survey report to be included in the Ecospan benthic survey report 2023 (**Appendix 9-1**).

Table 9-1 Summary of the scoping responses for benthic ecology

Respondent	Date/Document	Comment	Responses/where addressed in the sEIA report
Scottish ministers	Scoping Opinion-September 2023	The Applicant has considered the potential impacts on benthic ecology in section 4.6 of the Scoping Report. Direct loss of benthic habitat/communities within the proposed dredge footprint, the release of contaminants during dredging and deposit and smothering of benthic communities as a result of the deposition of suspended sediment during dredging and deposit have been scoped in for further assessment in the sEIA Report. Potential impacts during the operational phase of the Proposed Scheme have been scoped out from further assessment by the Applicant.	Noted
		The Scottish Ministers agree with the content and approach to the assessment of benthic ecology proposed in the Scoping Report and advise that this must be included in the sEIA Report.	**Appendix 9-1**

9.4 Assessment Methodology

9.4.1 Study Area

The study area for benthic ecology comprises the likely maximum extent over which potentially significant environmental impacts of the Proposed Scheme may occur together with an area outside of this to determine the relative importance of the area that could be affected. This has been informed by the sediment dispersion modelling carried out on the dredging and disposal activities and is based on the maximum predicted extent over which effects are predicted to occur (see **Chapter 7: Coastal Processes**) together with the results of the survey work (**Section 9.5.2.2**).

9.4.2 Baseline Environment

The assessment of benthic ecology has been informed based on a review of available information, including:

- EUSeaMap 2021. An online mapping resource that is hosted by the European Marine Observation and Data Network (EMODnet). This provides broadscale habitat maps as well as more specific habitat maps on a broad, medium and fine scale, obtained from surveys. The maps can predict seabed-habitat types by combining measurements, such as water depth and light levels amongst others, using statistical analysis and Geographical Information System modelling (EMODnet, 2022).
- A site-specific survey was undertaken between 22nd and 23rd of June 2023, that provided comprehensive information on the epibenthic and infaunal communities present with and around the footprint of the berth and approach channel.
- NBN Atlas. An online database, part of the National Biodiversity Network, that records biological sightings around the UK.

- Marine Life Information Network (MarLIN).
- AMBI benthic vulnerability index.

9.4.3 Impact Assessment Methodology

The methodology used to assess the potential environmental impacts associated with the Proposed Scheme is provided in **Section 5.5**. Professional judgement has been used to determine potential environmental impacts which could arise during the proposed dredge and disposal.

9.4.3.1 Sensitivity

The sensitivities of marine species and habitats have been developed using a four-point scale (high, medium, low or negligible) and the definitions of the sensitivity levels used in this assessment are provided in **Table 9-2** below. This scale has been developed with reference to the MarLIN Marine Evidence based Sensitivity Assessment (MarESA), (Tyler-Walters, 2018). The sensitivity of a receptor is dependent upon its adaptability (the degree to which a receptor can avoid or adapt to an effect), tolerance (the ability of a receptor to absorb stress or disturbance without changing character) and recoverability (the temporal scale and extent to which a receptor will recover following an effect).

In conjunction with MarESA, Marine Scotland's Feature Activity Sensitivity Tool (FeAST) has been used in assessment of sensitivity of protected features. FeAST has developed a sensitivity matrix of marine habitats and species to pressures taking place in the marine environment.

Table 9-2 Definitions of Sensitivity Levels for Benthic Ecology

Sensitivity	Definition
High	Individual receptor (species or habitat) has very limited or no capacity to accommodate, adapt or recover from the anticipated impact (e.g., receptor is killed/destroyed or damaged with recovery greater than 10 years).
Medium	Individual receptor (species or habitat) has limited capacity to accommodate, adapt or recover from the anticipated impact (e.g., killed/destroyed with recovery in 1to 10 years or damaged with recovery in 5 to 10 years).
Low	Individual receptor (species or habitat) has some tolerance to accommodate, adapt or recover from the anticipated impact (e.g., killed/destroyed with recovery with 1 year or damaged with recovery in 1 to 5 years).
Negligible	Individual receptor (species or habitat) is generally tolerant to and can accommodate or recover from the anticipated impact.

9.4.3.2 Nature Conservation Value

Nature conservation value (also referred to in the CIEEM guidelines as nature conservation importance) is a measure of the conservation value of a species potentially affected by the Proposed Scheme and has been used as an adjusting factor in determining the overall receptor sensitivity. The 'value' of a receptor has been used, as described in **Table 9-3**.

Table 9-3 Definitions of nature conservation value for receptors

Value	Definition
High	Nationally important/rare with limited potential for offsetting/compensation. Habitats (and species) protected under international law (e.g. Annex I habitats within a SAC boundary). May also be of significant wider-scale, functional or strategic importance.
Medium	Regionally important/rare with limited potential for offsetting/compensation. Habitats/species protected under Scottish law and/or a focus of Scottish conservation efforts (e.g. Annex I habitats not within an SAC boundary; Priority Marine Features (PMFs), species on the Scottish Biodiversity List). Species/habitat that may be rare or

Value	Definition
	threatened in the UK.
Low	Locally important/rare. Species for which targeted conservation work in the Edinburgh region is undertaken in line with the Edinburgh Biodiversity Action Plan. Habitats or species that provide prey items for other species of conservation value.
Negligible	Habitats and species which are not protected under conservation legislation and are not considered to be particularly important or rare.

It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. an Annex 1 habitat) but have a low or negligible physical/ecological sensitivity to an effect – it is important not to inflate impact significance just because a feature is 'valued'. This is where the narrative behind the assessment is important; the value can be used where relevant as a modifier for the sensitivity assigned to the receptor.

9.4.3.3 Magnitude

The magnitude of the impact is assessed according to:

- The extent of the area subject to a predicted impact;
- The duration the impact is expected to last prior to recovery or replacement of the resource or feature;
- Whether the impact is reversible, with recovery through natural or spontaneous regeneration or through the implementation of mitigation measures or irreversible, when no recovery is possible within a reasonable timescale or there is no intention to reverse the impact; and
- The timing and frequency of the impact, i.e. conflicting with critical seasons or increasing impact through repetition.

Definitions of the magnitude levels are given in **Table 9-4.**

Table 9-4 Definitions of the magnitude levels

Magnitude	Definition
High	Fundamental, permanent/irreversible changes, over the whole receptor, and/or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness. For example, more than 20% habitat damage.
Medium	Considerable, permanent/irreversible changes, over the majority of the receptor, and/or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness. For example, 10-20% habitat damage.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the receptors character or distinctiveness. For example, less than 10% habitat damage.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

9.5 Baseline Environment

9.5.1 Designated Sites for Nature Conservation

The following designated sites are present within the study area see also (**Figure 9-1):**

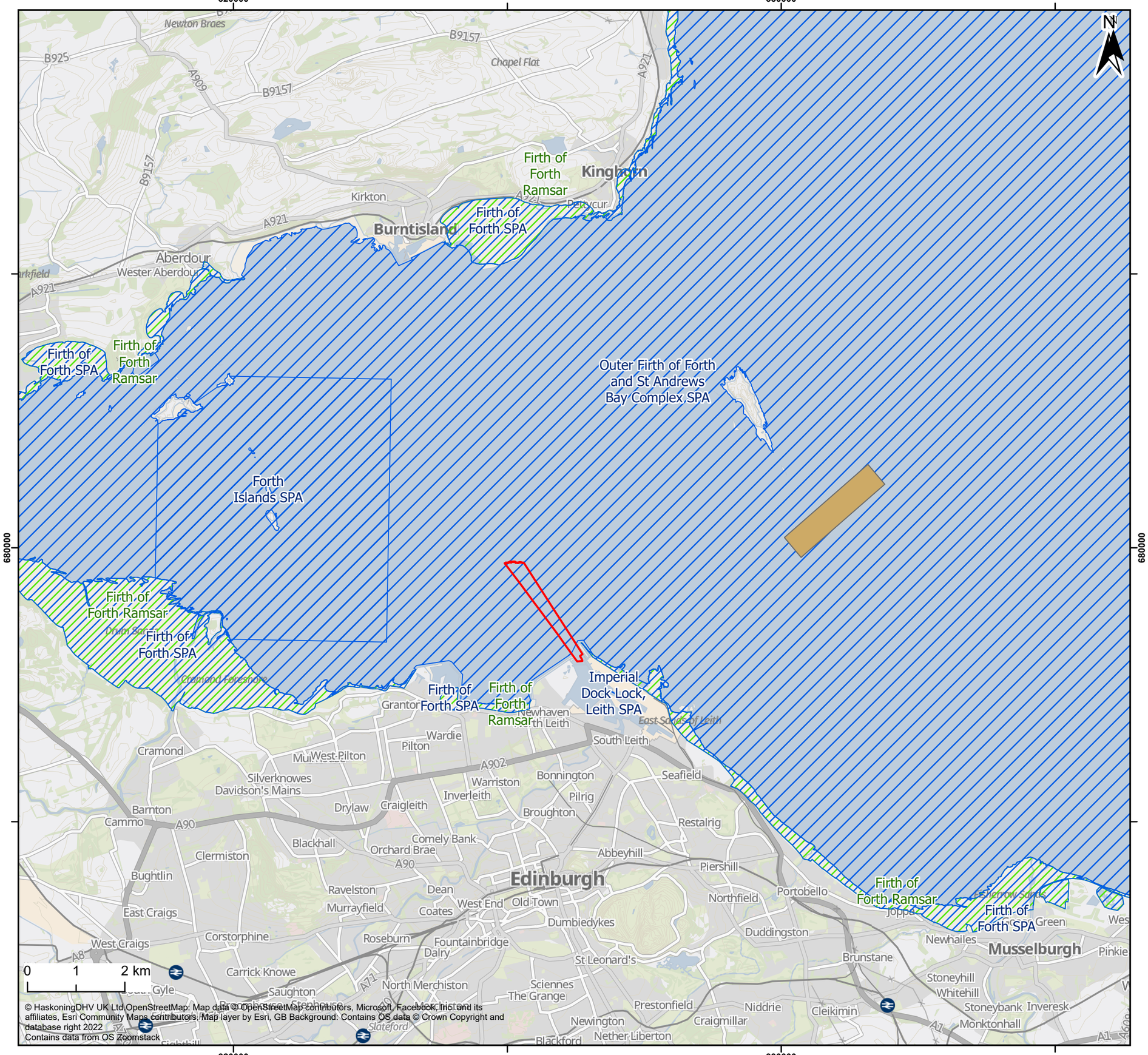
- Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA - 0km (within) from the Proposed Scheme;
- Firth of Forth Site of Special Scientific Interest (SSSI), SPA and Ramsar site – 0.2km from the Proposed Scheme; and
- Imperial Dock Lock, Leith SPA - Less than 1km from the Proposed Scheme.

In addition, the following designated sites for nature conservation have interest features that have the potential to be present in the study area:

- Forth Islands SPA - Approximately 4km from the Proposed Scheme;
- River Teith Special Area of Conservation (SAC) - Approximately 49km from the Proposed Scheme, screened in for long-ranging or migratory species only;
- Isle of May SAC - Approximately 43km from the Proposed Scheme, screened in for long ranging or migratory species only;
- Firth of Tay and Eden Estuary SAC - Approximately 64km from the Proposed Scheme, screened in for long-ranging or migratory species only;
- Berwickshire and North Northumberland Coast SAC - Approximately 63km from the Proposed Scheme, screened in for long-ranging or migratory species only; and
- Moray Firth SAC - Approximately 300km from the Proposed Scheme, screened in for long ranging or migratory species only.

SACs, SPAs and Ramsar sites have been considered by the accompanying sRIAA submitted alongside this sEIA Report, with their fish, ornithological and marine mammal features assessed in **Chapters 0, 11** and **12** respectively.

Whilst the proposed dredge and disposal does not directly impact on the Firth of Forth SSSI, SPA, and Ramsar site, this site is located directly adjacent, covering the intertidal area to the east (see **Figure 9-1**). The site covers approximately 7,425ha and is designated for its variety of geological and geomorphological features, coastal and terrestrial habitats, vascular plants, invertebrates, breeding, passage, and wintering birds. The proposed dredge and sediment deposition plume areas do not overlap with the Firth of Forth SSSI, SPA, and Ramsar site therefore, no further assessment on these designations is undertaken in this chapter.



Legend:

- Dredge Area
- Ramsar Sites
- Special Protection Area
- Disposal Site Narrow Deep B

Data Sources: ©NatureScot 2023, ©CEFAS 2023

Client:	Project:
Forth Ports Limited	Port of Leith Approach Channel Deepening

Title: Special Protection Areas and Ramsar sites

Figure: 9-1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	29/11/2023	ND	EF	A3	1:70,000

Co-ordinate system: British National Grid

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9.5.2 Benthic Habitats

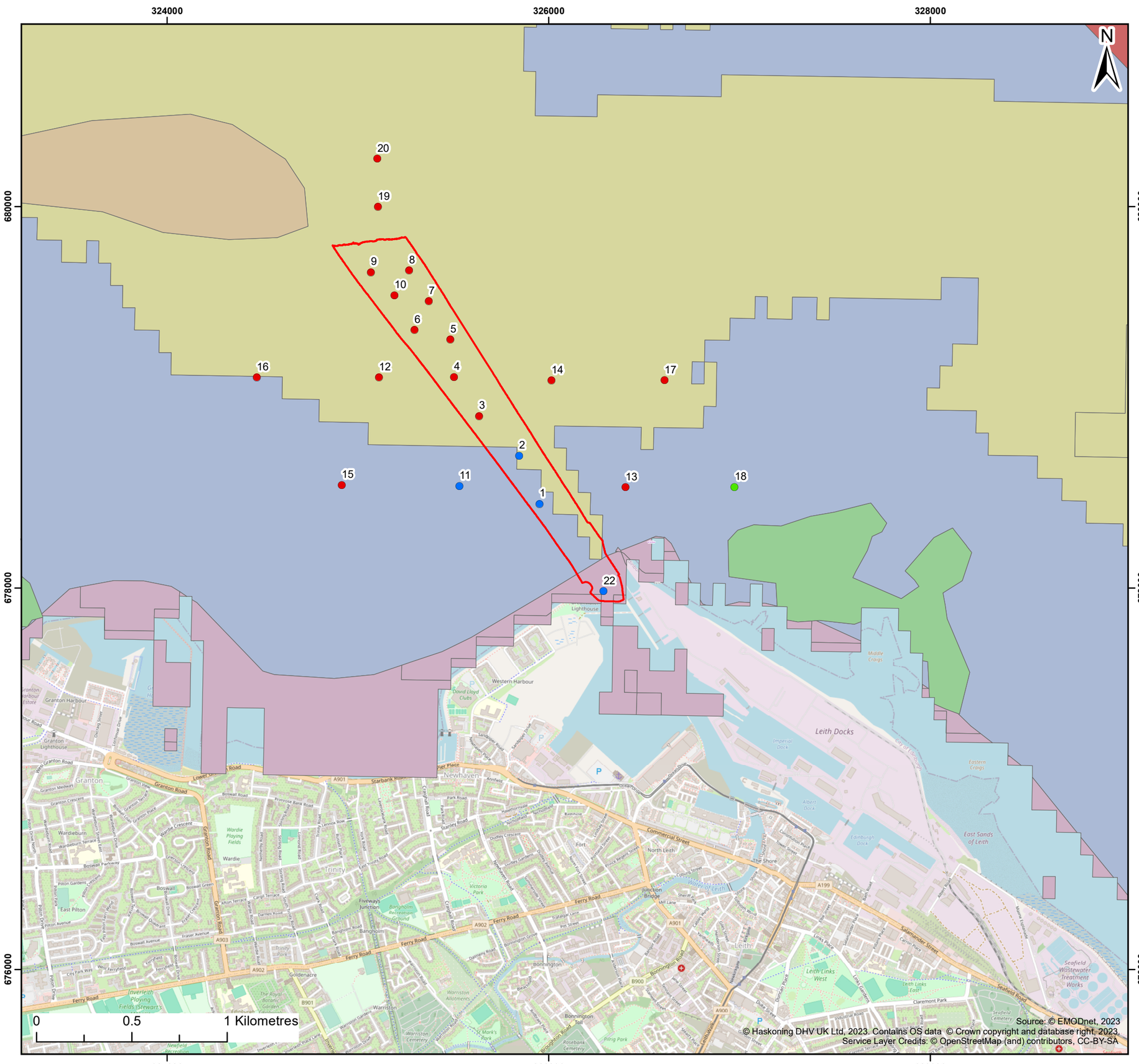
9.5.2.1 Available Reported Information

Broadscale seabed habitat mapping is available in the Firth of Forth from the EUSeaMap (2021) project, the newest release of the EMODnet broadscale habitat map for Europe[12]. The seabed within the footprint of the Proposed Scheme, and within the area likely to be affected by increased levels of sediment deposition as indicated in **Figure 7-18**, is mainly comprised of moderate energy Atlantic infralittoral mixed sediments (EUNIS 2019 habitat description code: MB42), with deeper areas in the Approach Channel to the port containing moderate energy Atlantic circalittoral mixed sediment (MC42). The latter is the primary habitat in deeper waters at a distance of 1km offshore from the outer berth. Towards the centre of the main Firth of Forth channel, there are extensive areas of finer sediment, principally moderate energy Atlantic circalittoral mud (MC62). Adjacent to the shoreline to the east of the proposed dredge area, to the south of the disposal site, are a series of rocky outcrops known as the Middle Craigs and Eastern Craigs, which are comprised of moderate energy Atlantic infralittoral rock (MB12) and are algal covered at lower elevations.

The benthic macrofaunal communities in proximity to Narrow Deep B spoil disposal ground are expected to be typical for estuarine conditions and not considered to be of high conservation significance due to the wide distribution, low diversity and lack of any rare or notable species (Elliot and Kingston, 1987). Narrow Deep B is an existing licenced spoil disposal ground therefore benthic communities within the site and surrounding areas have been impacted by ongoing spoil deposition activities that have occurred there over more than 50 years. Seabed habitat mapping from the EUSeaMap project indicates that the seabed in the spoil ground and in areas likely to be affected by sediment deposition during disposal are generally characterised by low to moderate energy Atlantic circalittoral mud (MC62) and infralittoral mud (MB42) (hence is likely to be prone to natural periodic disturbance). In the context of the wider area, low to moderate energy circalittoral mud is by far the most prevalent habitat type across the entirety of the mid- to outer- Firth of Forth.

9.5.2.2 Benthic Ecology Survey

A benthic ecology survey, comprising video transects and benthic samples, was carried out in June 2023 (**Figure 9-2**). The survey report can be found in **Appendix 9-1** with summary statistics in **Table 9-5**. Across the stations the diversity of species was generally very high. High abundances of annelid worms occurred across much of the sampling area.



Legend:

Dredge Area

Ecospan benthic sampling locations and biotopes (2023)

- A4.173
- A5.333
- A5.5213

EUSeaMap (2021) Broadscale Habitat Map

- A3.2: Atlantic and Mediterranean moderate energy infralittoral rock
- A5.33: Infralittoral sandy mud
- A5.35: Circalittoral sandy mud
- A5.43: Infralittoral mixed sediments
- A5.44: Circalittoral mixed sediments
- Infralittoral seabed

Client:	Project:
Forth Ports Limited	Port of Leith Outer Berth: Approach Channel Deepening

Title: Benthic Survey Sample Points and EUNIS Biotope Layer

Figure: 9-2 | Drawing No: PC4514-RHD-ZZ-XX-DR-Z-0002

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	05/12/2023	GC	CB	A3	1:20,000

Co-ordinate system: British National Grid

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Table 9-5 Univariate summary statistics of the benthic ecology survey

Sample	No of taxa	Abundance	Margalef's species richness (d)	Pileou's Evenness (J')	Shannon Wiener Diversity (H'(loge))	Simpson's Dominance (1-λ)	Distance to ZoI (Km)	Biotope
1	88	1650	11.7	0.73	1.42	0.94	Within	A5.333
2	20	61	4.62	0.85	1.11	0.9	Within	A5.333
3	138	2319	17.68	0.71	1.51	0.93	Within	A4.173
4	85	1162	11.9	0.73	1.41	0.93	Within	A4.173
5	138	2026	17.99	0.65	1.39	0.9	Within	A4.173
6	155	1728	20.66	0.75	1.65	0.95	Within	A4.173
7	160	1993	20.93	0.71	1.57	0.93	Within	A4.173
8	126	1632	16.9	0.74	1.55	0.95	Within	A4.173
9	152	2241	19.57	0.76	1.65	0.95	Within	A4.173
10	111	1006	15.91	0.72	1.48	0.93	Within	A4.173
21	84	1798	11.07	0.7	1.35	0.93	Within	A5.333
22	32	364	5.26	0.63	0.95	0.81	Within	A5.333
11	61	666	9.23	0.7	1.25	0.9	0.28	A5.333
12	152	1631	20.41	0.79	1.73	0.97	0.43	A4.173
13	94	1897	12.32	0.67	1.31	0.88	0.19	A4.173
14	134	1650	17.95	0.69	1.46	0.92	0.28	A4.173
15	134	1649	17.95	0.75	1.59	0.95	0.84	A4.173
16	136	1490	18.48	0.72	1.54	0.94	1.07	A4.173
17	117	1410	16	0.71	1.46	0.91	0.11	A4.173
18	150	2812	18.75	0.73	1.59	0.93	0.37	A5.5213
19	125	1449	17.04	0.73	1.54	0.94	0.71	A4.173
20	175	2073	22.78	0.78	1.75	0.97	0.86	A4.173

The SIMPROF MDS analysis on the macrobenthic communities found at the sampling locations found that the community structure formed statistically significant clusters based on the habitat biotopes (A5.333 or a mosaic of A4.137/A5.443). The community structure of the softer sedimentary biotopes (A5.333 and A5.443) is characterised by annelid worms with a high number of burrowing or tube building polychaete worms, which were the most common taxa contributing at least more than one percent to each biotope abundance (**Table 9-6**). The A5.333 biotope did support some epifaunal species with brittle starts found during the drop-down video survey. The A4.137/A5.443 mosaic contained species typically found on rock/coarse substrate due to the influence of A4.137 which is characterised by hydroids and anemones and nudibranchs. In addition, this biotope included starfish and widespread hydrozoan and bryozoan turf.

Table 9-6 Species that were contributing over one percent to the abundance found in each biotope community.

Species	Percentage abundance (%)	Average abundance	Biotope	Species notes
Melinna palmata	3.15	4.05	A4.173	Tube building polychaete worm
Levinsenia gracilis	2.73	3.44	A4.173	Burrowing polychaete worm
Ampharate lindstreomi	2.27	3.01	A4.173	polychaete worm
Juvenile Nephtys	2.02	2.58	A4.173	Burrower and mobile polychaete worm
Tubificoides amplivasatus	2.00	2.64	A4.173	polychaete worm
Mediomastus fragilis	1.98	2.56	A4.173	polychaete worm
Rhodine gracilior	1.94	2.68	A4.173	Burrowing and filter feeding polychaete worm
Galathowenia oculata	1.94	2.62	A4.173	Tube building polychaete worm
Chaetozone gibber	1.80	2.28	A4.173	Tube building polychaete worm
Pholoe inornata	1.74	2.33	A4.173	Tube building and burrowing polychaete worm
Tubificoides amplivasatus	6.80	2.74	A5.333	polychaete worm
Melinna palmata	6.35	2.57	A5.333	Tube building polychaete worm
Ampharate lindstreomi	5.86	2.14	A5.333	polychaete worm
Levinsenia gracilis	5.56	2.41	A5.333	Burrowing polychaete worm
Tubificoides swirencoides	5.30	2.49	A5.333	polychaete worm
Chaetozone gibber	5.13	2.16	A5.333	Tube building polychaete worm
Mediomastus fragilis	3.83	2.4	A5.333	polychaete worm
Junvenile Nephtys	3.32	1.19	A5.333	Burrower and mobile polychaete worm
Nephtys incisa	3.09	1.25	A5.333	Burrower and mobile polychaete worm
Euclymene oerstedi	2.88	2.13	A5.333	Tube building polychaete worm

A SIMPER analysis looked at the similarities between the communities found in the samples. There was an average similarity of 62% between the stations forming the mosaic A4.137/A5.443 showing that these communities were quite uniform. Stations within the biotope A5.333, mostly occurring within the maintenance dredge area, exhibited lower similarity between their communities.

To ensure the community analysis is as relevant as possible, further analysis of the benthic ecology survey was split into biotopes. Within the ZoI the survey found that the number of macrobenthic taxa, abundance and species richness were on average the same as the areas outside of the footprint for biotope mosaic A4.173/A5.443 and both were higher than biotope A5.333 (**Table 9-7**).

