REPORT

Port of Dundee Capital Dredge and Quay Improvement Works

EIA Report

Client:	Port of Dundee Limited
Reference:	PC6550-RHD-XX-XX-RP-EV-0038
Status:	Final/02
Date:	7 July 2025

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Acronyms

Acronym	Acronym description
AEoI	Adverse Effect on Integrity
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BAP	Biodiversity Action Plan
BPEO	Best Practicable Environmental Option
CD	Chart Datum
CES	Coastal East Scotland
CIA	Cumulative Impact Assessment
CGNS	Celtic Greater North Sea
CI	Confidence Interval
CIEEM	Chartered Institute of Ecology and Environmental Management
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Confidence Limit
CV	Coefficient of variation
Defra	Department for Environmental Food and Rural Affairs
DDC	Dundee City Council
DDT	Dibutyltin
DDV	Drop Down Video
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EPS	European Protected Species
FeAST	Feature Activity Sensitivity Tool
FCS	Favourable Condition Status
GES	Good Environmental Status
HF	High Frequency
HRA	Habitats Regulations Appraisal
IAMMWG	Inter-Agency Marine Mammal Working Group
IEMA	Institute of Environmental Management and Assessment
INNS	Invasive non-native species
JCP	Joint Cetacean Protocol

Acronym	Acronym description
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MarESA	MarLIN Marine Evidence based Sensitivity Assessment
MD-LOT	Marine Directorate – Licensing Operations Team
MPA	Marine Protected Area
MU	Management Unit
MWRs	Marine Works (EIA) (Scotland) Regulations 2017 (as amended)
nm	Nautical miles
NMFS	National Marine Fisheries Service
OWF	Offshore Windfarm
O&M	Operation and Maintenance
PAC	Pre-Application Consultation
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCW	Prince Charles Wharf
PCWE	Prince Charles Wharf Extension
PMF	Priority Marine Features
PTS	Permanent Threshold Shift
RMS	Root mean square
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level, cumulative
SEL_{SS}	Sound Exposure Level single strike
SNH	Scottish National Heritage
SPA	Special Protection Area
SPL	Sound Pressure Level
SPL_{peak}	Sound Pressure Level Peak

Acronym	Acronym description
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TBT	Tributyltin
TCPRs	Town and Country Planning (EIA) (Scotland) Regulations 2017 (as amended)
TTS	Temporary Threshold Shift
UK	United Kingdom
VHF	Very High Frequency
ZoI	Zone of Influence

1 Introduction

1.1 Background

One of the primary uses for the Port of Dundee is to service and support the offshore renewables industry. The port already provides facilities for the transhipment and storage of components, such as wind turbine generators (WTGs) and other component parts associated with wind farm projects. Due to the increasing size of the components and vessels used by the offshore renewables industry, the Port of Dundee Limited is proposing to undertake a suite of works at the Port of Dundee and Lady Shoal approach channel in order to accommodate the increasing needs of the offshore renewables industry.

The suite of works that comprise the Proposed Scheme includes the following (see **Figures 1-1** to **1-3**):

- Capital dredging works to:
    - Deepen the approaches to DunEco Quay and Prince Charles Wharf (PCW) to -6.0m Chart Datum (CD) and -6.5m CD, respectively;
    - Widen the PCW berth pocket to 70m and deepen to -9m CD, extend eastwards by approximately 200m to a depth of -10m CD (called the Prince Charles Wharf Extension (PCWE)); and
    - Deepen a section of the Lady Shoal Approach channel to -6.5m CD.
- Improvement works to the PCW.

It is anticipated that approximately 220,000m^3 of material would be removed, approximately 490,000m^3 including a 0.5m over-dredge allowance, from within the dredge footprints within the dredge areas. Disposal would be at the existing Middle Bank disposal site (FO028), as confirmed by the Best Practicable Environmental Option (BPEO) assessment submitted in support of the marine licence application (ref: PC6550-RHD-XX-XX-RP-EV-0061).

For further information on the Proposed Scheme see **Section 3**.

1.2 Requirement for Environmental Impact Assessment

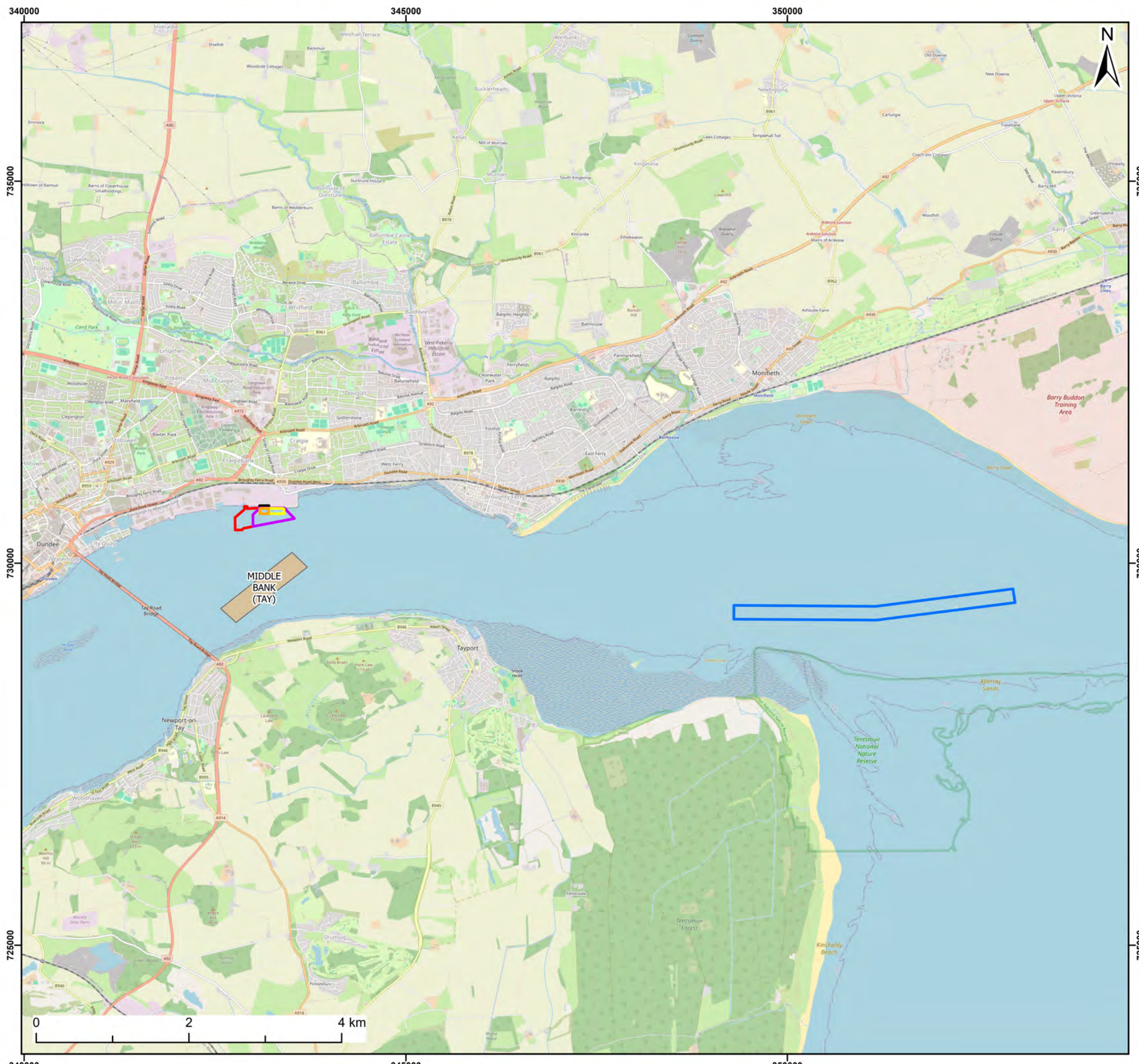
The following Environmental Impact Assessment (EIA) regulations apply to the Proposed Scheme:

- Marine Works (EIA) (Scotland) Regulations 2017 (as amended) (the MWRs); and,
- Town and Country Planning (EIA) (Scotland) Regulations 2017 (as amended) (TCPRs).

The Proposed Scheme falls under Schedule 2 10(g) of the above regulations, as:

Construction of harbours and port installations, including fishing harbours (unless included in schedule 1)

Thus, an EIA Screening Report (**Appendix 1-1**) was submitted to both the Dundee City Council (DCC) and the Marine Directorate – Licensing Operations Team (MD-LOT) along with requests for Screening Opinions in January 2025. DCC's Screening Opinion was received on 14th February 2025 (**Appendix 1-2**), which determined that the Proposed Scheme was not EIA development in accordance with the TCPRs and Circular 1/2017. Subsequent to this, MD-LOT provided its Screening Opinion on 3rd April 2025 (**Appendix 1-3**), which determined the Proposed Scheme to be EIA development under the MWRs.



Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area
- Quay Improvement Works
- Disposal Site

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Location Plan showing the Proposed Scheme

Figure:	Drawing No:
1-1	PC6550-RHD-XX-ZZ-D-EV-0064

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	10/07/2025	JH	JG	A3	1:50,000

Co-ordinate system: British National Grid

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343000

344000

731000

730000

N

Area - 8,105m²
Volume - 1,500m²

Area - 13,890m²
Volume - 15,500m²

Area - 46,910m²
Volume - 24,000m²

Area - 34,150m²
Volume - 19,000m²

0 200 400 Metres

Service Layer Credits: OpenStreetMap: © OpenStreetMap (and) contributors, CC-BY-SA

Legend:

- Remedial Quay Works

DunEco Quay Approach Channel
- Dredge Area
- Dredge Footprint

Prince Charles Wharf Approach Channel
- Dredge Area
- Dredge Footprint

Proposed Extension to PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Existing PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Proposed Works at the Port of Dundee

Figure:	Drawing No:
1-2	PC6550-RHD-XX-ZZ-DR-Z-0002

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	10/06/2025	JH	RG	A3	1:6,000
P01	10/12/2024	GC	RG	A3	1:6,000

Co-ordinate system: British National Grid

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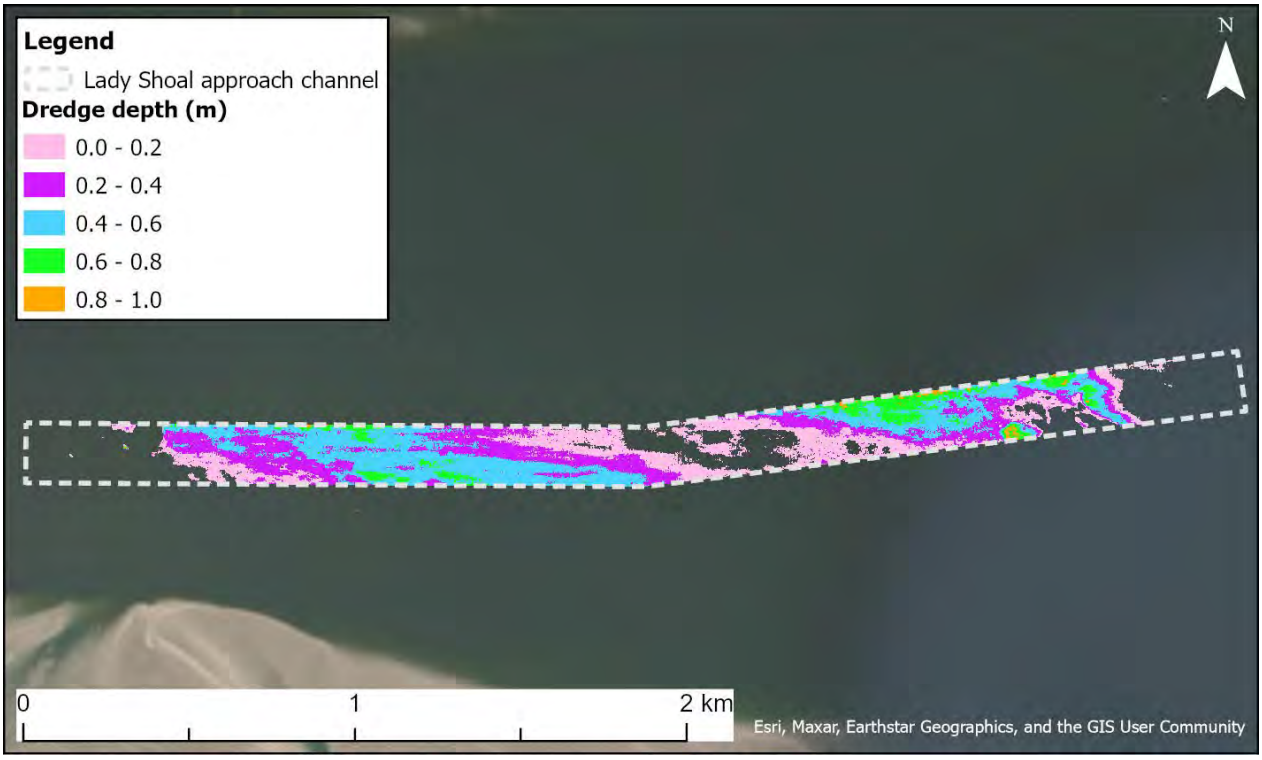