*Table 9-7 Averaged univariate summary statistics of the benthic ecology survey grouped by the ZoI and biotopes. * Based on one sample location*

ZoI	Maintenance dredge area	Biotope	Averages					
			No of taxa	Abundance	Margalef's species richness (d)	Pileou's Evenness (J')	Shannon Wiener Diversity (H'(loge))	Simpson's Dominance (1-λ)
Inside	Inside	A4.173/ A5.443	111.5	1740.5	14.79	0.72	1.46	0.93
Inside	Outside	A4.173/ A5.443	140.3	1771.0	18.66	0.72	1.55	0.94
Outside	Outside	A4.173/ A5.443	133.4	1656.	17.87	0.73	1.55	0.94
Inside	Inside	A5.333	56.0	968.3	8.16	0.73	1.21	0.90
Outside	Outside	A5.333	61.0	666.0	9.23	0.70	1.25	0.90

Between the biotope samples, inside and outside of the ZoI, the evenness, diversity and dominance statistics were less than nine percent different. This suggests no significant difference in the communities of species found inside or outside of the predicted ZoI. Samples that were taken from within the proposed capital dredge area but outside of the current maintenance dredge area showed higher overall mean numbers of taxa, and a higher mean species richness compared to the maintenance dredge area and areas outside of the ZoI within biotope mosaic A4.173/A5.443, but not statistically significant differences between the areas (Kruskal-Wallis, $p>0.05$). The additional species found in the areas outside the maintenance dredge areas included taxa of the Porifera phyla and the bivalve family Anomiidae. These species are more sensitive to smothering as they are filter feeders that rely on filtering particles out of the water column as well as directly impacted by removal. Furthermore, the additional taxa found outside of the maintenance dredge area but within the ZoI were in low numbers per grab samples, contributing to less than one percent of the overall average abundances of that area. These additional taxa included five species of Hydrozoa; *Campanulariidae, Fillifera, Lovenella clausa, Sertularella, Nemertesia* and two species of Annelids; *Golfingia elongata* and *Thysanocardia procera*. As well as 23 species of polychaetes: *Acromegalomma, Amphitcteis gunneri, Acmira catherinae, Cirriformia tentaculate, Dialychone longiseta, Dipolydora coeca, Dodecaceria, Epigamia alexandri, Eulalia aurea, Eulalia ornata, Eulalia viridis, Eupolynmia nesidensis, Eumida bahusiensis Eusyllis blomstrandi, Harmothoe clavigera, Harmothoe extenuata, Lepidonotus squamatus, Malmgrenia bicki, Pholoe assimillis, Phyllodoce longipes, Pseudomystides limbate, Serpulidae and Syllidia armata.*

Stations 2 and 4 supported sea pens, which are generally sensitive to physical disturbance but were found within the maintenance dredging area. The species found, *Virgularia mirabilis*, is more tolerant to physical disturbance than other sea pens however, and it was found in the sample taken from the edge of the dredge area.

There were no Species of Conservation Interest or invasive non-native species observed in the proposed dredging area (**Appendix 9-1**). The only area of interest was the biotope A5.5213 (which occurs under the priority feature 'Kelp and seaweed communities on sublittoral sediment') which occurs outside of the proposed dredging area and ZoI. The sensitivity of this community to smothering by suspended sediment is low.

9.5.2.3 Priority Marine Features

Although not necessarily afforded protection by legislation or other designations, Scottish Ministers adopted a list of PMFs that are marine nature conservation priorities in Scottish waters. In producing the list, species on existing conservation schedules were assessed against criteria that considered i) whether the species occurs in significant numbers in Scotland's seas; ii) whether the species is under threat of decline; and iii) the functional role that the species plays.

Distribution of intertidal/subtidal PMFs in Scottish waters is presented through Marine Scotland's National Marine Planning Interactive tool. According to the tool, very few habitat PMFs are recorded within the outer Firth of Forth and none are within the ZoI of the capital dredging or sediment plume footprint from sediment disposal.

Only one PMF habitat was identified, which occurred 0.369km outside of the ZoI, which was the sub biotope `A5.5213 (shown on **Figure 9-2**) - *Laminaria saccharina* and filamentous red algae on infralittoral sand`. The sensitivity of this sub-biotope to smothering is considered low and given that it is outside the ZoI, it is unlikely to be affected by the Proposed Scheme.

9.6 Prediction of Potential Significant Effects During the Construction Phase

Potential impacts on marine ecology during construction include:

- Direct loss of benthic habitats within the footprint of the existing maintenance dredge area;
- Direct loss and smothering of benthic habitats within the footprint of the approach channel extension area; and
- Release of contaminants during dredging and disposal.

9.6.1 Direct loss of Benthic Habitats with the Footprint of the Existing Maintenance Dredge Area

The biotope within the proposed dredge area that falls within the maintenance dredge area is characterised by the bivalves *Mysella bidentata* and *Abra* spp. in infralittoral sandy mud. These species occur in finer sediments and burrow into the sediment, feeding on the deposits on the seabed. Within the current maintenance dredge area the diversity of species is lower when compared to stations outside of this area. In addition, from the survey (**Appendix 9-1**), there were no unique species that were found within this area that were not found outside of the ZoI in each of the biotopes. The species and habitats observed are mostly opportunistic species that have rapid life cycles, high larval recruitment and grow quickly and as such are able to colonise disturbed habitats rapidly. The communities found in these areas are likely to have been affected by sedimentation in the past, which could have occurred from deposits from the River Leith and due to changes caused by previous dredging campaigns.

The species populations of the community found in the maintenance dredge area are mainly species that are opportunistic settlers, tolerant to change from dredging. The highest populations found were that of tube building polychaete worms that formed the ecological basis of the communities present within the maintenance dredge area. Based on the sediment (fine sand, silt and gravel) and tidal strengths (maximum 0.54 m/s) of the area (see **Chapter 7: Coastal Processes**) we can estimate that that the recovery of the populations of these polychaete worms and thus the other supported species, post dredging, will likely take less than three years (Coastline Surveys Europe, 2002; Foden *et al*., 2009).

Within the maintenance dredge area there were also abundances of the sea pen *Virgularia mirabilis* present from the DDV survey in two locations sampling site 2 (inside the maintenance dredge area) and 4 (just outside the maintenance dredge area). This species has a medium resistance and medium sensitivity to direct loss of habitat or abrasion (Wilson and Hill, 2023). They have moderate recoverability to habitat loss and can immediately recover from displacement (Wilson and Hill, 2023). Populations of these species were also detected outside of the maintenance dredge areas, which could benefit these species recovery post-dredging. Although, no information is known on their maturity and recovery time post habitat loss (Wilson and Hill, 2023). The presence of this species within and close to the maintenance dredging area indicates that it could recover relatively quickly as it has species to provide recolonisation potential and it has survived despite the presence of the existing maintenance channel.

Given the species present in this area (of **low** overall sensitivity and value) and the existing maintenance regime in the area (leading to a magnitude of **low**), the dredging in this area would have a **negligible effect** on the communities in this area.

Mitigation Measures
No mitigation is required.

Residual effect
The dredging in this area would have a **negligible effect** on the communities in this area.

9.6.2 Direct loss and Smothering of Benthic Habitats as a Result of Dredging within the Footprint of the Approach Channel Extension Area and Disposal Area

9.6.2.1 Direct Loss of Benthic Habitats

Table 9-7 shows that the number of taxa, and species richness, within the approach channel extension area is higher than the adjacent biotopes in the maintenance dredge area and higher than areas outside of the proposed area of dredging. These additional species included taxa of the Porifera phyla and the bivalve family Anomiidae, but these species were in relatively low abundance (less than 1% of the total abundance) and are not a priority or unique species to the area just slightly different species to the unidentified Anomiidae species detected outside of the extension area. The biotope mosaic present in this area includes the biotope A4.173 which is characterised by species that are typical of harder substrates and comprise mostly epifaunal species. Other species forming part of this mosaic includes anemones, crustaceans, and echinoderms. This biotope mosaic includes species that are more sensitive to direct impact and would be more sensitive to smothering. In addition, once the harder substrate is removed during dredging it is unlikely that the biotope mosaic will recover, and the area is more likely to recolonise with species from the area that is currently dredged for maintenance. There would therefore be a loss of the more diverse biotope with biotopes characterised by annelid worms.

9.6.2.2 Smothering of Benthic Habitats

As discussed in **Section 7.6**, sediment deposition within the disposal site has been predicted to be between approximately 1.5m and 1.9m (**Figure 7-18**); however, with progression away from the disposal site the amount of deposition reduces considerably. Seabed deposition reduces to less than 0.1m approximately 3km northeast and approximately 4km west-southwest from the centre of the disposal site. Deposition as a result of dredging is predicted to be below 0.1m (**Figure 7-18**).

Areas within the ZoI of sediment deposition from dredging and disposal are within the EUSeaMap broadscale habitats A5.44 (circalittoral mixed sediments) and A5.35 (circalittoral sandy mud).

The sandy mud habitats (A5.35) are expected to support mostly burrowing species and are the closest habitat to the disposal site. Further away from the disposal site, and the area affected by the deposition from dredging, is the broadscale habitat characterised as A5.44 (circalittoral mixed sediments), which is the same as the area described above in **Section 9.6.2.1** where the survey work has shown this area to be classified as the biotope A4.173 (EUNIS, 2019). The habitats surrounding the disposal site within the broadscale habitat A5.44 are thus expected to have a similar ecological structure to the ones found in the benthic survey (**Appendix 9-1**).

Within the area characterised as A5.35, the species and surrounding habitats are not anticipated to be adversely affected by the increased amount of sediment disposed at this site. This is due to the fact that the disposal area is already in use for disposal and that the habitats are predominantly sandy mud with opportunistic polychaetes that have high resilience to smothering and disturbance to the substratum.

Species within the biotope A4.137, immediately surrounding the channel extension dredge footprint and affected by the outer areas of the sediment deposition from disposal, are more sensitive to smothering and less likely to have been affected previously; however, the area outside of the dredge footprint is likely to recover as the hard substrate would not be lost and the same species are present outside of the affected area to enable recovery.

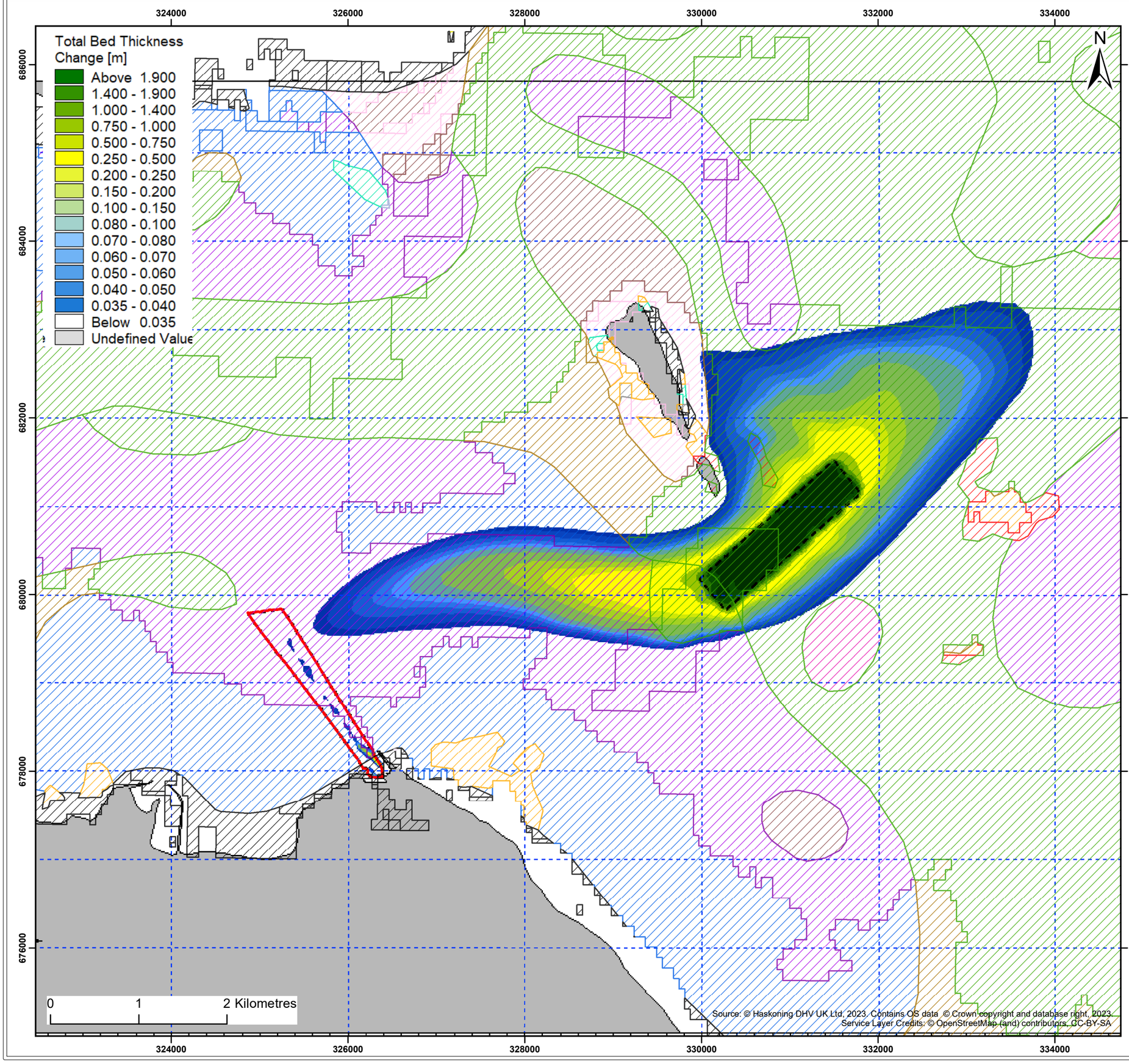
As noted in **Section 7.6.2.1**, after deposition has ceased the sediment would be continually re-suspended to gradually reduce the thickness. The longer-term outcome would be a significantly reduced thicknesses once the sediment supply from dredging has ceased.

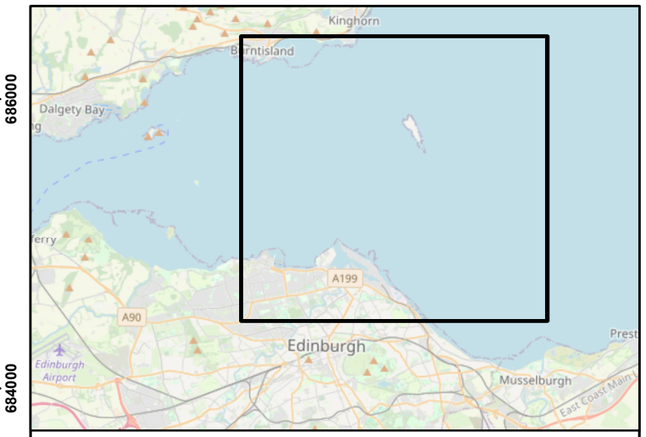
9.6.2.3 Prediction of Potential Effects from Dredging of the Approach Channel Extension Area and Disposal

Taking the combined areas of broadscale habitats present in the Firth and Tay estuaries, as published, impact zones have been estimated and less than 7% of the overall broadscale habitats in this area would be affected by the dredging of the approach channel extension and disposal activities (**Table 9.8** and **Figure 9-3**).

Table 9-8 Estimated impact (above 0.1m of deposition) on the percentage coverage of biotopes in the Firth and Tay area from the proposed dredging of the approach channel extension and disposal activities.

Broadscale habitats	Estimated maximum impact from proposed dredge (%)	Estimated maximum impact from sediment deposition from disposal (%)	Estimated overall maximum impact from ZoI (%)
A5.35 Circalittoral sandy mud	0.0	1.2	1.2
A5.44/A4.137 Circalittoral mixed sediments and faunal turf mosaic	2.5	1.9	4.4
A5.43/A5.333 Infralittoral mixed sediments/ Mysella bidenata and *Abra sp.*	0.5	0.7	1.2
Total	**3.0**	**3.8**	**6.8**





Legend:

- Dredge Area

EUSeaMap (2021) Broadscale Habitat Map

- A3.2: Atlantic and Mediterranean moderate energy infralittoral rock
- A3.3: Atlantic and Mediterranean low energy infralittoral rock
- A3: Infralittoral rock and other hard substrata
- A4.2: Atlantic and Mediterranean moderate energy circalittoral rock
- A4.3: Atlantic and Mediterranean low energy circalittoral rock
- A4: Circalittoral rock and other hard substrata
- A5.13: Infralittoral coarse sediment
- A5.14: Circalittoral coarse sediment
- A5.33: Infralittoral sandy mud
- A5.35: Circalittoral sandy mud
- A5.36: Circalittoral fine mud
- A5.43: Infralittoral mixed sediments
- A5.44: Circalittoral mixed sediments
- Infralittoral seabed

Client:	Project:
Forth Ports Limited	Port of Leith Outer Berth: Approach Channel Deepening

Title: Maximum Zone of Influence from Proposed Capital Dredge and Sediment Disposal Bed Level Change with the EUNIS Biotope Layer

Figure:	Drawing No:
9-3	PC4514-RHD-ZZ-XX-DR-Z-0003

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	05/12/2023	GC	CB	A3	1:42,337

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

The biotopes with the footprint of the approach channel extension area would be unlikely to recover and would be replaced with species from the area that is currently dredged for maintenance. Other areas within the same broadscale habitat should recover in the short to medium term.

The area directly affected by the disposal is within a biotope that is characterised as circalittoral sandy mud which is not expected to provide a habitat for species that are sensitive to smothering. Such habitats are more likely to support burrowing species or mobile epifaunal species. In addition, this area will already have been subject to deposition from previous dredge disposal campaigns and as such is expected to be colonised by opportunistic species rather than longer-lived more sensitive species.

The areas affected of the overall broadscale habitat are small, as shown above, and overall effect is <10%. Given this the magnitude of the impact is considered to be **Low**. The affected habitats are of local importance; given some of the habitat would recover but a small proportion would not, the sensitivity is considered to be between **medium** and **low**. The overall effect is therefore considered to be **minor adverse, which is not considered significant in EIA terms**.

Mitigation Measures
No mitigation is required.

Residual Impact
The residual impact remains as **minor adverse, which is not significant in EIA terms**.

9.6.3 Release of Contaminants During Dredge and Disposal

The potential effect of the release of contaminants during dredging and disposal on marine water and sediment quality is discussed in **Section 8.6**.

With the exception of a few PAHs all contaminates are below AL1 (**Table 8-6**), which is an accepted method of approval for determining the suitability for sediment disposal at sea.

Given this the magnitude of the potential impact is **low**. The sensitivity and value of the benthic habitats in this area are considered **low** and therefore **negligible** effect is predicted.

Mitigation Measures
No mitigation is required.

Residual Effect
The residual impact remains as **negligible, which is not significant in EIA terms**.

9.7 Prediction of Potential Significant Effects During the Operation Phase

There would not be any significant change during operation compared to the existing activity levels (for example, in terms of vessel traffic in and out of the busy port); therefore, there would not be any potential to impact marine ecology during the operational phase.

9.8 Summary

Table 9-9 summarises the potential effects on marine ecology receptors assessed in this chapter. Negligible and minor adverse effects are not significant in EIA terms.

Table 9-9 Summary of potential effects to marine ecology

Potential Impact	Sensitivity/Value	Magnitude	Significance	Mitigation	Residual Impact
Construction					
Direct loss of benthic habitats within the footprint of the existing maintenance area	Low	Low	Negligible	None proposed	Negligible
Direct loss and smothering of benthic habitats as a result of the proposed dredging of the approach channel extension and disposal activities	Medium	Low	Minor adverse	None proposed	Minor adverse
Release of contaminants during dredging and disposal	Low	Low	Negligible	None proposed	Negligible
Operation					
No effects predicted					

10 Fish and Shellfish Ecology

10.1 Introduction

This chapter of the sEIA Report considers the potential effects of the Proposed Scheme on migratory and estuarine fish populations in the Firth of Forth. It describes the methods used to assess potential impacts, and the baseline conditions currently existing within the Proposed Scheme's footprint and the surrounding area. The mitigation measures required to prevent, reduce or off-set any impacts are presented together with the likely residual effect significance levels after these measures have been adopted.

This chapter is supported by the following chapters:

- **Chapter 7: Coastal Processes**; and
- **Chapter 8: Marine Water Sediment Quality**.

10.2 Legislation, Policy and Guidance

10.2.1 Legislation

10.2.1.1 Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ('the Habitats Regulations')

The Habitats Regulations transpose Council Directive 92/43/EEC ('the Habitats Directive') into Scottish national law. The Regulations require competent authorities to consider or review planning permission, applied for or granted, affecting nature conservation designations within the UK's National Site Network – including SACs designated for migratory fish species – and, subject to certain exceptions, restrict or revoke permission where the integrity of the site would be adversely affected. Details on the sites within the National Site Network are designated for Annex II migratory fish features and may be affected by the Proposed Scheme are provided in **Section 10.5**. An HRA supplementary Report to Inform Appropriate Assessment (hereafter referred to as the sRIAA) (PC4514-RHD-YY-XX-RP-EV-0018), undertaken in accordance with the Habitats Regulations, has also been undertaken on the Proposed Scheme and provided in support of the marine licence applications.

10.2.2 Policy and Plans

10.2.2.1 Scotland's National Marine Plan

General policy 'GEN 9: Natural Heritage' of the Scotland's NMP focuses on the achievement of the objective 'living within environmental limits' by ensuring that development and use of the marine environment must, inter alia:

- Comply with legal requirements for protected areas and species;
- Not result in significant impact on the national status of PMFs; and
- Protect and, where appropriate, enhance the health of the marine area.

General policy 'GEN 13: Noise' of the NMP states that:

"Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects."

Within the Wild Salmon and Diadromous Fish section of the NMP, there is a policy stating that:

"The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision-making processes."

In adherence to this policy, marine planners and other decision makers should act in the way best calculated to further the achievement of sustainable development, including the protection of the health of the marine area. The Strategy for Marine Nature Conservation in Scotland's Seas sets out aims and objectives to achieve this. The Strategy outlines a three-pillar approach to conservation:

- Site protection: plans or projects may only be approved if they will not have a significant effect on the site integrity of SACs (and SPA, Ramsar sites, SSSIs and MPAs).
- Species protection: if there is evidence to suggest that a protected species may be affected by a Proposed Scheme, the protection afforded by legislation must be factored into the planning and design of the development and impacts fully considered.
- Wider seas measures: consideration must be given to PMFs in marine planning, including fishes listed as Priority Marine Species.

10.2.2.2 Edinburgh Biodiversity Action Plan

The UK generated the UK Biodiversity Action Plan (BAP) in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets.

The sixth edition of the Edinburgh BAP (covering 2022-2027) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the importance of ensuring protected and priority species (including PMF fish species) are reflected in plans, policies, strategies, projects and other activities, as appropriate.

10.3 Consultation

Responses received during the EIA scoping process relevant to fish and shellfish ecology (**Table 10-1**) have been taken into account when undertaking the assessment presented in this chapter.

Table 10-1 Fish and shellfish ecology consultation

Consultee	Date/Document	Comment	Response/where addressed in the sEIA Report
Scottish Ministers	Scoping Opinion – September 2023	The Applicant has considered the potential impacts on fish and shellfish ecology in section 4.7 of the Scoping Report. Underwater noise during dredging activity, the potential for increased suspended sediment concentration during dredging and deposit and release of contaminants during dredging and deposit have been scoped in for further assessment in the sEIA Report. As the 2022 EIA Report assessed the potential effects on changes to habitat availability on fish and shellfish species as negligible no further assessment is deemed to be required. In addition, piling noise from the construction of the proposed retaining wall is predicted to be of a lower	Further assessment of potential impacts is set out in **Section 10.6**.

Consultee	Date/Document	Comment	Response/where addressed in the sEIA Report
		magnitude than previously assessed in the 2022 EIA Report and therefore the Scoping Report concludes that no further assessment is required.	
		The Scottish Ministers agree with the content and approach to the assessment of fish and shellfish ecology proposed in the Scoping Report and advise that this must be included in the sEIA Report.	Noted
		The Applicant proposed that a number of topics were scoped out of the sEIA Report on the basis that either there is no pathway for effect from the Proposed Works or that any impacts can be controlled by standard mitigation measures already in place for the Licensed Works. A list of these topics can be found in section 4.2 of the Scoping Report. No representations or advice was received to disagree with the conclusion of the Scoping Report. However, the Scottish Ministers direct that where relevant mitigation was identified in the 2022 EIA Report, this should be included in the sEIA Report.	Whilst no further assessment is required for underwater noise associated with the Proposed Scheme, the relevant mitigation identified in the Outer Berth EIA report is included in this sEIA report (**Section 10.8**).

10.4 Assessment Methodology

10.4.1 Study Area

For the purpose of assessment on fish and shellfish ecology, the study area comprises the likely maximum extent over which potentially significant environmental effects of the Proposed Scheme may occur. This has been informed by the sediment dispersion modelling of the dredging and disposal activities (**Section 7.6.1**) and the extent to which underwater noise from dredging activities that could have physiological and/or behavioural effects on fish species. The study area encompasses both of these impact ranges, with the extent of the sediment plume being the larger of the two and is displayed in **Figure 7-11**.

10.4.2 Data Sources

Sources of data that have been used in providing the required evidence for the assessment include:

- Scottish Natural Heritage's (SNH) (now NatureScot) HRA on the Firth of Forth: A Guide for developers and regulators (SNH, 2016);
- Site-specific sediment dispersion modelling (as described in **Section 7.6.1**) and subsequent sediment deposition (as described in **Section 7.6.2**);
- Site-specific sediment sample analysis of dredged material, as described in **Section 8.5.3**; and
- Spawning and nursery grounds as identified by Ellis *et al.* (2012) and Coull *et al.* (1998).

10.4.3 Assessment Methodology

For the purposes of the assessment of potential impacts on fish and shellfish ecology receptors, the methodology used is as per the general approach set out in in **Section 5.6**.

10.5 Baseline Environment

The information presented herein is consistent with the Outer Berth EIA Report and is reiterated here for convenience and ease of reference.

10.5.1 Migratory Fish Associated with River Teith SAC

The NatureScot Firth of Forth HRA guidance document (SNH, 2016) states there is the potential for connectivity with the River Teith SAC due to the migration routes of Atlantic salmon *Salmo salar*, sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatilis*. These species are known to occur within the wider Forth Estuary during parts of their life cycle.

10.5.1.1 Sea Lamprey

Mature sea lamprey migrate to the River Teith SAC and freshwater reaches of the Forth every year to spawn. Spawning in the Teith and Forth usually occurs from May to July, when the water temperature reaches at least 15°C, in areas with pebble and cobbles substrate (SNH, 2016; NatureScot, 2023), and mature sea lamprey start to migrate upstream through the Firth of Forth as early as April. Adults die after spawning. Juvenile lamprey settle in silt beds within the SAC for up to five years, before pre-adult lamprey migrate downstream to the open sea, typically between October and December, during hours of darkness (SNH, 2016). Sea lamprey will spend up to two years feeding at sea and reaching sexual maturation before migrating back to the SAC (SNH, 2016).

10.5.1.2 River Lamprey

As with sea lamprey, river lamprey live in freshwater as juveniles, before migrating out to estuarine or coastal areas for maturation. Mature river lamprey adults return to the SAC every year from October to December, and begin spawning on gravel/pebble substrates when water temperatures reach 10-11°C, typically in late March to May (SNH, 2016; NatureScot, 2023). Juveniles disperse into silt beds and remain in the SAC for three to five years, before migrating, during darkness, to the Firth of Forth and other coastal or estuarine areas where they will spend up to two years feeding and reaching maturation.

10.5.1.3 Atlantic Salmon

Atlantic salmon within the Firth of Forth have a complex life cycle, which begins and ends in freshwater spawning grounds in the catchments of the rivers Forth, Teith, and Allan (SNH, 2016). Depending on water temperature and food availability, Atlantic salmon typically spend four years as juveniles in freshwater, before migrating downstream and out to sea. They then spend up to four years at sea, before migrating back to their spawning grounds as mature adults. Juvenile smolt migrate from freshwater to sea from March to May, and adults can migrate back to freshwater at any time of the year. Peak spawning occurs between November and December, but can extend from October to late February (SNH, 2016).

10.5.1.4 Other Migratory Fish

European eel *Anguilla 95lavate95* moves from freshwater to the sea to spawn, passing through the Firth of Forth en route to spawning grounds, which are thought to be located in the Sargasso Sea (Malcolm *et al.*, 2010). Planktonic European eel larvae return to European waters from the Sargasso Sea spawning grounds, developing into juvenile ‘glass’ eels in coastal and estuarine waters, before moving into freshwater riverine waters to continue development.

Young ‘glass’ eels generally arrive in Scottish marine waters from September to December but remain in coastal waters until April or May until river temperatures are sufficiently warm to promote further migration upstream. Mature adult eels undergo an ‘autumn’ seaward migration, but individuals may begin to leave rivers at almost any point of the year; in Scotland peak counts tend to be between August and October

(Malcolm *et al.*, 2010). As such, it is likely that key migratory periods in the Firth of Forth would be April to May (juvenile migration upstream) and August to October (adult downstream migration).

Data collected at the Longannet power station further upstream (SKM, 2011) shows that as well as European eel and the SAC features listed above, other migratory fish travel through the Firth of Forth. These species include European smelt *Osmerus eperlanus*, which migrates upstream during spring to spawn (Maitland and Lyle, 1996) and sea trout *Salmo trutta*, which migrate upstream as juveniles to overwinter and as adults to spawn (Malcolm *et al.*, 2010; O'Reilly *et al.*, 2021).

Twaite shad *Allosa falax* and allis shad *A. alosa*, which are both classified as rare species in Appendix III of the Bern Convention and Annexes II and V of the Habitats Directive, are occasionally recorded in the Firth of Forth but are not regular and are not features of any nearby SAC (Forth Rivers Trust, 2020).

10.5.2 Resident Estuarine Fish and Shellfish

The Firth of Forth supports a diverse range of fish species, and encompasses several areas reported to be spawning and nursery grounds for species, including herring *Clupea harengus,* cod *Gadus morhua,* whiting *Merlangius merlangus,* plaice *Pleuronectes platessa*, sprat *Sprattus*, and lemon sole *Microstomus kitt* (Ellis *et al.*, 2012; Coull *et al.,* 1998). An abundance of other species is also known to be present in the study area, including mackerel *Scomber scombrus*, blue whiting *Micromesistius poutassou* and ling *Molva molva* (Ellis *et al.*, 2012; Coull *et al.,* 1998).

Several other fish species are known to be present within the Firth of Forth, including flounder *Pleuronectus flesus*, lesser sandeel *Ammodytes tobianus*, common goby *Pomatoschistus microps*, and small spotted catshark *Scyliorhinus canicular* (Forth Port Properties Ltd, 2007).

A range of shellfish species may be found in the vicinity of the Proposed Scheme, including brown shrimp *Crangon crangon,* which have been recorded throughout the Firth of Forth, while the pink shrimp *Pandalus montagui* occurred in the lower reaches of the estuary (Jayamanne, 1995). Razor shells *Ensis spp*. Have been recorded in the inshore areas (Robson, 1997). Other shellfish species found in southeast Scotland that may be found in the Firth of Forth include European lobster *Hommarus 96lavate96*, edible crab *Cancer pagurus*, velvet swimming crab *Necora puber*; king scallop *Pecten maximus*, Norway lobster *Nephrops norvegicus*, and the squid *Loligo forbesi* (Beard and McGregor, 2004; Robson, 1997).

10.5.3 Conservation Interest

Although not necessarily afforded protection by legislation or other designations, Scottish Ministers adopted a list of PMFs that are considered to be marine nature conservation priorities in Scottish waters. In producing the list, species on existing conservation schedules were assessed against criteria that considered i) whether the species occurs in significant numbers in Scotland's seas; ii) whether the species is under threat or in decline; and iii) the functional role that the species plays. The list of PMFs includes a number of fish and shellfish species that are understood to be potentially present in the study area, as presented in **Table 10-2.**

Table 10-2 Fish and shellfish Priority Marine Species that are likely to be present in the study area

Common Name	Scientific Name
Anglerfish	*Lophius piscatorius*
Basking shark	*Cetorhinus maximus*
Blue mussel	*Mytilus edulis*
Cod	*Gadus morhua*

Common Name	Scientific Name
European eel	*Anguilla anguilla*
Herring	*Clupea harengus*
Ling	*Molva molva*
Mackerel	*Scomber scombrus*
Native oyster	*Ostrea edulis*
River lamprey	*Lampetra fluviatilis*
Saithe	*Pollachius virens*
Atlantic salmon	*Salmo salar*
Sand goby	*Pomatoschistus minutus*
Sandeels	*Ammodytes spp.*
Sea lamprey	*Petromyzon marinus*
Sea trout	*Salmo trutta*
European smelt	*Osmerus eperlanus*
Whiting	*Merlangius merlangus*

There are 22 fish species on the OSPAR List of Threatened and/or Declining Species, of which 19 are present in OSPAR Region II (Greater North Sea). The OSPAR list is designed to identify species that require protection and guides the OSPAR Commission in setting priorities for future conservation and protection of marine biodiversity. The list includes migratory species found regularly in the Firth of Forth (see **Sections 10.5.1** and **10.5.2**), namely Atlantic salmon, sea lamprey and European eel, plus resident fish species that are associated with estuarine environments around the east Scotland coast such as cod, spotted ray *Raja montagui*, thornback ray *R. 97lavate* and spurdog *Squalus acanthias*. During the summer of 2023, basking sharks *Cetorhinus maximus* were frequently sighted in the Firth of Forth (Farr, 2013), however there are currently no abundance information to calculate densities (Marine Scotland, 2023). Native oysters *Ostrea edulis* have also returned to the Firth of Forth as of September 2023 (Heriot Watt University, 2023).

10.6 Prediction of Potential Significant Effects during the Construction Phase

The following potential impacts on fish and shellfish ecology have been scoped into the sEIA:

- Underwater noise during dredging, which could have physiological and/or behavioural response impacts;
- Increased SSC during dredging and disposal; and
- Release of contaminants during dredging and disposal.

10.6.1 Underwater Noise during Dredging

Use of dredging vessels would not form a significant increase in vessel activity in and around a busy working port, and would not form a significant source of underwater noise disturbance; however, the use of TSHD or BHD would likely contribute to underwater noise that may cause a physiological and/or behavioural response in fish. Dredging works are due to be completed within four months.

The existence of a potential impact pathway for migratory fish would be dependent on the time of year that works are undertaken; outside the migratory period, impacts are less likely to occur than if undertaken during peak migration periods. Whilst the actual timing has yet to be determined, this assessment is based on a worst-case scenario that the proposed dredging works would coincide with the peak migration season for at least one of the species of migratory fish.

Fish have a wide range of auditory capabilities, depending on the species, with audible frequencies mostly in the range of 30Hz to 1kHz. Fish can detect sound through mechanosensory organs including the otolithic organs and (for detecting nearby sounds) a lateral line system. As such, underwater sound arising from dredging is expected to fall within the hearing ranges of transitional (i.e. moving between freshwater and marine environments) fish species from the River Teith SAC (Popper, 2003).

The extent to which underwater sound might cause an adverse impact on fish is dependent on the sound energy level, sound frequency, duration and/or repetition of the sound wave, and the sensitivity of the species in question (Popper and Hastings, 2009). Impacts can be summarised into the following three broad categories (Popper *et al.,* (2014):

- Physical trauma/mortality: Either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g., a barotrauma) that death occurs sometime later, due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity;
- Auditory damage (temporary or permanent threshold shift (TTS or PTS[5])): Short term changes in hearing sensitivity may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals, affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure; and,
- Disturbance (i.e. behaviour modification, masking of background noise): Tissue and other physical damage, or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, infection, impaired feeding and growth, or lack of breeding success, until recovery takes place.

Of particular relevance for migratory fish species is the risk of underwater noise forming a ‘barrier’ to movement along migratory routes, potentially preventing upstream or downstream movement thus affecting productivity/spawning success.

Due to the risk of dredging works coinciding with migratory periods and potential causing an impediment (or ‘barrier effects’) to migratory species, the underwater noise assessment specifically focuses on the following migratory species that are known to be present in the Firth of Forth:

- Sea and river lamprey;
- Atlantic salmon;
- Sea trout;
- European smelt; and
- European eel.

[5] *Permanent Threshold Shift (PTS) thresholds do not form part of Popper et al., (2014) guidelines.*

Through consultation with Scottish Ministers, it was agreed that updating the underwater noise modelling presented in the Outer Berth EIA Report was not required, given that the underwater noise generated by dredging vessels would have no greater effect than what was predicted during the construction of the Outer Berth development.

The presence of a gas-filled swim bladder (or other gas chamber) increases the risk of sound pressure related injury (i.e. barotrauma), since the involuntary movement of the swim bladder caused by sudden pressure changes (notably from impulsive noises) can cause damage to it and surrounding organs. As such, fish with swim bladders are more sensitive to exposure to sound pressure (i.e. more likely to be physically harmed) than those without a swim bladder (Popper *et al.*, 2014). Given that barotrauma can lead directly or indirectly to mortality, impulsive anthropogenic sounds at a level capable of causing such injuries pose the most severe risk to fish.

Behavioural responses to underwater noise disturbance have the potential to occur anywhere within the zone of audibility and may include evasive actions or other altered behaviour due to masking of ambient background sounds. Masking effects can be significant if an anthropogenic sound prevents fish from responding to biologically relevant sounds. Some fish can detect sounds over a broader frequency range and at greater distances than other species due to their ability to detect sound pressure due to them having swim bladders close to the otolithic organs (i.e. the swim bladders are 'involved in hearing') (Popper *et al.* 2003). Those species are likely to modify their behaviour in response to sound exposure over a greater distance than those lacking swim bladders, or those with swim bladders not involved in hearing.

Compared to other teleost fish, salmonids (such as Atlantic salmon and sea trout) are particularly sound insensitive and lack specialist hearing mechanisms (Chapman and Hawkins, 1973; Hawkins and Johnstone, 1978). Studies on both species (e.g. Nedwell *et al.*, 2003; Harding *et al.*, 2016), indicate little behavioural response to exposure to underwater noise from piling sources. While unlikely to display behavioural responses, salmonids do have a swim bladder hence may be susceptible to the adverse injurious effects of pressure changes. This is similarly true for European smelt. As such, Atlantic salmon, sea trout and European smelt are considered to have a **medium** sensitivity.

European eels also have a swim bladder that is not associated with hearing mechanisms; this species displays rapid behavioural recovery from anthropogenic disturbance (Bruintjes *et al.*, 2016). Although previously considered to have a **low** sensitivity to hearing, a review by Popper and Fay (2011) indicated that this species is able to respond to sound pressure at high frequency. European eel is therefore considered to have a **medium** sensitivity.

Lamprey species are non-teleosts and do not possess a swim bladder. Although studies have indicated that there may be behavioural response to low frequency sounds (Mickle *et al.*, 2018), they are considered to have **low** sensitivity. Particle motion (vibration) effects are considered to be potentially more important to **low** sensitivity demersal fish, however, there is presently limited publicly available information on this issue.

The underwater noise modelling and assessment presented in the Outer Berth EIA Report (**Section 10.6.1** and **Appendices 10.1** and **10.2**) showed that recoverable injury to fish could only be expected at very close range to the noise sources (distances of less than 50m from the noise source). The TTS onset is predicted for fish at distances up to 50m from the dredging. Fish species would have to remain within 50m of the dredger for a period of 12 hours to be at risk of either recoverable injury, or TTS onset, which is considered to be highly unlikely.

Given the width of the Firth of Forth (approximately 8km), and the spatial extent of the potential impact, it is concluded that there would be no impact on migratory species (either moving in or out of the Forth) as a result of the dredging. Based on the above, the magnitude of the impact is assessed to be **low.**

As such, the overall significance of the effect on migrating fish is **minor adverse significance** for species with a swim bladder (salmonids, European smelt and European eel) and **negligible** for species that lack a swim bladder (lamprey).

Mitigation Measures and Residual Effect
No mitigation is required to reduce the effect significance. The overall residual effect is **minor adverse significance, which is not significant in EIA terms.**

10.6.2 Increased Suspended Sediment Concentrations during Dredging and Disposal

Dredging of fine material during the construction phase of the Proposed Scheme would result in a temporary increase in SSC. An increase in SSC in the water column may lead to physiological effects in finfish, including impaired swimming ability, immunosuppression (i.e. increased susceptibility to disease) and reduced rates of growth and larval development (Robertson *et al.*, 2007). Particles in the water column may increase the risk of asphyxiation due to inhibition of gaseous exchanges at the gill lamellae or blockage of the opercular cavity. Increased SSC can also result in decreased foraging efficiency and a reduction in the ability to detect and evade predators. As with underwater noise, adverse water quality effects (i.e. increases in SSC) may also potentially act as a barrier to fish migration.

10.6.2.1 Sensitivity of Species

Generally speaking, fish present in estuarine waters are anticipated to have a degree of resilience to relatively large changes in SSC due to the natural fluctuations in such environments associated with tidal activity, discharge from the river during high rainfall and increased wave action during storms. Mobile species (which, by definition, would include migratory species) are generally able to detect early onset of increased SSC and relocate away from the affected area. Nevertheless, a sediment plume creating a 'barrier' effect could cause a significant disruption to the annual migration pattern (Serra *et al.,* 2001; Winter *et al.,* 2023); hence, such species are considered to be more sensitive than resident species. For the purpose of this assessment, it has been assumed that the programme for the dredging and disposal may coincide with peak migration periods, and the sensitivity of receptors, as a worst-case, is considered to be **high**.

10.6.2.2 Magnitude of Impact

Total dredging for the Proposed Scheme would be approximately 1,410,000m^3 of material.

The extent of the sediment plume predicted from the proposed dredging and subsequent disposal is described in detail in **Chapter 7: Coastal Processes**. **Figure 7-11** to **Figure 7-13** presents modelled sediment plumes at different water layers (surface, mid-depth and seabed), indicating the predicted maximum SSC during dredging and disposal. Following each disposal event, SSC is predicted to disperse to baseline levels within an hour. Increases in SSC would only be experienced during the dredging and disposal campaign; hence, would not affect more than one migration period for a given species.

The sediment dispersion modelling predicted that significant increases in SSC during dredging would be confined to the immediate vicinity of the dredge footprint. The highest concentrations would be near the estuary bed, where the maximum at any point during the model simulation is predicted to be greater than 18,000mg/l at the point of dredging. With distance from the point of dredging, maximum concentrations are predicted to reduce to less than 1,000mg/l about 100m away and to less than 150mg/l between 400m and

1,000m away. SSC of 1,000mg/l are similar to those observed during periods of elevated waves (**Section 7.5.8**). As the Firth of Forth is a dynamic estuarine system, the suspended sediment would be further dispersed throughout the system to levels that equate to the ambient conditions, and so from the perspective of fish and shellfish ecology are irrelevant. As noted, the Firth of Forth at the location of the Proposed Scheme is approximately 8km wide; hence, there would be no significant obstruction or 'barrier effect' to migrating lamprey, salmonids, European smelt or European eels.

The offshore disposal site (Narrow Deep B Spoil Disposal Ground) is a licensed site which has been used in the past for disposal of fine sediments and is located where the estuary widens (the estuary is over 12km wide at this location). Significant increase in SSC exceeding 18,000mg/l at the point of release would be confined within the footprint and immediate vicinity of the disposal site, with lower magnitude increases (i.e. up to 200mg/l) possible at distances of up to *c.*2km north and *c.*500m south of the site. Such increases are within the natural variation typically characteristic of a dynamic estuarine environment. The sediment plumes from the modelling output represent the maximum area affected over the course of the disposal campaign; it is important to note that the entire plume would not be present at any single time.

Again, given the availability of unaffected waters within the main migratory path through to the River Teith, and the fact that increases in SSC outside of the disposal site are likely to be relatively minor and in line with natural variation in a dynamic estuarine environment (and would return to baseline quickly), there would be no risk of 'barrier effect' to migrating fish, and the magnitude of effect is considered to be **low**.

10.6.2.3 Significance of Effect

The overall significance of the effect on migrating fish is assessed to be **minor adverse effect, which is not significant in EIA terms.**

Mitigation measures and residual effect
No mitigation is required and as such the residual impact is of **minor adverse effect, which is not significant in EIA terms**.

10.6.3 Release of Contaminants during Dredging and Disposal

The potential effect of the release of contaminants during dredging and disposal on marine water and sediment quality is discussed in **Section 8.6.1**, with a minor adverse impact predicted. Given this, the localised and levels of deposition predicted, the magnitude of the potential impact is **low**. The sensitivity of fish and shellfish are also **low** and therefore a potential effect is **negligible**.

Mitigation measures and Residual Effect
No mitigation is required and as such the residual effect is **negligible**.

10.7 Prediction of Potential Significant Effects During the Operation Phase

There would not be any significant change during operation compared to the existing activity levels (for example, in terms of vessel traffic in and out of the busy port); therefore, there would not be any potential to impact fish and shellfish ecology during the operational phase.

10.8 Summary

Table 10-3 summaries the potential effects to fish and shellfish ecology assessed in this chapter. Negligible adverse and minor adverse impacts are not significant in EIA terms.

Table 10-3 Summary of potential effects to fish and shellfish ecology

Potential Impact	Receptor	Magnitude	Effect	Mitigation proposed	Residual effect
Construction					
Underwater noise	Migratory fish (salmon, trout, European eel)	Low	Minor adverse	No additional mitigation required with soft start procedures as per the JNCC protocol (JNCC, 2010).	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Low	Negligible		Negligible
Increased SSC	All fish and shellfish	Low	Minor adverse	None required.	Minor adverse
Release of contaminants	All fish and shellfish	Low	Negligible	None required.	Negligible
Operation					
No effects predicted					

11 Ornithology

11.1 Introduction

This chapter of the sEIA Report considers the potential effects of the Proposed Scheme on marine and estuarine bird populations in the Firth of Forth.

It provides a description of the ornithology baseline conditions of the Proposed Scheme site and surrounding environments, based on project specific baseline surveys and publicly available information. This is followed by identification of the potential effects of the Proposed Scheme on ornithological receptors during the construction and operational phases, and an assessment of the magnitude and significance of the effects as a consequence of these potential impacts. The mitigation measures required to prevent, reduce or off-set any significant adverse effects are also presented together with the likely residual effects after such measures have been adopted.

This chapter is supported by the following chapters and technical appendices:

- **Chapter 0: Fish and Shellfish Ecology**; and
- **Outer Berth EIA Report Appendix 11-1:** Port of Leith Bird Surveys 2021/22: Survey Report, which provides species-specific information on the distribution and abundance of estuarine bird species and breeding common terns in the port and surrounding environments.

11.2 Legislation, Policy and Guidance

11.2.1 Legislation

11.2.1.1 Council Directive 2009/147/EC on the Conservation of Wild Birds ('the Birds Directive')

The Birds Directive, first passed in 1979 (79/409/EEC) and codified in 2009, provides a 'General System of Protection' for all species of naturally occurring wild birds in the UK. The Directive provisions the identification and classification of SPAs for significant populations of rare or vulnerable species (listed in Annex I of the Directive) and regularly occurring migratory species (required by Article 4 of the Directive). Article 5 of the Directive establishes a general scheme of protection for all wild birds.

The Directive requires national Governments to establish SPAs and to have in place mechanisms to protect and manage them. The SPA protection procedures, originally set out in Article 4 of the Birds Directive, have been replaced by the Article 6 provisions of the Habitats Directive and are transposed into Scottish law by the Conservation (Natural Habitats, &c.) Regulations 1994 and Section 1 of the Wildlife and Countryside Act 1981 (see below).

11.2.1.2 Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ('the Habitats Regulations')

The Habitats Regulations transpose Council Directive 92/43/EEC ('the Habitats Directive') into Scottish national law. The Regulations require competent authorities to consider or review planning permission, applied for or granted, affecting nature conservation designations within the UK's National Site Network – including SPAs and (as a matter of policy) Ramsar Sites – and, subject to certain exceptions, restrict or revoke permission where the integrity of the site would be adversely affected. Details on the sites within the National Site Network that have ornithological interest and may be affected by the Proposed Scheme are provided in **Section 11.5.1**.

11.2.1.3 Wildlife and Countryside Act 1981 (as amended) (includes amendments made via the Wildlife and Natural Environment (Scotland) Act 2011)

This Act codifies the Birds Directive into UK law and is the principal mechanism for statutory protection of wildlife in the UK. Section 1 of the Act provides protection for all species of wild birds and their nests. With exception to species listed in Schedule 2 of the Act, and with additional penalties for species listed in Schedule 1, Section 1 of the Act makes it an offence to intentionally or recklessly:

- Kill, injure, or take any wild bird;
- Take, damage or destroy the nest of any wild bird while that nest is in use or being built;
- Take or destroy an egg of any wild bird;
- Disturb any wild bird listed in Schedule 1 whilst it is building a nest or is in, on or near a nest containing eggs or young; and
- Disturb the dependent young of any wild bird listed in Schedule 1.

The Act also makes provision for the notification and confirmation of SSSIs.

11.2.1.4 Nature Conservation (Scotland) Act 2004

The Nature Conservation (Scotland) Act 2004 places duties on public bodies to further the conservation of biodiversity, increases protection for SSSIs (above that set out in the Wildlife and Countryside Act 1981), amends legislation on Nature Conservation Orders, provides for Land Management Orders for SSSIs and associated land and strengthens wildlife enforcement legislation (to include 'reckless' acts).

11.2.2 Policies and Plans

11.2.2.1 Scotland's National Marine Plan

General policy 'GEN 9: Natural Heritage' of the Scotland's NMP focuses on the achievement of the objective 'living within environmental limits' by ensuring that development and use of the marine environment must, inter alia:

- Comply with legal requirements for protected areas and species; and
- Protect and, where appropriate, enhance the health of the marine area.

In adherence to this policy, marine planners and other decision makers should act in the way best calculated to further the achievement of sustainable development, including the protection of the health of the marine area. The Strategy for Marine Nature Conservation in Scotland's Seas sets out aims and objectives to achieve this. The Strategy outlines a three-pillar approach to conservation:

- Site protection: plans or projects may only be approved if they will not have a significant effect on the site integrity of SPAs (and SAC), Ramsar sites and SSSIs.
- Species protection: if there is evidence to suggest that a protected species may be affected by a Proposed Scheme, the protection afforded by legislation (such as the Wildlife and Countryside Act 1981) must be factored into the planning and design of the development and impacts fully considered.
- Wider seas measures: consideration must be given to PMFs in marine planning (though this does not include wild birds species).

11.2.2.2 Edinburgh Biodiversity Action Plan

The UK generated the UK BAP in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets. The sixth edition of the Edinburgh BAP (covering 2022-2027) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the continued role of decision makers and statutory/non-statutory advisors in providing advice on all casework and licences affecting the Firth of Forth SPA and other protected sites in order to develop green and blue networks.

11.2.3 Best Practice and Guidance

The impact assessment has been based upon the guidance provided in the *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine* (CIEEM, 2018).

11.3 Consultation

Responses received during the EIA scoping process relevant to ornithology (**Table 11-1**) have been taken into account when undertaking the assessment presented in this chapter.

Table 11-1 Ornithology consultation

Consultee	Date/Document	Comment	Response/where addressed in the sEIA Report
Scottish Ministers	Scoping Opinion – September 2023	MD-LOT are in agreement with the conclusions of the ESR, with further assessment required on potential visual disturbance to birds caused by the increase in vessel activity at the deposit site.	Further assessment of potential impacts is set out in **Section 11.7.1.**
		MD-LOT agreed that further assessment was required on the effects of changes in water quality and prey availability as a result of the sediment plume arising from dredging and disposal on birds.	Further assessment of potential impacts is set out in **Section 11.7.2**
		MD-LOT agreed that noise generated by piling works for the construction of the retaining wall should be scoped out as this would constitute a lower magnitude effect than that previously assessed in the Outer Berth EIA Report and therefore would not cause any greater disturbance. This opinion is predicated on the assumption that all relevant mitigation measures are carried over from the Outer Berth Project.	Further assessment of potential impacts is set out in **Section 11.7.3**
		The disturbance to waterbirds as a result of dredging activity has also been scoped out as works would be located within an already busy shipping area.	No assessment required
		LOT also agreed that no further ornithological surveys were required. The assessment methodology and environmental baseline is therefore the same as that established as part of the Outer Berth development.	Surveys are discussed in **Section 11.6**

11.4 Assessment Methodology

11.4.1 Baseline Data Sources

Project-specific baseline bird surveys (detailed in Appendix 11-1 of the Outer Berth EIA Report) have been used to describe the baseline ornithological environment within the ornithological study area (described in **Section 11.4.2**) and inform the subsequent assessment on ornithological receptors. Other sources of data that were used in describing the baseline include:

- SPA site citations for Forth Islands SPA (NatureScot, 2018a), Firth of Forth SPA (NatureScot, 2018b), Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA (NatureScot, 2020) and Imperial Dock Lock, Leith SPA (SNH, 2004);
- Ramsar Site Information Sheet for Firth of Forth Ramsar site;
- NatureScot's 'SiteLink' Protected Areas portal[6];
- Marine Scotland's National Marine Planning Interactive tool[7];
- British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) core count data for sectors 83440 (Water of Leith – Ocean Drive Bridge to Western Harbour) and 83441 (Seafield to Eastern Breakwater), 2018/19 to 2019/20;
- JNCC's Seabird Monitoring Programme, a collaborative database of seabird breeding activity which includes nest counts at the Imperial Dock Lock, Leith SPA;
- SNH's (now NatureScot) HRA on the Firth of Forth: A Guide for developers and regulators (SNH, 2016); and
- Birds of Conservation Concern 5 (BoCC5) (Stanbury *et al*., 2021).

11.4.2 Baseline Bird Survey Methods

11.4.2.1 Survey Objectives

Baseline ornithology at the Port of Leith has been characterised through estuarine bird surveys of the port and surrounding marine and coastal areas undertaken as part of the Outer Berth EIA. There were three elements to the surveys:

- Twice-monthly estuarine bird counts within the impounded dock system and nearby coastal/offshore locations;
- Twice-monthly common tern colony counts, undertaken from May to July 2021 (inclusive), denoting the number of AON at Imperial Dock Lock, Leith SPA; and
- Twice-monthly common tern flight behaviour surveys at the SPA colony, which were undertaken from May to July 2021 (inclusive).

The objective of the baseline estuarine bird surveys was to provide baseline information on the number and distribution of coastal and marine bird species that use the Port of Leith and adjacent coastal, nearshore and offshore areas. The objective of the tern survey was to determine the level and nature of activity at the SPA colony during the breeding season.

[6] *https://sitelink.nature.scot/home*
[7] *https://marinescotland.atkinsgeospatial.com/nmpi/*

11.4.2.2 Survey Fieldwork Methodology

The full methodology for the surveys is described in Appendix 11-1 of the Outer Berth EIA Report. The scope and methodology for the surveys, including the study area, was agreed with NatureScot with the aim of providing sufficient baseline information to inform the assessment.

The ornithological study area, presented in **Figure 11-1,** extends approximately 2km to the east and west of Proposed Scheme and approximately 2km offshore. Two survey visits were scheduled each month, from March 2021 to February 2022 inclusive, with both low tide (+/- 3hrs) and high tide (+/- 3hrs) counts undertaken during each visit. In addition, Forth Ports Limited commissioned an additional single survey in March 2022 which, although above and beyond the scope agreed with NatureScot, provides data from a full, continuous overwintering season (classed as October to March, inclusive). Count methods were based on the BTO WeBS core (high tide) and low tide count methodology (Bibby *et al*., 2000) and can also be seen on **Figure 11-1**.

Tern colony counts were undertaken from a vantage point overlooking the colony using the Census Method One ('Count of Apparently Incubating Adults') for tern species, taken from JNCC's Seabird Monitoring Handbook (Walsh *et al*., 1995). A generally established protocol for tern flight surveys was not available at the time of undertaking; however, it was agreed with NatureScot that a methodology employed for common tern flight surveys undertaken at the Port in 2008-10 (Jennings, 2012) was appropriate. The study area was divided into four sectors and the surveyor undertook 20-minute counts (per sector), twice per month, of common tern flights heading both towards (inbound) and away from (outbound) the colony. Flight heights were recorded in the categories 0-5m, 5-10m, 10-20m and 20m+.

11.4.3 Assessing Noise Disturbance Levels

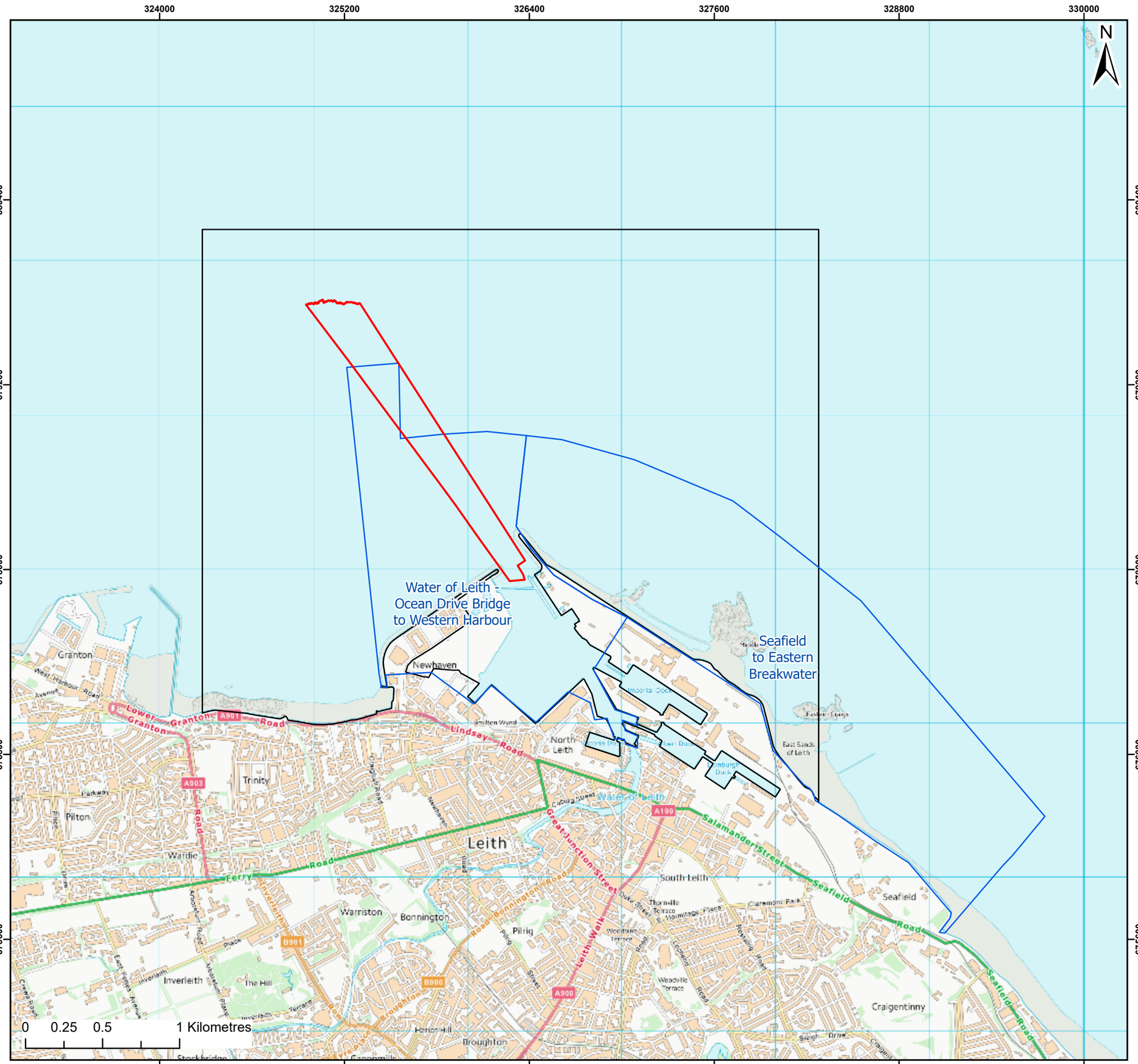
As outlined in **Section 5.5**, MD-LOT agreed that noise generated by piling works for the construction of the retaining wall could be scoped out as this would constitute a lower magnitude effect than that previously assessed in the Outer Berth EIA Report; assuming the continued use of a piling shroud and monitoring by an Environmental Clerk of Works (ECoW). This mitigation is considered in in **Section 11.7.3** to determine whether this mitigation is still appropriate.

11.4.4 Impact Assessment Methodology

11.4.4.1 Sensitivity of Ornithological Receptors

For ornithological receptors, sensitivity is dependent on the factors set out in **Section 5.5** (i.e. it based on the tolerance, adaptability and recoverability of the receptor). **Table 5-2** defines sensitivity levels for a generic receptor and is applicable for ornithological receptors. In considering ornithological sensitivity, it is important to note that sensitivity is a characteristic of the receptor population, not individual birds that make up that population. Receptor populations that are of high conservation value are likely to have higher sensitivity (due to lower tolerance and recoverability) than those that are of lower conservation value.

Assigning nature conservation value to ornithological receptors (also referred to in the CIEEM guidelines as nature conservation importance) is a measure of the conservation value of a species potentially affected by the Proposed Scheme and has been used as an adjusting factor in determining the overall receptor sensitivity. The nature conservation value of ornithology receptors is defined as per the criteria set out in **Table 11-2**. Species on the BoCC5 red list (Stanbury *et al*., 2021) are considered to have the greatest value, as these are species that, on a national or even international scale, have shown declining population and distribution trends. Species that are recognised as features of conservation interest through the provision of enhanced legal protection are also considered to be of comparatively high value.



Legend:

- Dredge Area
- Survey Area
- WeBS Sectors

Client:	Project:
Forth Ports Limited	Port of Leith Approach Channel Deepening

Title:

2021/22 baseline survey area and WeBS sectors

Figure:	Drawing No:
11-1	PC4514-RHD-YY-XX-FN-EV-0017

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	10/01/2022	ND	BH	A3	1:25,000

Co-ordinate system: British National Grid

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Table 11-2 Definitions of nature conservation value for ornithological receptors

Value	Definition
High	Species listed in the BoCC5 red list (Stanbury *et al*., 2021).
Medium	Species listed in the BoCC5 amber or green list (Stanbury *et al*., 2021) that qualify as SPA features listed in one or more of the following: • Annex I of the Birds Directive; and • Schedule 1 to the Wildlife and Countryside Act 1981.
Low	All other SPA features and/or BoCC5 amber list species.
Very low	All other species.

11.4.4.2 Assigning Spatial Magnitude to Impacts on Receptor Populations

Determination of spatial magnitude requires that a species receptor population is appropriately defined (CIEEM, 2018). For the purpose of this assessment, regional populations across the Firth of Forth are considered to be appropriate receptor populations.

For waterbird species, regional receptor populations used are one or both of the following:

- The latest WeBS five-year mean peak counts (2015/16 to 2019/20) from the 'Forth Estuary' site; and
- SPA populations as per the relevant citations (NatureScot, 2018a, 2018b and 2020) or the abundance figures presented in NatureScot's (then SNH) HRA on the Firth of Forth: A Guide for developers and regulators (SNH, 2016).

WeBS data tend not to include counts (or have only partial counts) of seabirds (including gulls and terns), hence for these species the reference SPA populations are herein applied as the regional receptor populations.

Spatial magnitude is considered in terms of the proportion of the receptor population that may be affected by a given impact and is classified into the four categories defined in **Table 11-3**. In some instances, mitigating circumstances (such as the seasonality of peak counts, or the documented distribution of a given species within the Firth of Forth) have been used in concluding the spatial magnitude of an effect.

Table 11-3 Definitions of spatial magnitude of impacts on ornithological receptor populations

Impact magnitude	Definition
High	Effect may lead to a major reduction in the abundance and status of the receptor population (i.e. >20% of the population is affected).
Medium	Effect may lead to a moderate reduction in the abundance and status of the receptor population (i.e. 5-20% of the population is affected).
Low	Effect may lead to a small but discernible reduction in the abundance and status of the receptor population (i.e. 1-5% of the population is affected).
Negligible	Effect would lead to no or indiscernible reduction in the abundance and status of the receptor population (i.e. less than 1% of the population is affected).

11.4.4.3 Assigning Temporal Magnitude

Temporal magnitude has been categorised according to whether a given impact is judged to be short term, medium term or long term, and whether it is considered to be temporary (reversible) or permanent (irreversible). For ornithology receptors, the following definitions have been used to guide the categorisation of temporal magnitude:

- Short term: effects which occur for <1 year over a maximum of one breeding and/or non-breeding season;

- Medium term: effects which occur over 1 to 5 years; and
- Long term: effects which occur for >5 years.

11.4.4.4 Effect Significance

Following determination of receptor sensitivity/value and the magnitude of a given impact, the significance of the effect (and residual impact if mitigation measures are to be implemented) has been determined as outlined in **Section 5.5.3.**

11.5 Baseline Environment

11.5.1 Designated Sites

The Proposed Scheme and wider Port area overlaps with, or is in close proximity to, a number of nature conservation designations of ornithological interest, as shown in **Figure 11-2**.

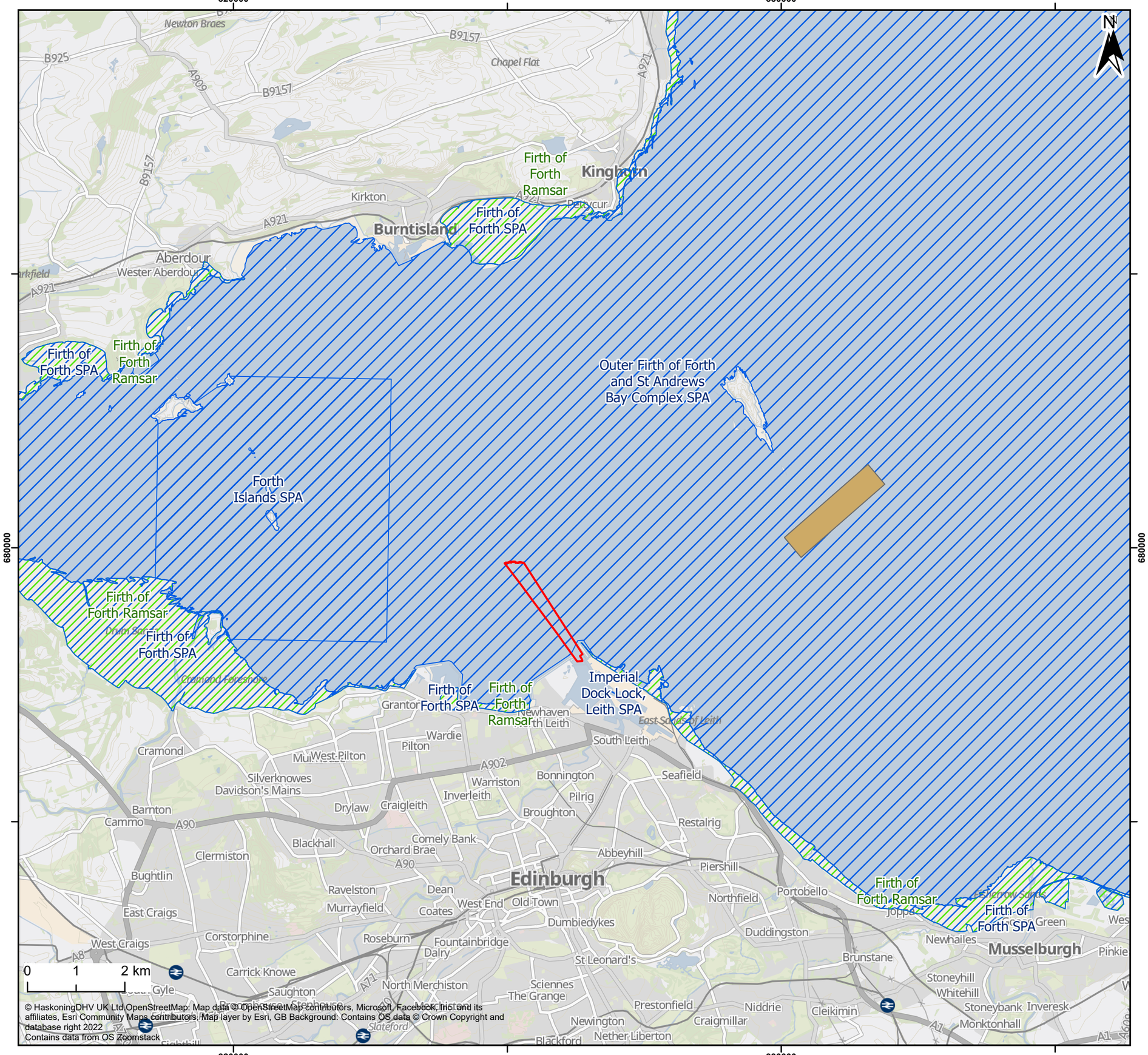
The Imperial Dock Lock, Leith SPA (UK9004451) is located within the impounded dock system. It is part of the UK site network, protected for the purpose of nature conservation under the Habitats Regulations and designated due to a nationally important population of breeding common tern on the dockside. In addition, the Proposed Scheme is located adjacent to the Firth of Forth SPA (UK9004411) and Ramsar site (UK13017) and within the OFFSABC SPA (UK9020316). The Firth of Forth SPA, underpinned in coastal areas by the Firth of Forth SSSI.

The Proposed Scheme is also adjacent to the Forth Islands SPA (UK9004171), a breeding seabird colony SPA. This SPA is designated for the breeding populations of seabirds on the islands of Inchmickery, Isle of May, Fidra, The Lamb, Craigleith, Long Craig and Bass Rock. Further details of the qualifying features of the above sites are described in the accompanying Approach Channel Deepening sRIAA Report (PC4514-RHD-YY-XX-RP-EV-0018).

11.6 Baseline Estuarine Bird Surveys

11.6.1 Survey Overview

The 2021/22 baseline estuarine bird survey showed that the study area supports a fairly wide variety of estuarine birdlife throughout the year, with the habitats present in the study area providing opportunities for foraging and resting (i.e. loafing and/or roosting). The variety, abundance, and seasonal occurrence of all the bird species seen were in line with expectations based on published literature and experience. A brief summary of the survey results is provided here, with a full survey report provided as Appendix 11-1 of the Outer Berth EIA Report.



Legend:

- Dredge Area
- Ramsar Sites
- Special Protection Area
- Disposal Site Narrow Deep B

Data Sources: ©NatureScot 2023, ©CEFAS 2023

Client:	Project:
Forth Ports Limited	Port of Leith Approach Channel Deepening

Title: Designated Sites with Ornithological Interests

Figure: 11-2

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	29/11/2023	ND	EF	A3	1:70,000

Co-ordinate system: British National Grid

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Over the course of the 24 survey visits, a total of 43 estuarine bird species were recorded interacting directly with the study area (i.e. they used the study area for foraging/roosting/loafing, as opposed to commuting through the study area without stopping). Species recorded included:

- 18 seabird species (i.e. gulls, terns, auks, skuas, gannet, cormorants, fulmar and divers);
- 14 waterfowl species (i.e. ducks and swans plus – for the purpose of this summary – grebes and herons); and
- 11 wader species.

The most numerous species recorded was common tern, which is unsurprising given the presence of the active breeding colony within the study area at Imperial Dock Lock, Leith SPA. Other abundant species recorded included gull species (notably black-headed gull and herring gull), eider and, during the postmigration breeding period, auks (particularly guillemot). Oystercatcher was the most abundant wader species recorded in the study area.

Most species of seabird were recorded offshore or nearshore; however, some of the more frequent species – particularly common tern, black-headed gull, herring gull and lesser black-backed gull – were recorded loafing or roosting in large numbers at the shore and/or within the Port estate itself. Small numbers of auks were recorded loafing in the impounded dock system, though most were recorded offshore.

Waterfowl were recorded across the study area, with most sea ducks (e.g. scoters, sawbills and long-tailed ducks) generally recorded in nearshore or offshore areas and mallards, teal and mute swans recorded in the impounded dock system or on the three small scrapes to the west of the Port (near to the West Breakwater lighthouse). Eider and goldeneye were recorded both in marine areas and within the dock system, particularly the latter which was present within the dock system in relatively large numbers during winter months.

Wading birds were generally recorded along the beach to the east of the port, with smaller numbers using the foreshore in the west of the study area.

Of the species recorded in the study area, 32 are species for which regional numbers (i.e. the wider Firth of Forth populations) are nationally or internationally important and hence are features of the nature conservation designations outlined in **Section 11.5.1**. Non-SPA species were generally only present in low numbers.

11.6.2 Other Available Baseline Estuarine Bird Data

WeBS core count data for estuarine birds in and around the Proposed Scheme site is available for the following sectors, both of which overlap with the Proposed Scheme (see **Figure 11-1**):

- Water of Leith – Ocean Drive Bridge to Western Harbour (83440), overlapping with and extending to the west of the Proposed Scheme; and
- Seafield to Eastern Breakwater (83441), overlapping with and extending to the east of the Proposed Scheme.

The core count data for these sectors can be found in Appendix 11-1 of the Outer Berth EIA Report. Data is only available for the years 2018/19 and 2019/20. The tables present peak monthly counts (i.e. the peak numbers of a given species recorded in a given month during the 2018/19 to 2019/20 period).

A total of 41 species were recorded across the two WeBS sectors. Species that were present in the WeBS data but were not recorded using the study area during the baseline estuarine bird survey included Arctic tern, golden plover *Pluvialis apricaria*, Mediterranean gull *Ichthyaetus melanocephalus*, pink-footed goose *Anser brachyrhynchus*, snipe *Gallinago gallinago*, spotted redshank *Tringa erythropus*, tufted duck *Aythya fuligula*, whimbrel *Numenius phaeopus* and wigeon *Anas penelope*. Most were recorded in very low numbers, except for pink-footed goose, the peak count of which was 150 individuals during the autumn passage period.

11.6.3 Common Tern Ecology

A summary of the tern survey is provided below, with a full survey report provided in Appendix 11-1 of the Outer Berth EIA Report.

11.6.3.1 Common Tern Abundance and Apparently Occupied Nest Counts

In the 2021 terns survey, common terns were first recorded on the site in May. The peak number of AONs in the colony was 264, recorded at the end of May. The number of AONs decreased through June and July, with approximately 14 AONs remaining during a colony count in mid-July. Good numbers of chicks were observed throughout. The peak count of 264 AON is in keeping with the most recent Seabird Monitoring Programme record of 246 AON in 2019, which was lower than previous counts of 514 AON in 2018, 985 AON in 2017, 719 AON in 2016 and 636 AON in 2015. A well-documented desertion of the nest (attributed to mink predation) was recorded in 2019 with no breeding success; there have been similar years with breeding failure, such as in 2002 and 2009 (SNH, 2016).

During the 2021/22 baseline estuarine bird surveys, an offshore count of 17 individuals was the highest count of foraging birds in the study area (there was no foraging activity recorded within the dock system itself), indicating that most birds from the colony appeared to commute outside the study area to forage. This point was also noted in a study of foraging ecology of terns at the colony by (Jennings, 2012).

11.6.3.2 Flight Behaviour

The direction of each individual ‘flyover’ by common terns accessing or leaving the colony during the flight behaviour surveys in 2021 were attributed to one of four sectors providing access to the open sea, as shown in Appendix 11-1 of the Outer Berth EIA Report. Heights of individual flights were also recorded, in categories of <5m, 5-10m, 10-20m and 20m+.

The highest peak flight rates were recorded in Sector 3, which offers the shortest route to sea, with around 75-85% of flights in this sector split evenly between the 10-20m and 20m+ categories during each count. Sector 1 (i.e. through the mouth of the port) was the second busiest flight sector, again mostly at heights of 10-20m and 20m+.

11.6.4 Summary of Key Sensitivities Identified from Baseline Information

While all of the species present in numbers of regional note are of medium or high conservation interest (see Appendix 11-1 of the Outer Berth EIA Report), the baseline information has indicated the following key habitats/sensitivities within the study area:

- The quayside at the Imperial Dock Lock, Leith SPA hosts a large number of nesting common terns during the breeding season (May to July). Post-breeding (August), terns from the colony were also observed used other quayside areas within the Port for loafing/roosting, including the Imperial Dock quayside and the western wall of the entrance lock to the port. Dockside areas, particularly around Imperial Dock, supported large numbers of roosting/loafing gulls throughout the year.

- Intertidal habitats in the eastern half of the study area, namely the East Sands of Leith and adjacent rocky outcrops (Eastern Craigs and Middle Craigs) were the most regularly used habitats by estuarine birds, including waders such as oystercatcher, dunlin, turnstone, redshank and bar-tailed godwit and other waterbirds/seabirds, such as roosting Sandwich terns, eider, shag and cormorant.
- The foreshore adjacent to the East Breakwater appeared to be the favoured foraging/roosting habitat for non-breeding ringed plover. Large eider roosts/loafing areas were also regularly recorded at this location, although comparably-sized groups of roosting/loafing eider were also recorded in the impounded dock system (particularly Imperial Dock) and at the East Sands of Leith.
- The sheltered waters available both within the impounded dock system (notably Western Harbour and Imperial Dock) and in the embayment in the western half of the study area supported overwintering goldeneye in numbers of high regional importance (November to February).

The above have been identified as key sensitivities based on the fact that one or more SPA/Ramsar site features, numbers of which may be of regional importance, appeared to show preference for those habitats for roosting and/or foraging during the baseline bird surveys (see distribution maps in Appendix 11-1 of the Outer Berth EIA Report).

11.6.5 Sources of Ornithological Disturbance

During the baseline estuarine bird survey, the surveyor recorded instances of human activity resulting in disturbance to birds using the study area. Full details are provided in Appendix 11-1 of the Outer Berth EIA Report, a summary of which is provided below.

There is public access to the Newhaven foreshore and the West Breakwater, in the western half of the study area, hence there was regular disturbance from walkers/dogs, anglers, swimmers and other recreational users. The most common source of disturbance in this sector was the presence of walkers/dog walkers along the foreshore and breakwater, which was recorded on most survey visits.

There was less recorded disturbance in the eastern half of the study area, due to limited public access along the shorefront. However, at the far east end of the study area, near to Portobello, there was regular disturbance from walkers/dog walkers.

Within the Port estate and impounded dock system there was regular recorded activity by vehicles (including heavy goods vehicles) and dock workers, as well as vessel movements within and into/out of the Port. Generally, such activities did not result in anything other than a ‘low’ level of disturbance to the birds present.

The presence of vessels in nearshore and offshore areas across the study area was also regularly recorded. While much of this was port-associated traffic, there was also regular presence of non-motorised and motorised vessels (including active fishing vessels) from Newhaven and Granton Harbours. Vessel activity was concentrated offshore, although there was regular nearshore activity by sailing vessels and kayaks at Newhaven.

11.7 Potential Effects During Construction

As SPA features are the only ornithological receptors screened into this sEIA Report, the potential effects of construction and operation on ornithological features have been evaluated in the accompanying Approach Channel Deepening sRIAA report. A summary of the conclusions drawn from the sRIAA report is provided in this section to support the assessment of potential effects.

11.7.1 Visual Disturbance at the Disposal Site

It is anticipated that the Proposed Scheme would result in a short term (less than one year) and temporary increase of approximately 800 vessel visits to the disposal site during the dredging works. The associated potential impacts from visual disturbance as a result of increased vessel movements around the disposal site would only have the capacity to affect those ornithological features that forage offshore in this area. These species have been identified as common tern, eider, shag, red-throated diver, sandwich tern and roseate tern, as well as breeding and non-breeding seabird assemblages. The associated designated sites for these species are the OFFSABC SPA, Firth of Forth SPA, Imperial Dock Lock, Leith SPA and the Forth Islands SPA.

The approach channel deepening would result in an increase in approximately 800 visits to the disposal site over an approximately four-month period, equating to 7.1 vessels per day. In the Outer Berth EIA Report Addendum (Royal HaskoningDHV, 2022) submitted as part of the Outer Berth licence application, it was reported that in 2019 that there were 3,087 vessel movements over the disposal site, equating to an average of 8.5 vessel trips per day. Consequently, birds that utilise the disposal site area will have habituated to this form of disturbance (Schwemmer, *et al.,* 2011).

Given the existing level of vessel activity, short-term and temporary nature of works and habituation of ornithological features to visual disturbance, the magnitude of the impact and sensitivity of the receptor are considered to be **low**. It is therefore concluded that the increased vessel presence and visual disturbance at the disposal site associated with the Proposed Scheme has the potential to result in a **negligible effect, which is not significant in EIA terms**.

11.7.2 Sediment Plumes Arising from Dredging and Disposal Activities

Screened in ornithological features that may forage in sub-tidal areas within the vicinity of the modelled dredge and disposal sediment plumes were common tern, eider, shag, red-throated diver, roseate tern and Sandwich tern, as well as breeding and non-breeding seabird assemblages.

The model outputs of the sediment plumes resulting from dredging and disposal activities are visualised below, with the maximum suspended sediment concentrations above ambient conditions in the bottom layer found in **Figure 7-11**, the mid layer in **Figure 7-12** and the surface layer in **Figure 7-13**. SSC are predicted to return to background levels in less than one hour after dredging and disposal activities cease. Increases in SSC were found to be the highest in the bottom layer of the water column, followed by mid layer and the lowest at the surface layer.

Any trace contaminants disturbed during dredging would be bound to fine sediment particles hence would only be present within the sediment plume. Chemical analyses of the dredge material have been undertaken and is reported in the **Section 8.5.3**. The analyses show that contaminant levels within the sediment are suitable for offshore disposal and therefore would not pose a significant risk to prey resources; therefore, there is no risk to bird species reliant on benthic prey or non-piscivorous birds, such as waders and wildfowl, that feed on invertebrates or algae.

Ornithological features that forage in the sub-tidal areas affected by the sediment plumes would be able to use alternative unaffected marine areas elsewhere within their foraging range as the sediment plumes cover only a small proportion of the available foraging range in the Firth of Forth. Furthermore, as fish resource is not significantly impacted by the sediment plumes (See **Section 10.6.2**) and increases in SSC are concentrated towards the bottom of the water column. The ability of ornithological features to hunt and feed within the areas affected by sediment plumes is expected to be unaffected.

For piscivorous (or partly piscivorous) waterbird and seabird species, namely tern species, lesser black backed gull, shag and red-throated diver, the distribution maps presented in the Bird Survey Report 2021-22 (this can be found in Appendix 11-1 of the Outer Berth EIA Report) do not indicate a foraging reliance on the approach channel, and it is considered that there may be active avoidance of the approach channel due to the vessel activity associated with the main access into and out of the Port of Leith. Instead, foraging activity was either spread across the marine area or focused to the west and east of the study area and outside the affected range; therefore, it is considered that it would be possible for those species to forage in alternative areas unaffected by increases in suspended sediment around the entrance to the port.

Common tern are present across the study area in numbers of high regional importance and have a mean maximum foraging range of 17.6km (standard deviation of 9.1km), with a maximum flight range from the Imperial Dock Lock colony of *c*.21km (Wilson *et al.*, 2014; Woodward *et al.*, 2019); hence, the overall proportion of available foraging habitat for terns from the SPA that would potentially be affected by the dredging works would be very small. Additionally, the 2021/22 baseline survey indicated that common terns generally did not actively forage within the nearshore waters around the Port. A peak foraging count of just 17 individuals represented less than 1% of the overall peak count of birds present at the SPA. This was also noted during foraging ecology surveys undertaken by Jennings (2012). This provides further evidence that the majority of breeding terns would, therefore, forage beyond the extent of any sediment plume. As such, the proportion of common terns foraging within the affected area would be relatively low and hence the spatial magnitude of the effect (with regard to the regional receptor populations) would be minimal.

The Proposed Scheme is considered to have no significant effect on designated piscivorous seabirds and waterbirds that may feed on fish resources within the modelled sediment plume areas or for non-piscivorous waterbirds and waders present in the intertidal/shallow-subtidal regions potentially affected by the approach channel sediment plume. Invertebrate and algal feeding birds, as well as other waterbirds including waterfowl present along the shoreline would be unaffected by the indirect effects on prey resources, also constituting no significant effect on designated features.

Given this adaptability and lack of reliance on specific foraging areas and the potential impact to fish prey resources (see **Section 10.6.2**), the sensitivity of piscivorous species is considered to be **low**. For such species, the spatial magnitude on the regional receptor population is also **low**.

Given the overall magnitude of impact on receptor populations and the sensitivity of bird species to that impact, the potential effect is considered to be **negligible** on piscivorous and partly piscivorous species that may feed on fish resources within the modelled dredge and disposal sediment plume. The potential effect is also considered to be **negligible** for non-piscivorous species feeding on invertebrates and algae, as well as other waterbirds including waterfowl present along the shoreline.

11.7.3 Noise Disturbance from Construction of the Retaining Wall

Although noise disturbance through the construction of the sheet piled retaining wall has been scoped out of assessment within this sEIA, the accompanying mitigation measures are re-assessed below.

Mitigation Measures and Residual Impacts

With the exception of breeding and post-breeding common tern, a qualifying feature of the Imperial Dock Lock, Leith SPA, the Outer Berth HRA concluded that impact piling would not have an adverse effect on the Conservation Objectives of the SPAs and Ramsar site or their qualifying features.

To avoid an adverse effect on breeding and post breeding common tern, and therefore the Imperial Dock Lock, Leith SPA, a piling shroud was installed on the piling hammer during piling activities and an ECoW was in place to monitor disturbance (from 1 May to 30 September).

Monitoring by the ECoW (see Appendix 6-1 of the accompanying Approach Channel Deepening sRIAA report) observed that disturbance by nearby activities and predators were a regular occurrence. Only two disturbance instances appeared to have been a result of impact piling, on 15 May and 19 July. These instances were not considered particularly significant in comparison to the more frequent disturbances that were attributed to other causes.

Taking the ECoW's observations into account and that the piling associated with the retaining wall would be on a much smaller scale, it is proposed that the use of an ECoW is not required should piling take place during the common term breeding and post breeding period. A piling shroud would be fitted to the piling hammer.

With these mitigation measures in place, the spatial magnitude of the effect is likely to be reduced (in that a smaller proportion of the regional population would be present within the affected area), and the sensitivity of the above species (in terms of adaptability and tolerance) is also likely to be reduced. As such, the residual significance of the impact on breeding and post-breeding common terns is predicted to be **minor adverse**, **which is not significant in EIA terms**.

11.8 Prediction of Potential Significant Effects During the Operation Phase

There is not expected to be any significant change in operation, compared to the existing activity levels; therefore, it is not expected that there would be any potential to impact ornithological receptors during the operational phase.

11.9 Summary of Potential Effects to Ornithology

Table 11-4 summarises the significance of the potential impacts and subsequent effects on ornithological receptors assessed in this chapter. Negligible and minor adverse effects are not significant in EIA terms.

Table 11-4 Summary of potential effects to ornithology

Impact	Receptor	Effect significance	Mitigation proposed	Residual effect
Construction phase				
Visual disturbance at the disposal site	Common tern, eider, shag, red-throated diver, sandwich tern and roseate tern, as well as breeding and non-breeding seabird assemblages.	Negligible	None required	Negligible
Sediment Plumes Arising from Dredging and Disposal activities	Common tern, eider, shag, red-throated diver, roseate tern and sandwich tern, as well as breeding and non-breeding seabird assemblages.	Negligible		Negligible
Noise disturbance from construction of the sheet piled retaining wall	Breeding and non-breeding common terns	N/A	Use of piling shroud to reduce source noise levels.	Minor adverse

12 Marine Mammals

12.1 Introduction

This chapter of the sEIA Report considers the potential effects of the Proposed Scheme with respect to marine mammals. It describes the methods used to assess potential impacts, and the baseline conditions currently existing within the Proposed Scheme's footprint and the surrounding area. The mitigation measures required to prevent, reduce or off-set any impacts are presented together with the likely residual effect significance levels after these measures have been adopted.

This chapter is supported by the following chapters and appendices:

- **Chapter 7: Coastal Processes;**
- **Chapter 8: Marine Water and Sediment Quality;**
- **Chapter 0: Fish and Shellfish Ecology**; and
- Outer Berth EIA Report Appendix 10-1: Underwater Noise Modelling Report.

12.2 Legislation, Policy and Guidance

12.2.1 Legislation

Marine mammal species in the waters surrounding the Proposed Scheme are protected by national and international legislation. **Table 12-1** details the legislation and policy relevant to marine mammals for the Proposed Scheme.

Table 12-1 International and national legislation relevant to marine mammals

Legislation	Level of protection	Species included	Details
The Berne Convention 1979	International	All cetaceans, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*	The Convention conveys special protection to those species that are vulnerable or endangered. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981.
The Bonn Convention 1979		All cetacean species	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction.
Oslo and Paris Convention for the Protection of the Marine Environment 1992		Various whale species and harbour porpoise *Phocoena phocoena*	OSPAR has established a list of threatened and/or declining species in the north-east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the European Commission (EC) Habitats and Birds Directives and measures under the Berne Convention and the Bonn Convention.
Convention on Biological Diversity 1993		All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
Agreement on the Conservation of Small Cetaceans of		All cetaceans	ASCOBANS entered into force in 1994 under the auspices of the Convention on Migratory Species (or Bonn Convention), with additional areas (the north-east Atlantic and Irish Sea) included into

Legislation	Level of protection	Species included	Details
the Baltic, North East Atlantic, Irish and North Seas, (ASCOBANS) 2008			the convention in 2008. The aim of the convention is to promote cooperation between parties with a view to maintaining the Favourable Conservation Status (FCS) of small cetaceans throughout the agreement area.
International Convention for the Regulation of Whaling 1956		All cetaceans	This convention established the International Whaling Commission who regulate the direct exploitation and conservation of larger whales as a resource, and the impact of human activities on cetaceans.
Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973		All cetaceans	Prohibits the international trade in species listed in Appendix 1 (including sperm whales, northern right whales, and baleen whales) and allows for the controlled trade of all other cetacean species.
Marine (Scotland) Act 2010	National	All cetaceans, grey and harbour seal	This Act provides a framework for the sustainable management of Scotland's seas and one of its key aims is to streamline and simplify the licensing and consenting process for marine projects. Under the Marine (Scotland) Act, the Conservation of Seals Act 1970 have been re-enacted, providing designation of specific seal haul-out sites for protections from intentional or reckless harassment. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland.
The Conservation of Offshore Marine Habitats and Species Regulations 2017		All cetaceans	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further in the separate Habitats Regulation Assessment report. It should be noted that the Habitats Regulations apply onshore, within the territorial seas and to marine areas within UK jurisdiction, beyond 12nm.
Nature Conservation (Scotland) Act 2004		All cetaceans, grey and harbour seal	The Nature Conservation (Scotland) Act 2004 sets out a series of measure designed to conserve biodiversity, and to protect and enhance the biological and geological natural heritage. This Act also provides amendments to the Wildlife and Countryside Act 1981 specifically for Scottish waters, adding that it is an offence to disturb cetacean species (either recklessly or intentionally). This Act also enacts requirements under the Bern Convention 1979.
Conservation of Seals Act 1970		Grey and harbour seal	The Marine (Scotland) Act 2010 replaces the Conservation of Seals Act 1970 in Scottish waters. See above for further information.
The Wildlife and Countryside Act 1981 (as amended)		All cetaceans	Schedule 5: all cetaceans are fully protected within UK territorial waters. This includes disturbance or harassment of a wild animal (either intentionally or recklessly).
The Countryside and Rights of Way Act 2000		All cetaceans, grey and harbour seal	Under the Countryside and Rights of Way Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.
The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014		Grey and harbour seals	This Order designates certain places as seal haul-out sites for the purposes of section 117 of the Marine (Scotland) Act 2010. Harassing a deal (intentionally or recklessly) at a designated haul-out site is an offence under section 117.

12.2.2 Policy and Plans

12.2.2.1 Scotland's National Marine Plan

Within Scotland's NMP are a set of GES indicators that must be met. Within these, of relevance to marine mammal species are:

- "*Biological diversity is maintained and recovered where appropriate. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions (GES 1);*
- *All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (GES 4); and*
- *Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (GES 11)".*

12.2.2.2 Scottish Priority Marine Features

Scottish PMFs (SNH, 2014) are habitats and species considered to be marine nature conservation priorities in Scottish waters. The aim of this work is to produce a focussed list of marine habitats and species to help target future conservation work in Scotland. The list includes 13 species of cetacean and both seals species, listed for either offshore waters only, or in both in and offshore waters.

12.2.2.3 Protected Species and Marine Wildlife Licence Guidance

All species of cetacean (whale, dolphin and porpoise) occurring in UK waters and otters are listed in Annex IV of the Habitats Directive as European Protected Species (EPS), meaning that they are species of community interest in need of strict protection, as directed by Article 12 of the Directive.
This protection is afforded in Scottish territorial waters (out to 12nm) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Regulation 39(1) of these Regulations make it an offence to:

- Deliberately or recklessly capture, injure or kill a wild animal of an EPS; and,
- Deliberately or recklessly:
    - Harass a wild animal or group of wild animals of an EPS;
    - Disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
    - Disturb such an animal while it is rearing or otherwise caring for its young;
    - Obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
    - Disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;
    - Disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed, or reproduce, or rear or otherwise care for its young; or
    - Disturb such an animal while it is migrating or hibernating.

Further protection is afforded through an additional disturbance offence given under Regulation 39(2) which states that "*it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean)*".

12.3 Consultation

Responses received during the EIA scoping process relevant to marine mammals (**Table 12-2**) have been taken into account when undertaking the assessment presented in this chapter.

Table 12-2 Marine Mammal consultation

Consultee	Date/Document	Comment	Responses/where addressed in the sEIA report
Scottish Ministers	Scoping Opinion – September 2023	The Applicant has considered potential impacts on marine mammals in Section 4.8 of the Scoping Report. The potential for auditory injury and/or behavioural impacts from underwater noise during dredging works has been scoped in for further assessment in the sEIA Report. In addition, changes in water quality and prey availability as a result of sediment plume from dredging is scoped in for further assessment.	The further assessment for impacts from underwater noise during dredging works are considered in **Section 12.6.**
		Considering the previous assessment and mitigation measures detailed in the 2022 EIA Report and noting that the piling for the Proposed Works will be temporary and of short duration, no further assessment of the potential impacts from piling on marine mammals is proposed.	All relevant mitigation has been considered in **Section 12.6.**
		The Scottish Ministers agree with the content and approach to the assessment of marine mammals proposed in the Scoping Report and advise that this must be included in the sEIA Report.	Noted.
		The Scottish Ministers highlight that any mitigation measures that are relevant to the Proposed Scheme must be included in the sEIA Report.	All relevant mitigation has been considered in **Section 12.6.**

12.4 Assessment Methodology

12.4.1 Impact Assessment Methodology

The approach to determining the significance of an effect follows a systematic process for all impacts. This involves identifying, qualifying and, where possible, quantifying the sensitivity, value and magnitude of all marine mammal receptors which have been scoped into this assessment. Using this information, a significance of each potential effect has been determined. Each of these steps is set out in the following sections.

The assessments for potential impacts as a result of underwater noise impacts are based on the modelling impact ranges (and areas), which are used to calculate the number of marine mammals potentially at risk (based on the known densities of each relevant marine mammal species in the vicinity of the Proposed Scheme), and are then related to the population estimate, using the defined magnitude levels are defined above.

Sensitivity

The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is negatively affected. The sensitivity level of marine mammals to each type of impact is justified within the impact assessment and is dependent on the following factors:

- Adaptability – The degree to which a receptor can avoid or adapt to an effect;
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect;

- Recoverability – The temporal scale over and extent to which a receptor will recover following an effect; and
- Value – A measure of the receptors importance and rarity (as reflected in the species conservation status and legislative importance).

Table 12-3 defines the levels of sensitivity for marine mammals. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking are considered for each species, using available evidence including published data sources.

Table 12-3 Definitions of sensitivity levels for marine mammals

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

Value

In addition, the 'value' of the receptor forms an important element within the assessment, for instance, if the receptor is a protected species. It is important to understand that high value and high sensitivity are not necessarily linked. A receptor could be of high value (e.g. an Annex II species) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis. In the case of marine mammals, a large number of species fall within legislative policy; all cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin *Tursiops truncatus*, grey seal and harbour seals are Annex II species and also afforded international protection. As such, all species of marine mammals can be considered to be of high value.

The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement. **Table 12-4** provides definitions for the value afforded to a receptor based on its legislative importance.

Table 12-4 Definitions of value levels for marine mammals

Value	Definition
High	Internationally or nationally important. Internationally protected species that are listed as a qualifying interest feature of an internationally protected site (i.e. Annex II protected species designated feature of a European designated site) and protected species (including EPS) that are not qualifying features of a European designated site.
Medium	Regionally important or internationally rare. Protected species that are not qualifying features of a European designated site, but are recognised as a BAP priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the marine mammal study area.
Low	Locally important or nationally rare. Protected species that are not qualifying features of a European designated site and are occasionally recorded within the study area in low numbers compared to other regions.
Negligible	Not considered to be or particular important or rare. Species that are not qualifying features of a European designated site and are never or infrequently recorded within the study area in very low numbers compared to other regions.

It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. an Annex 1 habitat) but have a low or negligible physical/ecological sensitivity to an effect – it is important not to inflate effect significance just because a feature is 'valued'. This is where the narrative behind the assessment is important; the value can be used where relevant as a modifier for the sensitivity assigned to the receptor.

Magnitude of Impact

The significance of the potential effect is also based on the intensity or degree of impact to the baseline conditions and is categorised into four levels of magnitude: high; medium; low; or negligible, as defined in **Table 12-5.**

Table 12-5 Definitions of magnitude levels for marine mammals

Magnitude	Definition
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 1% of the reference population are anticipated to be exposed to the effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that more than 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 10% of the reference population are anticipated to be exposed to the effect.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 1% and 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to effect.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that less than 0.001% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the projects). Assessment indicates that less than 0.01% of the reference population are anticipated to be exposed to the effect. OR

Magnitude	Definition
	Intermittent and temporary effect (limited to the construction phase of development or project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that less than 1% of the reference population anticipated to be exposed to effect.

The thresholds defining each level of magnitude of impact have been determined using expert judgement, current scientific understanding of marine mammal population biology and JNCC *et al.* (2010) draft guidance on disturbance to EPS species. The magnitude of each impact is calculated or described in a quantitative or qualitative way within the assessment.

The number of animals that can be 'removed' from a population through injury or disturbance varies between species but is largely dependent on the growth rate of the population; populations with low growth rates can sustain the removal of a smaller proportion of the population than one with a larger growth rate. The JNCC *et al.* (2010) draft guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at FCS. The JNCC *et al.* (2010) draft guidance also provides consideration of permanent displacement and limited consideration of temporary effects. As such this guidance has been considered in defining the thresholds for magnitude of effects.

Temporary effects are considered to be of medium magnitude at greater than 5% of the reference population being affected within one year. JNCC *et al.* (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth would be halted. In assigning 5% to a temporary impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

Permanent effects to greater than 1% of the reference population being affected within a single year are considered to be high magnitude in this assessment. This is based on ASCOBANS advice (ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the impact to less than 1% of the population (ASCOBANS, 2015).

Effect Significance

Following the identification of receptor value and sensitivity and magnitude of the impact, it is possible to determine the significance of the potential effect. The impact assessment matrix as presented in **Table 5-4** has been used wherever relevant to determine effect significance levels, alongside expert judgement to ensure overall effect significances are realistic and proportional.

12.4.1.1 Conservation Status

When assessing potential impacts consideration is given to the definition of the Conservation Status of a species. There are three parameters that determine when the Conservation Status of a species can be taken as Favourable:

- Population(s) of the species is maintained on a long-term basis;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- The habitat on which the species depends (for feeding, breeding, rearing etc.) is maintained in sufficient size to maintain the population(s) over a period of years/decades.

Member states report back to the EU every six years on the Conservation Status of marine EPS. In the UK, of the common or newly arriving marine mammal species, 11 out of 12 cetacean species have been assessed as having an 'unknown' Conservation Status, and one has not been assessed (based on the 2013-2018 reporting (JNCC, 2019). Some of these species were given a FCS in previous reporting periods, however, the implementation of more robust FCS assessment methodology requires a higher number of UK population estimates over time than are currently available. **Table 12-6** presents the Conservation Status of commonly occurring marine mammal species within UK waters that are of relevance for the Proposed Scheme (JNCC, 2019).

There are two species of seals common to UK waters, the grey seal and harbour seal. The current conservation status, as assessed in the 4th UK report on implementation of the Habitats Directive (submitted to the European Commission in 2019), of the grey seal is 'favourable' (JNCC, 2019). The current conservation status, as assessed in the 4th UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), of the harbour seal is 'unfavourable' for the overall assessment (JNCC, 2019).

Table 12-6 FCS assessment of cetacean species of relevance for the Proposed Scheme (JNCC, 2019)

Species	FCS assessment		
	Assessment for range	Assessment for population level	Assessment for supporting habitats
Harbour porpoise	Favourable	Unknown	Unknown
Bottlenose dolphin	Favourable	Unknown	Unknown
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable	Unknown	Unknown
Minke whale *Balaenoptera acutorostrata*	Favourable	Unknown	Unknown
Humpback whale *Megaptera novaeangliae*	Not assessed		
Sei whale *Balaenoptera borealis*	Not assessed		
Grey seal	Favourable	Favourable	Favourable
Harbour seal	Favourable	Unfavourable - inadequate	Unknown

12.4.2 Transboundary Impact Assessment

There is a significant level of marine development being undertaken or planned by European Union Member States (i.e. Norway, Denmark, Germany Belgium and the Netherlands) in the North Sea. Populations of marine mammals are highly mobile and there is potential for transboundary impacts, especially when considering noise impacts.

Transboundary impacts have been assessed, where possible, in consultation with developers in other Member States to obtain up to date project information to feed into the assessment.

Transboundary impacts have been assessed, as with the other cumulative impacts, for the relevant marine mammal Management Units (MUs). The potential for transboundary impacts will be addressed by considering the reference populations and potential linkages to international designated sites as identified through telemetry studies for seals and ranges and movements of cetacean species.

The assessment of the effect on the integrity of the transboundary European sites as a result of potential impacts on the designated marine mammal populations have been undertaken and presented in the sRIAA provided in support of the marine licence applications.

12.5 Baseline Environment

The baseline environment was determined as part of the Outer Berth EIA Report and replicated here, updated with more recent data where available.

A number of marine mammal species are found off the east coast of Scotland, and within the Firth of Forth, with the most common being harbour porpoise, white-beaked dolphin, grey seal and harbour seal (Paxton *et al*., 2016; Waggitt *et al*., 2019; Carter *et al*., 2022). Other species include minke whale, with increased presence in the summer periods (Department of Energy and Climate Change (DECC), 2016; Paxton *et al*., 2016; Waggitt *et al*., 2019). In addition, in recent years, the population of bottlenose dolphin has been increasing in this area, as the Moray Firth population extends its range south (Civil *et al*., 2018). Less common marine mammal species in this area include sei whale, humpback whale[8], killer whale *Orcinus orca*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus* and long-finned pilot whales *Globicephala melas* (DECC, 2016; Waggitt *et al*., 2019).

A large-scale survey of the presence and abundance of cetacean species around the north-east Atlantic, undertaken in the summer of 2022 (the Small Cetaceans in the European Atlantic and North Sea (SCANS) IV survey; Gilles *et al.,* 2023), indicates harbour porpoise to be the most common cetacean species present in the relevant survey block NS-H. The distribution of harbour porpoises from the recent surveys were similar to those observed in the SCANS-III summer 2016 results (Hammond *et al*. 2021), however, recent sightings in the English Channel suggests a steady increased. Other cetacean species recorded in survey blocks NS include bottlenose dolphin, Risso's dolphin white-beaked dolphin, common dolphin, white-sided dolphin, fine whale and minke whale (**Figure 12-1**).

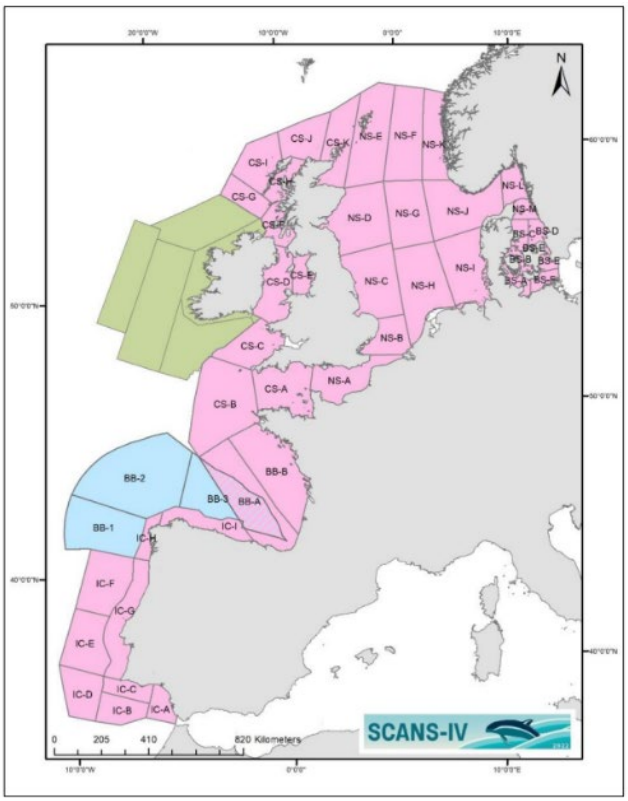

Figure 12-1 Area covered by SCANS-IV and adjacent surveys: pink blocks were surveyed by air and blue blocks were surveyed by ship. The cross-hatched area is where the ship survey BB-3 and aerial survey block BB-A overlapped in an area of 39,018km²

[8] *https://www.edinburghlive.co.uk/news/edinburgh-news/incredible-video-captures-huge-humpback-19884228*

Distribution and abundance maps have been developed by Waggitt *et al.* (2019) for cetacean species around Europe. These maps were generated based on a collation of survey effort across the north-east Atlantic between 1980 and 2018, with a total of 1,790,375km of survey effort for cetaceans. All survey data was standardized to generate distribution maps at 10km resolution, with maps generated for each species included for each month of the year. Distribution maps of cetacean species within the north-east Atlantic also indicate that harbour porpoise and white-beaked dolphin are present off northeast Scotland in the highest densities, followed by Risso's dolphin, killer whale and minke whale, while bottlenose dolphin[9], short-beaked common dolphin and Atlantic white-sided dolphin are present but in lower densities (**Figure 12-2**; values are provided at 10km resolution. A different colour gradient is used for each species. Bottlenose dolphin in (a) represents the offshore ecotype, and therefore does not include the distributions of resident bottlenose dolphin populations (such as Moray East) (Waggitt *et al.,* 2019).

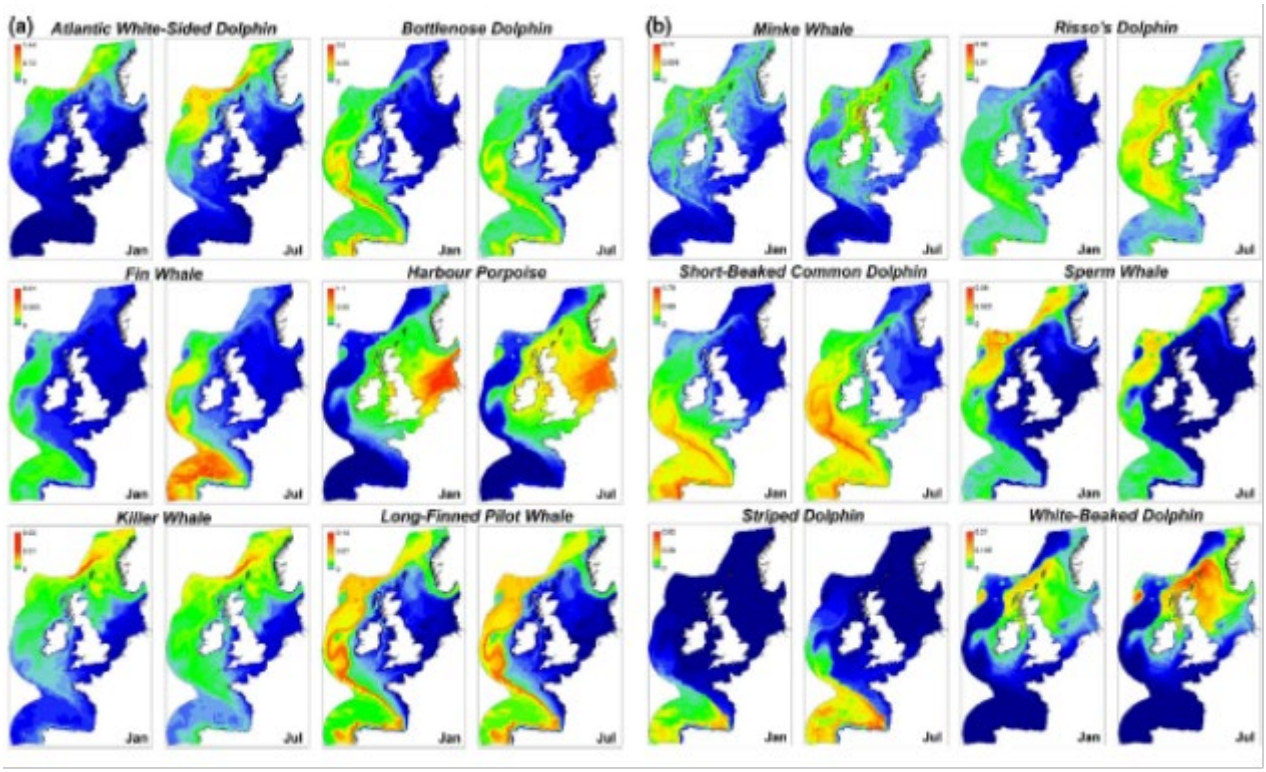

Figure 12-2 Spatial variation in predicted densities (animals per km^2) of cetacean species in January and July in the North-East Atlantic (taken from Waggitt et al., 2019)

Two species of seal are found in the UK, the grey seal and the harbour seal. The grey seal is found on both sides of the North Atlantic Ocean although the greatest proportion of the population is found in UK waters. The UK population of harbour seals has in recent years been in decline but is now increasing and is close to the level it was before the decline occurred. The decline in population levels varies between colonies, with some in Scotland experiencing high levels of declines, while others were stable or increasing. Approximately 35% of the world's grey seals breed in the UK, of which 80% are from sites in Scotland, with the main colonies being in the Outer Hebrides and Orkney (Special Committee on Seals (SCOS), 2022). Approximately 32% of the European harbour seal population are found in the UK, which has declined from approximately 40% in 2002 (SCOS, 2022).

[9] *These density maps show the presence of offshore bottlenose dolphin only, and do not therefore include consideration of the resident populations around the UK and northern Europe coastlines.*

Within the Firth of Forth the closest designated grey seal haul-out site[10] is Inchkeith, approximately 5km from the Proposed Scheme. There are haul-out sites for grey and harbour seal in the Firth of Forth and along the east coast of Scotland (**Figure 12-3**; SCOS, 2022), therefore there is the potential for foraging seals within the vicinity of the Proposed Scheme. The nearest major (and protected) haul-out sites are located approximately 44km at the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC (64km), designated for grey seal, and approximately 65km to the Firth of Tay and Eden Estuary SAC from the Proposed Scheme, designated for harbour seal (**Figure 12-3**; SCOS, 2022).

Global Positioning System (GPS) tracking data from tagged grey and harbour seals indicates there is the potential for grey seal to be present in the Proposed Scheme and Forth of Firth area, and to have travelled from some distance from the north and south, although harbour seal are less likely to be travel from significant distance (**Figure 12-4**; Carter *et al.,* 2022).

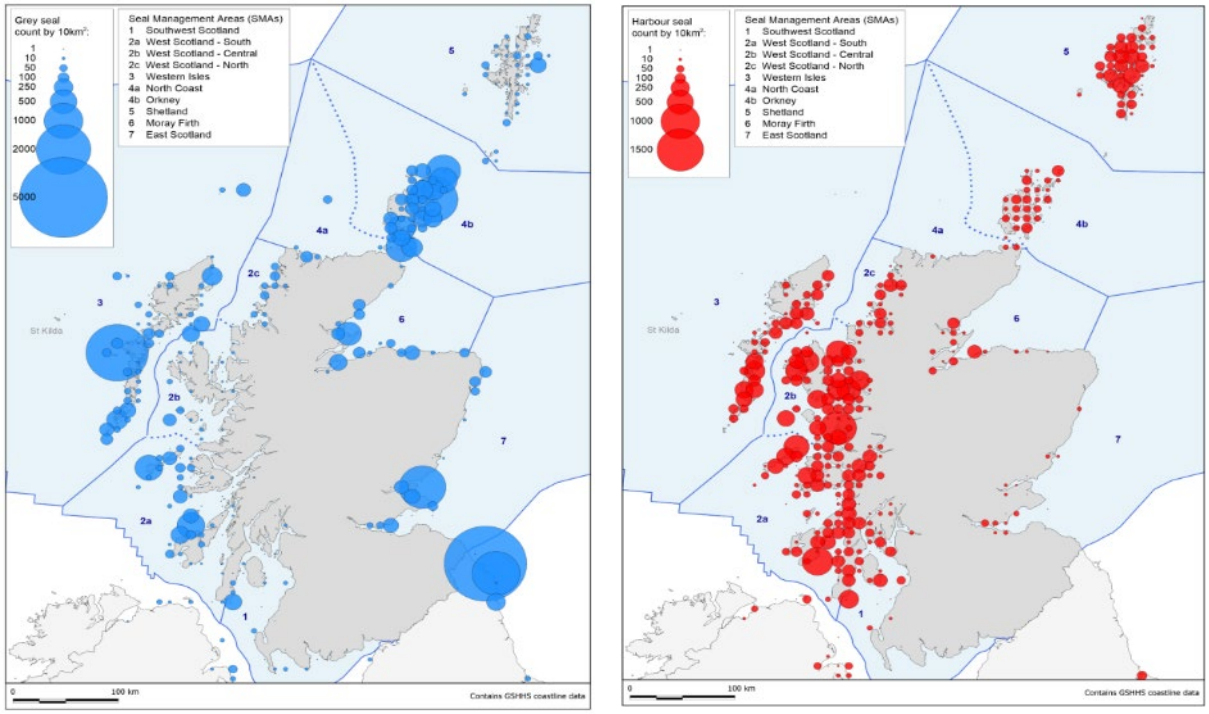

Figure 12-3 Map of (i) grey seal (blue) and (ii) harbour seal (red) distribution by 10km squares based on haul-out counts obtained from the most recent aerial surveys carried out during the harbour seal moult in August 2016-2021 (taken from SCOS, 2022)

[10] *The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014*

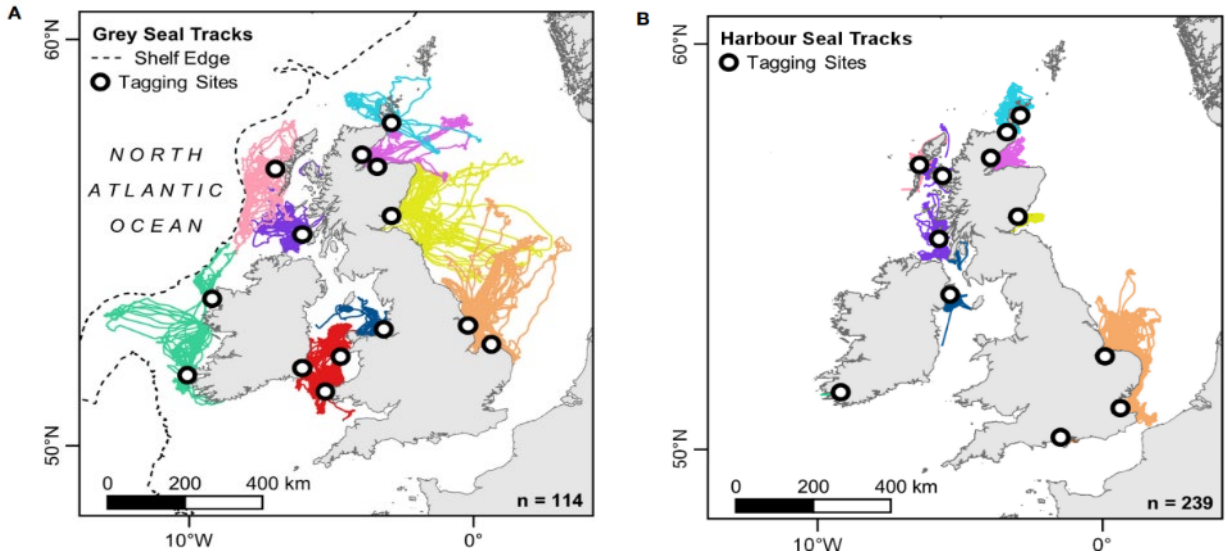

Figure 12-4 GPS tracking data for (a) grey and (b) harbour seals (taken from Carter et al., 2022)

The following sections focus on the key marine mammal species in the Firth of Forth area, including harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal, and harbour seal; however, there are other species that, while relatively rare in the area presently, are becoming increasingly common, such as humpback whale and sei whale. The information on these species in the area is sparse, and they are therefore not considered further for the Proposed Scheme; however, the key impact of underwater noise considers the potential for impact to whale species through the assessment on minke whale. The resultant impact ranges and areas would be the same for the rarer whale species as they are for minke whale, and any mitigations would protect both humpback whale and sei whale, as they will be designed to protect minke whale; therefore, while not considered in detail, these two rarer whale species will be fully mitigated for due to the potential for underwater noise impacts, and there would therefore be no significant impact to either of these species, if they were to increase in presence in the area.

12.5.1 Harbour Porpoise

12.5.1.1 Distribution and Abundance

Within the North Sea area, harbour porpoise are the most common marine mammal species. Heinänen and Skov (2015) identified that within the North Sea, water depth and hydrodynamic variables are the most important factors in harbour porpoise densities in species areas, in both winter and summer seasons. The seabed sediments also play an important role in determining areas of high harbour porpoise density, as well as the number of vessels present in the area.

The Proposed Scheme is located in SCANS-IV survey block NS-D (**Figure 12-1**) and the estimated abundance of harbour porpoise in this survey block is 38,577 (95% Confidence Interval (CI) = 18,017-76,361); with a density estimate of 0.5985 individuals/km^2 (Coefficient of Variation (CV) = 0.367 (Gilles *et al.,* 2023).

For harbour porpoise, the Waggitt *et al.* (2019) distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with the Proposed Scheme indicates an average annual density estimate of 0.461 individuals per km^2.

There are three MUs for harbour porpoise around the UK: North Sea; West Scotland; and the Celtic and Irish Sea (Inter-Agency Marine Mammal Working Group (IAMMWG), 2023). The Proposed Scheme is

located in the North Sea (NS) MU for harbour porpoise, which has an abundance estimate of 346,601 (CV= 0.09; 95% CI = 289,498 – 419,967; IAMMWG, 2023).

12.5.1.2 Diet and Prey Species

The distribution and occurrence of harbour porpoise and other marine mammals is most likely to be related to the availability and distribution of their prey species. For example, sandeels (*Ammodytidae*), which are known prey for harbour porpoise, exhibit a strong association with particular surface sediments.

The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and Ammodytes. Other prey species such as cephalopods, other molluscs, crustaceans and polychaetes have also been recorded. The diet varies geographically, seasonally and annually, reflecting changes in available food resources and differences in diet between sexes or age classes (Berrow and Rogan, 1995; Kastelein *et al.,* 1997; Börjesson *et al.,* 2003; Santos and Pierce, 2003; Santos *et al.,* 2004).

12.5.2 Bottlenose Dolphin

12.5.2.1 Distribution and Abundance

A resident population of bottlenose dolphin is present in the Moray Firth and are known to travel south along the coast to the Firth of Tay. Historically, very few sightings of bottlenose dolphin were recorded south of the Firth of Forth on the east coast of the UK, however, in recent years an increase in bottlenose dolphins along the coastline of north-east England have been reported (Aynsley, 2017; Hacket, 2022). They have been recorded approximately 300 miles outside of what would be considered their 'normal' home range (Cheney *et al*. 2018), with one individual from the Moray Firth population being recorded as far south and east as The Netherlands (Hoekendijk *et al*., 2021).

For the entire SCANS-IV survey area, bottlenose dolphin abundance in the summer of 2022 was estimated to be 80,809, with an overall estimated density of 0.0551/km^2 (CV = 0.194; 95% CI = 52,711 – 117,736; Gilles *et al.*, 2023). This recent SCANS-IV survey didn't account for any bottlenose dolphins within the Proposed Scheme (survey block NS-D); however, the SCANS-III survey identified bottlenose dolphin block R , where the Proposed Scheme is located (same as block NS-D), abundance and density estimates for bottlenose dolphin (Hammond *et al.*, 2021) of 1,924 bottlenose dolphin (95% CI = 0 - 5,048) and a density estimate of 0.0298 bottlenose dolphin/km^2 (CV = 0.861).

For bottlenose dolphin, the distribution maps (**Figure 12-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay. Densities of bottlenose dolphin in the North Sea are very low in comparison (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with Proposed Scheme, indicates an average annual density estimate of 0.00008 individuals per km^2. However, as noted above, the Waggitt *et al.,* (2019) distribution maps include data for the offshore eco-type of bottlenose dolphin, and therefore would not provide accurate mapping for areas with resident bottlenose dolphin populations (such as the east coast of Scotland).

The IAMMWG (2023) define seven MUs for bottlenose dolphin. The Proposed Scheme site is located in the Coastal East Scotland (CES) MU; the CES has an abundance estimate of 224 (95% CI = 214 – 234; IAMMWG, 2023; Arso Civil *et al*., 2021).

12.5.2.2 Diet and Prey Species

Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), as well as octopus and other

cephalopods, have all been recorded in the diet of bottlenose dolphin (Santos *et al.,* 2001; Santos *et al.,* 2004; Reid *et al.,* 2003).

Analysis of the stomach contents of ten bottlenose dolphin in Scottish waters, from 1990 to 1999, reveals that the main prey are cod *Gadus morhua* (29.6% by weight), saithe *Pollachius virens* (23.6% by weight), and whiting *Merlangius merlangus* (23.4% by weight), although other species including salmon *Salmo salar* (5.8% by weight), haddock *Melanogrammus aeglefinus* (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al.,* 2001).

12.5.3 White-Beaked Dolphin

12.5.3.1 Distribution and Abundance

White-beaked dolphin are the second most commonly occurring cetacean in UK shelf waters, regularly encountered in coastal and offshore waters while very rare in deeper waters beyond the shelf edge (DECC, 2016). Their distribution is generally restricted to the northern half of UK waters, with greatest abundance in the central and northern North Sea, Orkney and Shetland and north-west Scotland (DECC, 2016). The results of the Joint Cetacean Protocol Phase III Report (Paxton *et al.*, 2016) identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea.

For the entire SCANS-IV survey area, white-beaked dolphin abundance in the summer of 20 was estimated to be 67,138 with an overall estimated density of 0.0458/km^2 (CV = 0.325; 95% CI = 33,978 – 119,349; Gilles *et al.*, 2023). The SCANS-IV surveys show higher densities in the northern North Sea area. The Proposed Scheme is located in SCANS-IV survey block NS-D (Gilles *et al.*, 2023) with an abundance estimate of 5,149 white-beaked dolphin (95% CI = 961-10,586) and a density estimate of 0.0799 white-beaked dolphin/km^2 (CV = 0.481).

For white-beaked dolphin, the distribution maps (**Figure 12-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (Waggitt *et al.*, 2019). Examination of this data, including all 10km grids that overlap with Proposed Scheme, indicates an average annual density estimate of 0.008 individuals per km^2.

There is a single MU for white-beaked dolphin, the Celtic and Greater North Seas (CGNS) MU. The reference population for white-beaked dolphin in the CGNS MU is 43,951 animals (CV = 0.22; 95% CI = 28,439 – 67,924; IAMMWG, 2023).

12.5.3.2 Diet and Prey Species

Analysis of the stomach contents of white-beaked dolphin have shown that the species feed on a wide range of fish and squid species, including cod, whiting, and hake *Merluccius merluccius* (Kinze *et al.,* 1997; Reeves *et al.,* 1999). White-beaked dolphin have also been observed to associate with herring *Clupea harengus* (Harmer, 1927; Fraser, 1946; Evans, 1980) and mackerel *Scomber scombrus* (Evans *et al.,* 1987) shoals, and anecdotal evidence from fisherman in Scotland suggests that individuals seen inshore may coincide with mackerel appearing in the same areas (Canning *et al.,* 2008).

Dietary analysis for 22 white-beaked dolphin stranded around the UK coast between 1992 and 2003 (Canning *et al.,* 2008) found that while a wide variety of prey species were identified, the majority of prey were from a much smaller number of species. Haddock and whiting were the most predominantly found,

representing 43% and 24% respectively of the total reconstructed weight, cod represented a further 11% of the total reconstructed weight.

12.5.4 Minke Whale

12.5.4.1 Distribution and Abundance

Minke whales are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid *et al.,* 2003). They occur mainly on the continental shelf in water depths less than 200m and are predominantly a seasonal visitor to UK waters, with sightings increasing from May to October, with sightings rare outside of this period (e.g. Joint Cetacean Protocol data; Paxton *et al.,* 2016). All minke whales in UK waters are considered to be part of the CGNS MU (IAMMWG, 2021).

For the entire SCANS-IV survey area, minke whale abundance in the summer of 2022 was estimated to be 12,417 with an overall estimated density of 0.0085/km^2 (CV = 0.361; 95% CI = 7,038 – 26,943; Gilles *et al.,* 2023). The Proposed Scheme is located within SCANS-IV survey block NS-D (Gilles *et al.,* 2023) where there is an abundance estimate of two, minke whale (95% CI = 547-7,357) and a density estimate of 0.0419 individuals/km^2 (CV = 0.594).
For minke whale, the distribution maps (**Figure 12-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the Celtic and Irish Seas, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with Proposed Scheme indicates an average annual density estimate of 0.0035 individuals per km^2.

There is single MU for minke whale, the CGNS MU. The reference population for minke whales in the CGNS MU is 20,118 animals (CV = 0.18; 95% CI = 14,061 – 28,786; IAMMWG, 2023).

12.5.4.2 Diet and Prey Species

Minke whales feed on a variety of fish species, including herring, cod and haddock. Minke whale feed by engulfing large volumes of prey and water, which they then 'sieve' out of through their baleen plates and swallow their prey whole. Sandeels and mackerel were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al.,* 2007).

12.5.5 Grey Seal

12.5.5.1 Distribution and Abundance

Grey seals only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coasts of Canada and United States of America and in north-west Europe (SCOS, 2022). Approximately 36% of the world's grey seals breed in the UK, and 80% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. They haul out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100km between haul-out sites (SCOS, 2022).

Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season, in eastern England, pupping occurs mainly between early November and mid-December (SCOS, 2022).

Grey seal forage in the open sea and they may range widely to forage and frequently travel over 100km between haul-out sites (SCOS, 2022). Foraging trips can last anywhere between one and 30 days. Tracking of individual grey seals has shown that most foraging probably occurs within 100km of a

haul-out site, although tagging studies have shown grey seal to make foraging distances of up to 448km (Carter *et al*., 2022). Grey seal are likely to present in and around the Proposed Scheme (SCOS, 2022; Russell *et al.,* 2017; Carter *et al.,* 2022).

Carter *et al.,* (2022) provides habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. The habitat preference approach predicted distribution maps provide estimates per species, on a 5km x 5km grid, of relative at-sea density for seals hauling-out in the British Isles. It is important to note that Carter *et al.* (2022) provides *relative density* (i.e. percentage of at-sea population within each 5km x 5km grid square), whereas previous usage maps (Russel *et al.,* 2017) have presented *absolute density* (i.e. number of animals).

For grey seal, the mean predicted *relative density* for all grid squares that overlap with the Proposed Scheme is 0.627/km^2 of, a relative density of very high when compared to the overall distributions of grey seal (Carter *et al*., 2020).

Grey seal population trends are assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth (SCOS, 2022). The pup production estimates are converted to estimates of total population size (1+ aged population) using a mathematical model and projected forward (SCOS, 2022). The most recent surveys of the principal grey seal breeding sites Scotland, Wales, Northern Ireland and south-west England, resulted in an estimate of 67,850 (approximate 95% CI 60,500-75,200; SCOS 2022). When the pup production estimates are converted to estimates of total population size, there was an estimated 162,000 grey seals at the start of 2022 (approximate 95% CI 146,700-178,500; SCOS, 2022).

As grey seal can travel up to 100km from haul-out sites for foraging, a larger MU area has been used for the assessment to ensure that the wider population is considered for the impact assessments. The reference population extent for grey seal will therefore incorporate the Moray Firth (MF) MU and East Scotland (ES) MU (IAMMWG, 2013; SCOS, 2022). Assessments have been made against the ES MU (as is the one within which the Proposed Scheme lies) and against the MF and ES MUs together. The reference population for these areas are presented in **Table 12-7**. These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.2515 grey seals are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total grey seal numbers within each MU, rather than the number counted within each MU (**Table 12-7**).

Table 12-7 Grey Seal Count Population Estimates

Population area	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal total population
East Scotland MU	2,712	SCOS, 2022	0.2515	10,783
Moray Firth MU	1,856	SCOS, 2022	0.2515	7,380
Wider reference population	4,574		0.2551	18,163

12.5.5.2 Haul-Out Sites

As noted above, the nearest grey seal haul-out site is Inchkeith, approximately 4.5km from the Proposed Scheme. Other nearby haul-out sites include Inchmickery and Cow & Calves, and Kinghorn Rocks (approximately 5.5km and 9.5km from the Proposed Scheme respectively). **Figure 12-3** indicates approximately 150 grey seals haul-out at Inchkeith, and approximately 100 at Inchmickery and Cow & Calves (SCOS, 2022). Grey seals are known to pup at the Inchkeith haul-out site. There are also a number

of other grey seal haul-out sites in the Firth of Forth area, including at the Isle of May and Berwickshire and Northumberland Coast SAC.

12.5.5.3 Diet and Prey Species

Grey seals will typically forage in the open sea and return regularly to land to haul-out, although they may frequently travel up to 100km between haul-out sites. Foraging trips generally occur within 100km of their haul-out sites, although grey seal can travel up to several hundred kilometres offshore to forage (SCOS, 2019). Grey seal generally travel between known foraging areas and back to the same haul-out site, but will occasionally move to a new site. For example, movements have been recorded between haul-out sites on the east coast of England and the Outer Hebrides (SCOS, 2022).

Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2022; Hammond and Grellier, 2006). Diet varies seasonally and from region to region (SCOS, 2022).

In the North Sea, principal prey items are sandeel, whitefish (such as cod, haddock, whiting and ling *Molva molva*) and flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder *Platichthys flesus*, and dab *Limanda limanda*) (Hammond and Grellier, 2006). Amongst these, sandeels are typically the predominant prey species.

Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg per seal per day depending on the prey species (SCOS, 2022).

12.5.6 Harbour Seal

12.5.6.1 Distribution and Abundance

Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina vitulina* (SCOS, 2022). Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of the UK, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth.

Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle. They forage at sea and haul-out on land to rest, moult and breed.

Harbour seal generally take foraging trips of between 30km and 50km; however, movements of harbour seal vary among individuals, and have reported foraging trips of up to 273km (Carter *et al.,* 2022). The range of these trips varies depending on the location and surrounding marine habitat.

The harbour seal density estimates for the Projects have been calculated from the latest seal at sea maps produced by the Sea Mammal Research Unit (Carter *et al.,* 2022), based on the grids that overlap with each area. Harbour seal are likely present in lower number around the Proposed Scheme, as harbour seal densities in the area are generally lower than for grey seals (SCOS, 2022; Russell *et al.,* 2017; Carter *et al.,* 2020). For harbour seal, the mean predicted *relative density* for each grid square that overlaps with the Proposed Scheme is 0.258/km^2, a relative density of low when compared to the overall distributions of harbour seal (Carter *et al*., 2020).

As for grey seal, the reference population extent for harbour seal will incorporate the ES MU and MF MU (IAMMWG, 2013; SCOS, 2022). The reference population for harbour seal is therefore currently based on

the following most recent estimates for the ES MU and the MF MU (**Table 12-8**). These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.72 harbour seals (Lonergan *et al.,* 2013) are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total harbour seal numbers within the SE England MU.

Table 12-8 Harbour Seal Count Population Estimates

Population area	Harbour seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Harbour seal total population
East Scotland MU	262	SCOS, 2022	0.72	364
Moray Firth MU	690	SCOS, 2022	0.72	958
Wider reference population	952		0.72	1,322

Assessments will be done in the context of the nearest MU as well as the wider reference population. As a worst-case it is assumed that all seals are from the nearest MU, the ES MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

12.5.6.2 Haul-Out Sites

The nearest harbour seal haul-out sites are Inchmickery and Cow & Calves (approximately 5.5km from the Proposed Scheme), and Kinghorn Rocks (approximately 9.5km from the Proposed Scheme). **Figure 12-3** indicates between 10 and 25 harbour seal seals haul-out at Kinghorn Rocks, and between 10 and 25 at Inchmickery and Cow & Calves (SCOS, 2022). There are also a number of other harbour seal haul-out sites in the Firth of Forth area, including within the Firth of Tay and Eden Estuary SAC.

12.5.6.3 Diet and Prey Species

Harbour seal take a wide variety of prey including sandeels, gadoids, herring *Clupea harengus* and sprat *Sprattus sprattus*, flatfish and cephalopods. Diet varies seasonally and regionally, prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2022). It is estimated harbour seals eat 3-5kg per adult seal per day depending on the prey species (SCOS, 2022).

The range of foraging trips varies depending on the surrounding marine habitat (e.g. 25km on the west of Scotland (Cunningham *et al.,* 2009), and 30-45km in the Moray Firth (Tollit *et al.,* 1998; Thompson and Miller 1990). Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution than grey seals and do not travel as far from haul-outs.

12.5.7 Summary of Marine Mammals

The known densities and populations of marine mammals at the Proposed Scheme, as described within the sections above, are summarised in **Table 12-9** below.

Table 12-9 Marine mammal densities and reference populations used in the underwater noise assessments

Marine mammal species	Density (/km²)	Source of density estimate	Reference population	Source of reference population
Harbour porpoise	0.5985	SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023)	38,577	SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023)
Bottlenose dolphin	0.0298	SCANS-III Survey Block R (Hammond *et al.*, 2021)	224	Updated population estimate for the CES MU Arso Civil *et al.*, 2021)
White-beaked dolphin	0.0799	SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023)	43,951	CGNS MU (IAMMWG, 2023)

Marine mammal species	Density (/km²)	Source of density estimate	Reference population	Source of reference population
Minke whale	0.0419	SCANS-IV Survey Block NS-D Gilles *et al*., 2023)	20,118	CGNS MU (IAMMWG, 2023)
Grey seal	0.6275	*Carter et al., 2022*	10,783; 18,163	ES MU (Special Committee on Seals (SCOS), 2023); ES & MF MU (SCOS, 2023)
Harbour seal	0.2576	*Carter et al., 2022*	364; 1322	ES MU (SCOS, 2023); ES & MF MU (SCOS, 2023)

12.6 Prediction of Potential Significant Effects During the Construction Phase

The potential impacts on marine mammals considered during the construction phase are:

- Potential for auditory injury and/or behavioural impacts from underwater noise during piling;
- Potential for auditory injury and/or behavioural impacts from underwater noise during dredging works;
- Any changes to water quality; and
- Any changes in prey availability.

Any increase in vessels through the construction phase is expected to be minimal, and in line with current use of the port and surrounding area. Therefore, it is not expected that there would be any potential for impact as a result of the presence of construction vessels (including impacts as a result of underwater noise, or collision risk), either at the Proposed Scheme, or while transiting past any nearby seal haul-out sites. Due to the distance between seal haul-out sites and the Proposed Scheme, there is not expected to be any potential for direct impact to the sites; therefore, the potential for any impact from vessels is scoped out of further assessment.

For the Proposed Scheme, there is the potential for both impact piling and vibro-piling to be utilised. The potential for impact piling has greater potential for impact to marine mammals and therefore has been assessed as the worst-case. As shown by the Underwater Noise Modelling Report (Appendix 10-1 of the Outer Berth EIA Report), the resultant impact ranges for vibro-piling (for cumulative exposure (SEL_{cum})) are the same as those modelled for impact piling, and therefore the assessments provided below for impact piling would also be valid for vibro-piling (for cumulative exposure). Vibro-piling is a continuous noise source, and therefore single strike (SPL_{peak}) modelling results are not relevant for that activity.

12.6.1.1 Potential for Impacts from Underwater Noise during Piling

Impact piling has long been established as a source of high level underwater noise (Würsig *et al.,* 2000; Caltrans, 2001; Nedwell *et al*., 2003; 2007; Parvin *et al*., 2006; Thomsen *et al*., 2006). If a marine mammal is located very close to the piling sound source, the high peak pressure sound levels have the potential to cause death or physical injury, with a severe injury having the potential to lead to death, without mitigation. High exposure levels from underwater noise sources (such as impact piling) can cause auditory injury or hearing impairment, through permanent loss of hearing sensitivity (PTS) or from a temporary loss in hearing sensitivity (TTS). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal but is also influenced by the duration of exposure. The level of impact on an individual is related to the Sound Exposure Level (SEL) that an individual receives.

PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

All species of cetaceans rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al.,* 2007). As such, sensitivity to PTS from pile driving noise is assessed as high for harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.,* 2007), but not for finding prey. Therefore, Thompson *et al.* (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans; however, using the precautionary approach, both seal species are given a sensitivity of high to the impact of PTS exposures. The effect would be permanent and marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from the effects.

Harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are assessed as having medium sensitivity to TTS onset or for disturbance due to underwater noise.

12.6.1.2 Potential for PTS Onset

The underwater noise modelling results and resultant assessments for the for PTS in harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are presented in **Table 12-10**.

The modelling for the single strike piling has been undertaken using the maximum hammer energy of 280kJ. The range for cumulative SEL (SEL_{cum}) for PTS is the distance an animal would need to be from the pile location to not be at risk of PTS from cumulative exposure (in this case, due to three piles being installed in one 24 hour period). SEL_{cum} determines the potential risk of PTS from the repeated percussive strikes required to install a single pile. The ranges at which an individual could experience PTS are assessed as a result of cumulative exposure during the entire piling duration of six hours (two hours per pile, up to three piles per day), based on the animals fleeing at a precautionary average swimming speed.

Table 12-10 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS from impact piling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – single strike	Harbour porpoise	<50m <0.01km²	0.006 harbour porpoise (0.000015% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<50m <0.01km²	0.0003 bottlenose dolphin (0.0001% CES MU)	
	White-beaked dolphin	<50m <0.01km²	0.0008 white-beaked dolphin (0.000002% CGNS MU)	
	Minke whale	<50m <0.01km²	0.0004 minke whale (0.000002% CGNS MU)	
	Grey seal	<50m <0.01km²	0.006 grey seal (0.00006% of the ES MU; or 0.00004% of the Wider MU)	
	Harbour seal	<50m <0.01km²	0.003 harbour seal (0.0007% of the ES MU; or 0.0002% of the Wider MU)	
PTS without mitigation –	Harbour porpoise	<100m <0.1km²	0.060 harbour porpoise (0.00002% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
cumulative exposure				to effect, without mitigation).
	Bottlenose dolphin	<100m <0.1km²	0.003 bottlenose dolphin (0.0001% CES MU)	Permanent effect with negligible magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	<100m <0.1km²	0.0008 white-beaked dolphin (0.000002% CGNS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	<100m <0.1km²	0.0004 minke whale (0.000002% CGNS MU)	
	Grey seal	<100m <0.1km²	0.006 grey seal (0.00006% of the ES MU; or 0.00004% of the wider MU)	Permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	<100m <0.1km²	0.003 harbour seal (0.0007% of the ES MU; or 0.0002% of the wider MU)	

The impact range for all marine mammal species, due to a single strike of impact piling is less than 50m (**Table 12-10**). The magnitude of the potential impact without any mitigation is negligible for all marine mammal species, with less than 0.001% of the relevant reference populations anticipated to be exposed to the effect without mitigation.

The impact range (without mitigation) within which PTS onset could occur from cumulative exposure, due to up to three piles being installed in a 12 hour period (a total of six hours of piling) for all marine mammal species is 100m (**Table 12-10**). This takes into account the anticipated soft-start and ramp-up procedure, as provided within JNCC protocols (2010). The magnitude of the potential impact without any mitigation is assessed as negligible for harbour porpoise white-beaked dolphin and minke whale, and low for bottlenose dolphin, and grey and harbour seal.

It should be noted that assessment for PTS from cumulative exposure is highly precautionary for the following reasons:

- The maximum impact ranges, based on the worst-case exposure levels an animal may receive at different depths in the water column, have been used in the assessment; this is highly conservative as it is unlikely a marine mammal would remain at this depth level;
- The assessment does not take account of periods where exposure will be reduced when they are at the surface or heads are out of the water; and
- The cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response.

12.6.1.3 Potential for TTS Onset

The underwater noise modelling results and resultant assessments for the for TTS in harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are presented in **Table 12-11**.

As for PTS, the range for SEL_{cum} for TTS is the distance an animal would need to be from the pile location to not be at risk of TTS from cumulative exposure due to three piles being installed in one 24 hour period. The ranges at which an individual could experience TTS are assessed as a result of cumulative exposure during the entire piling duration of six hours, based on the animals fleeing at a precautionary average swimming speed.

Table 12-11 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of TTS from impact piling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – single strike	Harbour porpoise	60m 0.01km²	0.006 harbour porpoise (0.00002% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<50m <0.01km²	0.0003 bottlenose dolphin (0.0001% CES MU)	
	White-beaked dolphin	<50m <0.01km²	0.0008 white-beaked dolphin (0.000002% CGNS MU)	
	Minke whale	<50m <0.01km²	0.0004 minke whale (0.000002% MU)	
	Grey seal	<50m <0.01km²	0.006 grey seal (0.00006% of the ES MU; or 0.00004% of the wider MU)	
	Harbour seal	<50m <0.01km²	0.003 harbour seal (0.0007% of the ES MU; or 0.0002% of the wider MU)	
TTS without mitigation – cumulative exposure	Harbour porpoise	780m 0.5km²	0.3 harbour porpoise (0.0008% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m <0.1km²	0.003 bottlenose dolphin (0.001% CES MU)	
	White-beaked dolphin	<100m <0.1km²	0.008 white-beaked dolphin (0.00002% CGNS MU)	
	Minke whale	200m <0.1km²	0.004 minke whale (0.00002% MU)	
	Grey seal	<100m <0.1km²	0.06 grey seal (0.0006% of the ES MU; or 0.0003% of the wider MU)	
	Harbour seal	<100m <0.1km²	0.03 harbour seal (0.01% of the ES MU; or 0.002% of the wider MU)	

The maximum impact range (without mitigation) within which TTS onset could occur due to a single strike, is 60m for harbour porpoise, and less than 50m for all other species (**Table 12-11**). The magnitude of the potential impact without any mitigation is assessed as negligible for all species, with less than 1% of the relevant reference population anticipated to be exposed to the temporary effect without mitigation.

The impact range (without mitigation) within which TTS onset could occur from cumulative exposure over 12 hours (up to six hours of piling) for harbour porpoise is up to 780m, and less than 100m for all other species (Table 12-11). The magnitude of the potential impact without any mitigation is assessed as negligible for all marine mammal species, with 1% or less of the relevant reference populations anticipated to be exposed to the temporary effect without mitigation.

12.6.1.4 Potential for Disturbance

For marine mammal species, there is currently no agreed threshold for disturbance from underwater noise. The US National Marine Fisheries Service (NMFS) guidance (NMFS, 2018a) sets the Level B harassment threshold[11] for marine mammals at 160dB re 1µPa (root mean square (rms)) for impulsive noise and 120dB re 1µPa (rms) for continuous noise. However, Southall *et al.* (2021) found that simple all-or-nothing thresholds such as these, that attempt to relate single noise exposure parameters (e.g., received noise level) and behavioural response across broad taxonomic grouping and sound types, can lead to severe errors in predicting effects.

During a harbour development project in Scotland, the behavioural response of harbour porpoise and bottlenose dolphin was recorded, both for impact piling and vibro-piling, using an array of acoustic recording devices (Graham *et al*., 2017). Monitoring was undertaken for a year prior to construction, and during construction. The impact piling sound level was recorded as being 240dB re 1µPa. Neither harbour porpoise or bottlenose dolphins were excluded from the area as a result of the piling, but fine-scale changes in the local abundance were detected, and bottlenose dolphins were present in the area less often when impact piling was occurring, compared to where no activity was occurring (Graham *et al*., 2017). This indicates that harbour porpoise and bottlenose dolphin can be disturbed from a very localised area, and for a short-period of time.

While there is the potential for a displacement response from the area for any marine mammal species, it is predicted that they would return once the activity has been completed, and therefore any impacts from underwater noise as a result of piling will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on marine mammals. Any disturbance would be temporary and they would be expected to return to the area once the noise had ceased or they had become habituated to the sound. The magnitude of impact for all marine mammal species is assessed as being low, due to the predicted short-term nature and localised potential for disturbance.

12.6.1.5 Mitigation Measures

Mitigation will be undertaken for all piling works at the Proposed Scheme, in accordance with the best practice guidance for minimising the risk of injury to marine mammals from piling noise provided by the JNCC[12] (JNCC, 2010). Mitigation measures include:

- The establishment of a mitigation zone of 500m from the piling location:
- Only commence piling operations during the hours of daylight and good visibility (and within the 12 hour construction window);
- Pre–piling search for marine mammals of mitigation zone by Marine Mammal Observer(s):
    - Delay if marine mammals detected within the mitigation zone.
- Soft-start and ramp-up of piling for a period of not less than 20 minutes;
- Pre–construction activity search and soft-start procedure should be repeated before piling recommences, if piling operations pause for a period of greater than 10 minutes; and
- All mitigation procedures, soft-start and ramp-up, and reporting requirements, are as per the JNCC guidelines, with the exception of the reduced mitigation zone.

[11] *Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.*

[12] *https://data.jncc.gov.uk/data/31662b6a-19ed-4918-9fab-8fbcff752046/JNCC-CNCB-Piling-protocol-August2010-Web.pdf*

12.6.1.6 Effect Significance

PTS Onset

Taking into account the receptor sensitivity (of high for all marine mammal species), and the potential magnitude of the effect (of negligible for all species), the effect significance for PTS in all species, from either a single strike or for cumulative exposure, has been assessed as being of **minor adverse significance** (**Table 12-12**).

The residual impact of the potential risk of PTS onset to marine mammals as a result of underwater noise during piling would be reduced to **negligible** with the adoption of the mitigation measures (**Table 12-12**).

Table 12-12 Assessment of effect significance for the potential for PTS onset in marine mammals from underwater noise during impact piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS onset during piling – single strike	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Negligible
PTS onset during piling - cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Negligible

TTS Onset

Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of negligible for all species), the effect significance for TTS in all species, from either a single strike or for cumulative exposure, has been assessed as being of **minor adverse effect, which is not considered significant in EIA terms**.

While the piling mitigation measures are designed to protect marine mammals from PTS onset, they would also reduce the potential for TTS onset, as they are designed to ensure (as far as is possible) that there are no marine mammal species within close proximity to the piling location prior to piling commencing. The residual impact of the potential risk of TTS onset to marine mammals as a result of underwater noise during piling would therefore remain of **minor adverse effect, which is not considered significant in EIA terms**, with the adoption of the mitigation measures (**Table 12-13**).

Table 12-13 Assessment of effect significance for the potential for TTS onset in marine mammals from underwater noise during impact piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS onset during piling – single strike	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS onset during piling - cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Minor adverse

Potential for Disturbance

Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of minor for all species), the effect significance for disturbance in all species has been assessed as being of **minor adverse effect, which is not considered significant in EIA terms** (**Table 12-14**).

Table 12-14 Assessment of effect significance for the potential disturbance of marine mammals from underwater noise during impact piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance due to impact piling	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Low	Minor adverse	-	Minor adverse

12.6.2 Potential Impacts from Underwater Noise during Dredging Works

The dredging process emits continuous, broadband sound into the marine environment. SPLs can vary widely, dependent on the dredger type, operational stage, or environmental conditions (e.g. sediment type, water depth, salinity and seasonal phenomena such as thermoclines; Jones and Marten, 2016). These factors will also affect the propagation of sound from dredging activities and along with ambient sound already present, will influence the distance at which sounds can be detected.

Sound sources for TSHD have been modelled to provide a worst-case scenario. Sound sources include the draghead on the seabed, material going through the underwater pipe, as well as sound sources from the vessel, such as inboard pump, thrusters, propeller and engine noise (Central Dredging Association (CEDA), 2011; World Organization of Dredging Associations (WODA), 2013). Noise measurements indicate that the most intense sound emissions from TSHD dredgers are typically low frequencies, up to and including 1kHz (Robinson *et al.,* 2011). Underwater noise from a TSHD is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011).

Based on reviews of published sources of underwater noise during dredging activities (e.g. Thomsen *et al.,* 2006; CEDA, 2011; Theobald *et al.,* 2011; WODA, 2013; Todd *et al.,* 2014), sound levels that marine mammals may be exposed to during dredging activities are usually below auditory injury thresholds or PTS exposure criteria; however, TTS cannot be ruled out if marine mammals are exposed to noise for prolonged periods (Todd *et al.,* 2014), although marine mammals remaining in close proximity to such activities for long periods of time is unlikely.

Underwater noise as a result of dredging activity also has the potential to disturb marine mammals (Pirotta *et al.,* 2013). Therefore, there is the potential for short, perhaps medium-term behavioural reactions and disturbance to marine mammals in the area during dredging activities. Marine mammals may exhibit varying behavioural reactions intensities as a result of exposure to noise (Southall *et al.,* 2007).

The sensitivity of marine mammals to underwater noise during dredging activities is considered to be medium in this assessment as a precautionary approach. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

12.6.2.1 Potential for PTS and TTS Onset

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS or TTS onset, as a result of underwater noise during dredging activities (**Table 12-15**) has been assessed based on the number of animals that could be present in each of the modelled impact ranges and areas. The results of the underwater noise modelling show that at the source levels predicted for the dredging activities, any marine mammal would have to remain in close proximity (i.e. less than 100m) of the sound source for 12 hours to be exposed to levels of sound that are sufficient to induce PTS as per the Southall *et al*. (2019) threshold criteria.

Table 12-15 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset as a result of underwater noise associated with dredging activities, based on underwater noise modelling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	<100m 0.03km²	0.02 harbour porpoise (0.00005% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m 0.03km²	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m 0.03km²	0.003 white-beaked dolphin (0.000006% CGNS MU)	
	Minke whale	<100m 0.03km²	0.001 minke whale (0.000007% CGNS MU)	
	Grey seal	<100m 0.03km²	0.02 grey seal (0.0002% of the ES MU; or 0.0001% of the wider MU)	
	Harbour seal	<100m 0.03km²	0.008 harbour seal (0.002% of the ES MU; or 0.0006% of the wider MU)	Permanent effect with negligible to low magnitude (less than 0.001% to 0.001% to 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
TTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	250m 0.2km²	0.1 harbour porpoise (0.0003% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m 0.03km²	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m 0.03km²	0.003 white-beaked dolphin (0.000006% CGNS MU)	
	Minke whale	<100m 0.03km²	0.001 minke whale (0.000007% MU)	

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
	Grey seal	<100m 0.03km²	0.02 grey seal (0.0002% of the ES MU; or 0.0001% of the wider MU)	
	Harbour seal	<100m 0.03km²	0.008 harbour seal (0.002% of the ES MU; or 0.0006% of the wider MU)	

The magnitude of the potential impact of PTS and TTS onset as a result of dredging activity is negligible for all marine mammal species, with less than 0.001% of the reference population likely to be affected for any permanent impacts (PTS), and less than 1% at risk of temporary impact (TTS).

12.6.2.2 Mitigation Measures

Due to the small impact ranges, and low number of individuals at risk, no mitigation measures are required for dredging activities.

12.6.2.3 Effect Significance

PTS and TTS Onset

Taking into account the receptor sensitivity (of high for PTS and medium for TTS for all marine mammal species) and the potential magnitude of the impact (of negligible for all species), the effect significance for PTS and TTS in all species, from cumulative exposure, has been assessed as being of **minor adverse effect, which is not considered significant in EIA terms** (**Table 12-16**).

Table 12-16 Assessment of effect significance for the potential for PTS onset in marine mammals from underwater noise during dredging

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse

Potential for Disturbance

McQueen *et al.* (2020) found that habitat avoidance was not at a sufficient spatial scale to pose risks to harbour porpoises or seals, in the context of activity in dredging areas (adjacent to navigation channels and port infrastructure areas)[13]. The unweighted 140dB re 1µPa SPL generic threshold level for behavioural avoidance of high-frequency cetaceans and pinnipeds in water is exceeded at distances up to approximately 400m from the dredge (McQueen e*t al.,* 2020).

For behavioural assessments, there are a myriad of significant data gaps that contribute to the uncertainty of the assessment. The major sources of uncertainty are clear exposure–response relationships among observed marine mammal behavioural studies (McQueen *et al.,* 2020). In some cases, there are orders of

[13] *using the maximum source level of 192 dB re 1 µPa - m, SELs for the marine mammals were calculated using the sheet for "non - impulsive, continuous, mobile sources" from the publicly available NMFS (2018b) spreadsheet tool.*

magnitude differences in reported sound thresholds for similar behavioural reactions, likely influenced by the difficulties with behavioural response scoring (Gomez *et al*., 2016) and study-specific context (e.g., multivariate exposure conditions; Ellison *et al.,* 2012). Although there is the potential for behavioural response to the construction activities and excavation works it is anticipated to be localised in effect and short in duration with animals returning to the area shortly after the sound source is stopped or completion of the works.

Although there is the potential for behavioural response to the dredging activities, it is anticipated to be localised in effect and short in duration, with animals returning to the area shortly after the sound source is stopped or completion of the works. Therefore, there is unlikely to be the potential for any significant impact on marine mammals, and the magnitude of impact for all marine mammal species is assessed as being low, due to the predicted short-term nature and localised potential for disturbance. Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of minor for all species), the effect significance for disturbance in all species has been assessed as being of **minor adverse effect, which is not considered significant in EIA terms** (**Table 12-20**Table 12-17).

Table 12-17 Assessment of effect significance for the potential for disturbance to marine mammals from underwater noise during dredging

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance due to dredging	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Low	Minor adverse	-	Minor adverse

12.6.3 Potential for Indirect Impacts to Marine Mammals

Marine mammals often inhabit turbid environments and cetaceans utilise sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al*., 2014). Pinnipeds are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al*., 2014).

Increased turbidity is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely. Therefore, harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal have a negligible sensitivity to increases in suspended sediments during construction.

Any direct impacts to marine mammals as a result of any contaminated sediment during construction activities are unlikely as any exposure is more likely to be through potential indirect impacts via prey species, as assessed in **Section 12.6.3.3.** Therefore, marine mammals are considered to have a negligible sensitivity to any direct impacts from suspended sediment during construction activities.

12.6.3.1 Increase in SSC in Water Body due to Dredging and Disposal

An increase in SSC during the dredging and disposal for the Proposed Scheme could lead to a potential reduction in water clarity and therefore quality. Modelling results predict the increase in SSC to be highly localised and temporary during dredging and that they would be highest at the bottom while minimum at the surface layers within the water column. Dredging will be non-continuous and SSC levels will dissipate to

within background levels between dredging activities (see **Chapter 8: Marine Water and Sediment Quality**).
The magnitude of the temporary impact of increase in SSC for all species is **low**.

Mitigation Measures
No mitigation measures are required beyond the implementation of good practice during construction works.

Effect Significance
The residual effect of the potential risk of indirect impacts on marine mammals as a result change to water quality would be of **negligible effect.**

12.6.3.2 Potential Release of Contaminates during Dredging and Disposal

Any trace contaminants disturbed during dredging would be bound to fine sediment particles hence would only be present within the sediment plume. Chemical analysis of the source dredge material has been undertaken and is reported in **Section 8.6.1**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal (as determined through comparison against Centre for Environment, Fisheries and Aquaculture Science (Cefas) action levels).

A small quantity of contaminated disposal material, limited sediment exposure coupled with good dilution capacity provided due to the location of the development and disposal ground, it is considered that magnitude of impact for all species would be **low,** and the overall effect significance is **negligible**.

Mitigation Measures
No mitigation measures are required beyond the implementation of good practice during construction works.

Effect Significance
The residual effect of the potential risk of indirect impacts on marine mammals as a result change to water quality would be of **negligible effect** (**Table 12-18**).

Table 12-18 Assessment of effect significance of indirect impacts on marine mammals from changes to water quality

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Increase in SSC	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Negligible	Low	Negligible	None required	Negligible
Potential release of contaminates		Negligible	Low	Negligible	None required	Negligible

12.6.3.3 Potential for Changes to Prey Availability

The diet of the harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet its daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

Bottlenose dolphin and white-beaked dolphin are opportunistic feeders, feeding on wide range of prey species and have large foraging ranges (see **Section 12.5)** and are therefore considered to have low sensitivity to changes in prey resources.

Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level (see **Section 12.5**). Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

Grey and harbour seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges (see **Section 12.5**). Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources. Grey seal feed on a variety of prey species. Both species of seal are considered to be opportunistic feeders that are able to forage in other areas and have relatively large foraging ranges. Grey seals are therefore considered to have low sensitivity to changes in prey resources.

The potential impact of underwater noise on fish species was scoped out of the sEIA on the basis that potential impacts as a result of the Proposed Scheme would be below that considered for the Outer Berth development. Soft start piling mitigation will be adhered to, to ensure no significant impacts arise.

All potential impacts are assessed as being of either negligible or minor adverse significance; therefore, the potential for a change in prey availability to marine mammals, due to either underwater noise impacts or a change in water quality, is assessed as being of low magnitude to all marine mammal species.

Mitigation Measures
No mitigation measures are required.

Effect Significance
The residual impact of the potential risk of indirect impacts on marine mammals as a result change in prey availability would be of **minor adverse effect, which is not considered significant in EIA terms** (**Table 12-19**).

Table 12-19 Assessment of effect significance of indirect impacts on marine mammals from changes in prey availability

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Indirect impacts to prey availability due to underwater noise impacts to fish species	Harbour porpoise Minke whale	Low to medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Low	Low	Minor adverse	None required	Minor adverse
Indirect impacts to prey availability due to water quality impacts to fish species	Harbour porpoise Minke whale	Low to medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Low	Low	Minor adverse	None required	Minor adverse

12.7 Prediction of Potential Significant Effects During the Operation Phase

There is not expected to be any significant change in operation, compared to the existing activity levels; therefore, it is not expected that there would be any potential to impact marine mammals during the operational phase.

12.8 Summary

Table 12-20 summarises the significance of all potential impacts to marine mammal species, as assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 12-20 Summary of potential impacts to marine mammals

Potential impact	Receptor	Effect significance	Mitigation proposed	Residual impact
Underwater noise during piling				
PTS onset during piling – single strike or cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010)	Negligible
TTS onset during piling – single strike or cumulative exposure		Minor adverse		Negligible
Disturbance due to impact piling		Minor adverse	None required	Minor adverse
Underwater noise during dredging				
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure		Minor adverse	None required	Minor adverse
Disturbance due to dredging		Minor adverse	None required	Minor adverse
Indirect effects due to a change in water quality and prey availability				
Indirect impacts to prey availability due to underwater noise or water quality impacts to fish species	Harbour porpoise Minke whale	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Minor adverse	None required	Minor adverse

13 Cumulative Impact Assessment

13.1 Introduction

In addition to the determination of the potential impacts from the proposed development in isolation, the EIA Regulations require that an assessment is made of the potential for cumulative impacts, which considers the impacts from the Proposed Scheme cumulatively with other proposed projects.

A useful ground rule in EIA is that the environmental impacts of any other development that is already built and operational is effectively included within the baseline conditions, so such effects are already taken account of in the EIA process and can be excluded from the CIA; however, projects that are in the planning process need to be considered. Any that are ahead of the development being assessed (i.e. likely to be submitted or receive consent before the development being assessed or are currently being built) must be taken into account during a CIA. Any that are substantially further back in the planning process and are unlikely to be submitted or get consent until after the development being assessed, can be disregarded because the developer of that project should be taking the effects of the current development into account in their own EIA.

The key aspects for consideration when undertaking CIA are:

- The temporal and geographic (spatial) boundaries of the effects of activities;
- Interactions between the activities and the environment;
- The environmental effects of the project (including future projects and activities); and
- Thresholds of sensitivity of the existing environment.

CIA is limited to those plans and projects for which sufficient information exists to allow consideration of the potential for such an effect to arise. In the absence of such publicly available data, it is not possible to undertake a detailed cumulative assessment, but it is possible to make judgements on the likely potential impacts on the basis of the characteristics of the other projects being considered and whether there is the potential for the impacts of the various projects to interact spatially or temporally.

To assess potential for cumulative effects a 'screening' assessment was carried out to determine whether the identified projects have the potential to give rise to cumulative impacts with the proposed development and, therefore, whether further assessment is required (**Table 13-1**).

Table 13-1 Long list of projects for consideration of cumulative effects

Project	Location and Distance from the Proposed Scheme	Screened in for further consideration (and reasoning)
Nigg Energy Park East Quay	Cromarty Firth, approximately 196km (340km around the coastline)	No – construction works now completed
NorthConnect HVDC Cable	Landfall at Peterhead, 187km (195km around the coastline)	No – project was not granted consent in Norway, and now on hold
Moray West OWF	Moray Firth, approximately 224km (291km around the coastline)	No – construction works now completed
Moray East OWF	Moray Firth, approximately 233km (281km around the coastline	**Yes** – potential for overlap in construction timeframes

Project	Location and Distance from the Proposed Scheme	Screened in for further consideration (and reasoning)
Sea Wall Repair and Extension – Alexandra Parade	Peterhead, approximately 189km (195km around the coastline)	**Yes** – potential for overlap in construction
Ardersier Port Development	Moray Firth, approximately 185km (344km around the coastline)	**Yes** – potential for overlap in construction
Seagreen Alpha and Bravo OWFs (Optimised Project)	Forth of Forth, approximately 69km from cable corridor and 96km from windfarm site (or 73km from cable corridor and 98km from windfarm site around the coastline)	No – OWF is now fully operational
Neart na Gaoithe OWF (Revised Design)	Firth of Forth, approximately 60km	**Yes** – potential for overlap in construction timeframes
Inch Cape OWF (Revised Design)	Firth of Forth, approximately 61km (landfall at Prestonpans – 11km)	No – offshore construction will not overlap with the Proposed Scheme
Grangemouth Flood Protection Scheme	Firth of Forth, approximately 30km (31km around the coastline)	No - Only the EIA Scoping report was available, which stated that construction would be undertaken from 2022, for a period of between five and 10 years. Given that no formal application has been submitted, it is unlikely that this scheme would overlap with the proposed development.

The marine elements of the Outer Berth development (i.e. those with the potential for cumulative impacts with the Proposed Scheme) would be completed by the time the construction works for the Proposed Scheme begins. As such, the presence of the Outer Berth development forms part of the baseline upon which the Proposed Scheme has been assessed.

13.2 Assessment of Cumulative Effects

Based on the screening assessment the following projects have been screed into the CIA:

- Moray East Offshore Wind Farm (OWF);
- Sea Wall Repair and Extension – Alexandra Parade;
- Ardersier Port Development; and
- Neart na Gaoithe OWF (Revised Design).

Given the significant distance the projects are from the proposed development, the closest being 60km away, cumulative effects only have the potential to occur to marine mammals given their wide ranging habits.

Due to the limited potential for any effect from either a change in water quality or a change in prey availability, and that the nearest other project screened in with relevant potential effects the Neart na Gaoithe OFW, at 60km from the Proposed Scheme, this CIA is restricted to the potential for cumulative underwater noise impacts only. In addition, as each project is required to provide mitigation for any potential for PTS onset, there is no potential for cumulative PTS onset impacts to occur. Therefore, the assessment only considers the potential for TTS onset and disturbance cumulative impacts. Given the significant distance the projects are from the proposed development, the closest being 60km away, cumulative effects only have the potential to occur to marine mammals given their wide-ranging habits. The potential for cumulative impacts for are presented for grey seal (**Table 13-2**), harbour seal (**Table 13-3**), bottlenose dolphin (**Table 13-4**), minke whale (**Table 13-5**), and white-beaked dolphin (**Table 13-6**).

In summary, there is no potential for significant impact to any species as a result of any other project together with the Proposed Scheme. The magnitude of impact is assessed as low for all species, and with the sensitivity of medium for TTS onset and disturbance, the overall cumulative impact assessment for all marine mammal species is **minor adverse, which is not significant in EIA terms.**

Table 13-2 Cumulative impact assessment on grey seals

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential impact	Assessment	Potential Effect	Assessment	
Neart na Gaoithe OWF (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the Proposed Scheme.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to impact piling used as the worst-case)	0.02 grey seal (0.0002% of the ES MU; or 0.0001% of the wider MU) No potential for significant adverse effect.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between 1,263 and 1,833 grey seal may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be short, and therefore was concluded that there would not be a significant effect.	Due to the temporary nature of the piling at the Proposed Scheme, and that any effect to grey seal at Neart na Gaoithe would be temporary, and that it is unlikely that all grey seal in the vicinity of the projects would be from the Isle of May SAC, it is concluded that there is **no significant in-combination effect** to grey seal.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant adverse effect.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of grey seal may occur up to 15km from the piling location. Therefore, for the 'drill-drive-drill' scenario up to 95 seals may be disturbed, and under the 'drive only' scenario, up to 113 grey seal may be displaced.	Due to the localised and temporary nature of the piling at the Proposed Scheme, in-combination with the low number of grey seal that may be disturbed as a result of the piling activities at Neart na Gaoithe, and that it is unlikely that all grey seal in the vicinity of the project would be from the IoM SAC, it is concluded that there is **no significant in-combination effect** to grey seal.

Table 13-3 Cumulative impact assessment for harbour seal

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the Proposed Scheme.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to impact piling used as the worst-case)	0.008 harbour seal (0.002% of the ES MU; or 0.0006% of the wider MU) No potential for significant effect.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between 95 and 152 harbour seal may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be short, and therefore was concluded that there would not be a significant effect.	Due to the temporary nature of the piling at the Proposed Scheme, and that any effect to harbour seal at Neart na Gaoithe would be temporary, and that it is unlikely that all harbour seal in the vicinity of the projects would be from the Firth of Tay and Eden Estuary SAC, it is concluded that there is **no significant in-combination effect** to harbour seal.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant effect.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of harbour seal may occur up to 15km from the piling location, and that between 283 and 314 individuals may be exposure to sound levels high enough to cause behavioural changes. However, population modelling has shown that this would alter the existing harbour seal population trend, and that therefore there would be no significant effect on the population as whole[14].	Due to the localised and temporary nature of the piling at the Proposed Scheme, in-combination with the conclusion that piling at Neart na Gaoithe would not alter the harbour seal population of the Firth of Tay and Eden Estuary SAC, and that it is unlikely that all harbour seal in the vicinity of the project would be from this SAC, it is concluded that there is **no significant in-combination effect** to harbour seal.

[14] https://marine.gov.scot/sites/default/files/appropriate_assessment_1.pdf

Table 13-4 Cumulative impact assessment for bottlenose dolphin

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
Moray East OWF	The Moray West OWF is currently under construction. There is therefore the potential for piling to overlap with the piling at the Proposed Scheme.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to impact piling used as the worst-case)	0.0009 bottlenose dolphin (0.0004% CES MU). No potential for significant effect	TTS from piling as the worst-case activity[15].	Not assessed.	There is no risk of in-combination TTS onset at the Proposed Scheme and piling at the Moray West OWF.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	Disturbance from piling as the worst-case activity.	The assessment found that up to 53 bottlenose dolphin may be disturbed (or up to 23.75% of the CES MU) for a single piling event, or up to 54 individuals (24.07 of the CES MU) for concurrent piling. The number of individuals at risk of disturbance was used to inform population modelling for bottlenose dolphin, resulting in a reported magnitude of low, and overall impact significance of minor adverse.	Due to the localised and temporary nature of the piling at the Proposed Scheme, and the very small number at risk of disturbance, it is concluded that there are **no significant in-combination effects** to bottlenose.
Sea Wall Repair and Extension –	Activities to be	TTS (highest	0.0009 bottlenose	TTS from construction activities[16]	There is no risk of TTS onset to bottlenose dolphin due to the low	There is no risk of significant in-combination TTS onset at the Proposed Scheme and the sea

[15]

[16] https://marine.gov.scot/sites/default/files/environmental_appraisal_document_redacted.pdf

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
Alexandra Parade	undertaken include excavation, and placement of rock armour. Works to be completed by the end of 2022, and therefore there is the potential for overlap with the construction of the Proposed Scheme.	potential impact range of 100m for TTS cumulative exposure due to impact piling used as the worst-case)	dolphin (0.0004% CES MU). No potential for significant effects		noise levels associated with the activities. There is therefore no potential for significant effect to bottlenose dolphin.	wall repair project. It is concluded that there are **no significant in-combination effects** to bottlenose.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant effects.	Disturbance from construction activities	Disturbance response for bottlenose dolphin was predicted to occur up to 30m from the source of noise. There is therefore no potential for significant effect to bottlenose dolphin.	Due to the localised and temporary nature of the piling at the Proposed Scheme, and that any effect to bottlenose dolphin due to the sea wall repair at Alexandra Parade is a low risk, and would be temporary, it is concluded that there are **no significant in-combination effects** to bottlenose dolphin.
Ardersier Port Development	This project is to develop a port and port related series for energy uses at a former fabrication yard.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to	0.0009 bottlenose dolphin (0.0004% CES MU). No potential for significant effects	TTS from piling works (vibro-piling only)	TTS from vibro-piling may occur in bottlenose dolphins up to 1m from the source. This is within the standard mitigation zone of 500m (JNCC, 2010), and therefore, there would no potential for TTS onset in bottlenose dolphins.	There is no risk of in-combination TTS onset at the Proposed Scheme and the Ardersier Port Development. It is concluded that there are **no significant in-combination effects** to bottlenose.

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	Construction activities will include dredging, and quay wall construction (using vibro-piling)[17]. Construction may take place until 2024, and therefore there is the potential for construction phase overlap with the Proposed Scheme.	impact piling used as the worst-case)				
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	Disturbance effects from piling works (vibro-piling only)	The potential for disturbance was not assessed. However, given the activities being undertaken at this project, it can be assumed that any disturbance effect would be the similar as the at the Proposed Scheme.	Due to the localised and temporary nature of the piling at the Proposed Scheme, and that any effect to bottlenose dolphin due to the Ardersier Port Development is a low risk, and would be temporary, it is concluded that are **no significant in-combination effects** to bottlenose dolphin.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to	TTS (highest potential impact range of 100m for TTS cumulative exposure due to	0.0009 bottlenose dolphin (0.0004% CES MU). No potential for significant effects	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between up to six bottlenose dolphins may receive noise levels capable of causing TTS. However, no bottlenose dolphins were recorded within 8km of the wind farm, and therefore the risk of any individuals being at risk of TTS onset is very low, and not significant.	Due to the temporary nature of the piling at the Proposed Scheme, and that any effect to bottlenose dolphin at Neart na Gaoithe is a low risk, and would be temporary, it is concluded that are **no significant in-combination effects** to bottlenose dolphin.

[17] https://marine.gov.scot/sites/default/files/volume_2_envionmental_impact_assessment_report_redacted.pdf

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	overlap with the piling at the Proposed Scheme.	impact piling used as the worst-case)				
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of bottlenose dolphin may occur up to 13.3km from the piling location. However, no bottlenose dolphins were recorded within 8km of the wind farm, and therefore the risk of any individuals being affected by displacement is very low, and not significant.	Due to the localised and temporary nature of the piling at the Proposed Scheme, and that it is unlikely that bottlenose dolphin would be present in the vicinity of Neart na Gaoithe, it is concluded that are **no significant in-combination effects** to bottlenose dolphin.

Table 13-5 Cumulative impact assessment for minke whale

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential impact	Assessment	Potential Effect	Assessment	
Neart na Gaoithe OWF (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with	TTS (highest potential impact range of 100m for TTS cumulative exposure due to impact	0.001 minke whale (0.000006% of the CGNS MU population). No potential for significant adverse effect.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between 77 and 88 minke whale may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to minke whale at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant in-combination effect** to minke whale due to TTS onset.

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential impact	Assessment	Potential Effect	Assessment	
	the piling at the Proposed Scheme.	piling used as the worst-case)				
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant adverse effect.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of minke whale may occur up to 42km from the piling location. Therefore, for the 'drill-drive-drill' scenario up to 77 individuals may be disturbed, and under the 'drive only' scenario, up to 88 minke whale may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of minke whale that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be **no significant in-combination effect** on minke whale due to disturbance.

Table 13-6 Cumulative impact assessment for white-beaked dolphin

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential impact	Assessment	Potential Effect	Assessment	
Neart na Gaoithe OWF (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with	TTS (highest potential impact range of 100m for TTS cumulative exposure due to impact	0.0008 white-beaked dolphin (0.000002% of the CGNS MU population). No potential for significant adverse effect.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between 64 and 72 white-beaked dolphin may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to white-beaked dolphin at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant cumulative effect** to white-beaked dolphin due to TTS onset

In-combination project	In-combination Project Information	Proposed Scheme Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential impact	Assessment	Potential Effect	Assessment	
	the piling at the Proposed Scheme.	piling used as the worst-case)				
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant adverse effect.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of white-beaked dolphin may occur up to 13.3km from the piling location. Therefore, for the 'drive only' scenario, up to 28 white-beaked dolphin may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of white-beaked dolphin that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be **no significant cumulative effect** to white-beaked dolphin due to disturbance.

14 Summary of Potential Impacts and Mitigation Measures

This chapter provides an overall summary of the findings of the sEIA for the receptors where further assessment work has been undertaken, including:

- Coastal processes;
- Marine water and sediment quality;
- Marine ecology;
- Fish and shellfish resource;
- Ornithology; and
- Marine mammals.

Table 14-1 and
Table 14-2 list the potential environmental impacts that are predicted to arise during the construction and operational phases of the proposed development, respectively. The significance of each of the potential impacts is stated, along with any mitigation measures that are recommended to avoid or reduce adverse impacts. The residual impact (i.e. the significance of the potential impact remaining following mitigation) is also stated. Negligible and minor adverse impacts are not significant in EIA terms.

Table 14-1 Summary of the significance of potential environmental impacts, mitigation and residual impacts during the construction phase of the Proposed Scheme

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual Impact
Coastal Processes				
Changes in Suspended Sediment Concentrations due to Capital Dredging of the Approach Channel and Berth Pocket	Marine water quality	Minor adverse	None Required	Minor Adverse
Changes in Seabed Level due to Capital Dredging of the Approach Channel and Berth Pocket	Seabed	Minor Adverse	None Required	Minor Adverse
Marine Water and Sediment Quality				
Deterioration in water quality due to release of sediment-bound contaminants	Marine water quality	Negligible	None required	Negligible
Marine Ecology				
Direct loss of benthic habitats within the footprint of the Proposed Scheme	Marine ecology	Negligible	None proposed	Negligible
Smothering of benthic habitats as a result of the proposed dredging and disposal activities	Marine ecology	Minor adverse	None proposed	Minor adverse
Release of contaminants during dredging and disposal	Marine ecology	Negligible	None proposed	Negligible
Fish and Shellfish Ecology				
Underwater noise	Migratory fish (salmon, trout, European eel)	Minor adverse	No additional mitigation required with soft start procedures as per the JNCC protocol (JNCC, 2010).	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Negligible		Negligible
Increased SSC	All fish and shellfish	Minor adverse	None required	Minor adverse
Release of contaminants	All fish and shellfish	Negligible	None required	Negligible
Ornithology				
Visual disturbance at the disposal site	Common tern, eider, shag, red-throated diver, sandwich tern	Negligible	None required	Negligible

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual Impact
	and roseate tern, as well as breeding and non-breeding seabird assemblages.			
Sediment Plumes Arising from Dredging and Disposal activities	Common tern, eider, shag, red-throated diver, roseate tern and sandwich tern, as well as breeding and non-breeding seabird assemblages.	Negligible		Negligible
Noise disturbance from construction of the sheet piled retaining wall	Breeding and post-breeding common terns	N/A	Use of piling shroud to reduce source noise levels and soft start procedures.	Minor adverse
Marine mammals				
Underwater noise during piling				
PTS onset during piling – single strike or cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010)	Negligible
TTS onset during piling – single strike or cumulative exposure		Minor adverse		Negligible
Disturbance due to impact piling		Minor adverse	None required	Minor adverse
Underwater noise during dredging				
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure		Minor adverse	None required	Minor adverse
Disturbance due to dredging		Minor adverse	None required	Minor adverse
Indirect effects due to a change in water quality and prey availability				
Indirect impacts to prey availability due to underwater noise or water quality impacts to fish species	Harbour porpoise Minke whale	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin	Minor adverse	None required	Minor adverse

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual Impact
	Grey seal Harbour seal			

Table 14-2 Summary of the significance of potential environmental impacts, mitigation and residual impacts during the operational phase of the Proposed Scheme

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual impact
Coastal Processes				
Changes to Tidal Currents due to the Presence of the Approach Channel and Berth Pocket	Tidal regime	No effect	None required	No effect
Changes to Sediment Transport and Erosion/Accretion Patterns due to the Presence of the Approach Channel and Berth Pocket	Sediment transport	Minor Adverse	None required	Minor Adverse

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