Figure 1-3 Lady Shoal approach channel dredge area (white dashed line) and footprint (by dredge depth)

1.3 Changes to the Proposed Scheme since Screening for EIA

Given the Proposed Scheme was determined to not be an EIA development under the TCPRs, the landside works, i.e. the extension to the laydown area and landside improvements to the PCW, can be carried out under the Port of Dundee Limited's Permitted Development Rights, as long as the landside works would not have an Adverse Effect on Integrity (AEoI) of any European (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) or Ramsar sites. A shadow Habitats Regulations Appraisal (HRA) has therefore been undertaken on the landside elements, which confirmed that they would not result in an AEoI on relevant European or Ramsar sites.

In light of the above, and the fact that the EIA Screening exercise did not identify any significant effects arising as a result of the proposed landside works, as supported by DCC's Screening Opinion (see **Section 5.3** for further details), the landside works have been removed from the Proposed Scheme to be progressed independently. Any cumulative effects of the landside works with the Proposed Scheme have been considered as part of the Cumulative Impact Assessment (CIA) (see **Chapter 13**).

1.4 Marine Licensing

A request for a marine construction licence and marine disposal licence is being sought from MD-LOT to permit the proposed improvement works to the PCW and the disposal of the dredged material. The dredging activity would be undertaken under the Dundee Harbour and Tay Ferries Order Confirmation Act 1952.

1.5 Study area

The study area considered in this EIA Report (EIAR) is the Zone of Influence (ZoI) over which direct and indirect potential impacts of the Proposed Scheme may occur. The maximum extent of the Proposed Scheme's ZoI was considered to relate to potential impacts on mobile species namely migratory fish, otter and marine mammals, and is described in the relevant sections of this EIAR.

1.6 Structure of this Report

This EIAR is structured as follows:

Chapter 1 provides an introduction to the Proposed Scheme, the requirement for EIA and describes changes to the Proposed Scheme since screening for EIA.

Chapter 2 details the Need for the Proposed Scheme and the associated benefits.

Chapter 3 provides a 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.

Chapter 5 describes the approach taken in producing this EIAR, including the 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 environment. Potential impacts that could arise as a result of the Proposed Scheme have been identified 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 with other plans and projects.

Chapter 14 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 EIAR.

Appendices

Appendix 1-1 EIA Screening Report
Appendix 1-2 DCC's Screening Opinion
Appendix 1-3 MD-LOT's Screening Opinion
Appendix 7-1 Hydrodynamic Modelling Report
Appendix 8-1 Sediment Sampling Plan and MD-LOT's Approval
Appendix 8-2 Sediment Analyses Results
Appendix 9-1 Benthic Survey Report
Appendix 10-1 Underwater Noise Modelling Report
Appendix 11-1 Port of Dundee Overwintering Bird Surveys 2023/24: Survey Report
Appendix 11-2 Port of Dundee Overwintering Bird Surveys 2024/25 Distribution and abundance maps

2 Need for the Proposed Scheme

The Proposed Scheme is an essential component in Scotland's economic recovery and energy transition plans, and in the achievement of Scotland's net zero carbon emissions targets. The Proposed Scheme represents a further £24m private sector investment that will ensure that the Port of Dundee can continue to meet the ever-increasing requirements of the offshore renewables industry.

The 2025 Draft Sectoral Marine Plan for Scotland [1] highlights that offshore wind energy is one of Scotland's greatest assets with a potential capital value of around £100 billion, given full deployment of the potential pipeline. There are a range of substantial projected benefits linked to the growth of offshore wind in Scotland including job creation, economic regeneration, technology development and investment in marine environment recovery and enhancement.

Renewable energy is critical to the decarbonisation effort to achieve net zero greenhouse gas emissions. It plays a significant role in safeguarding energy security that has been highlighted due to recent events around the globe, and which has caused a supply crunch in the oil market, further exacerbating the volatility of energy prices.

Dundee has been identified as one of Scotland's top locations to support the renewables industry by Scottish Enterprise under the National Renewables Infrastructure Plan, and is within the Scottish Government's Low Carbon Renewables East Enterprise Area. The Port of Dundee plays a critical part in this, being ideally located to on-going and proposed offshore renewable developments, and by providing a range of facilities and proven expertise in the provision of operational services to the renewable energy markets, including extensive storage areas, warehousing and deep-water berths, alongside a heavy lift quayside

The increasing size of components and vessels being used by the offshore renewables industry means that improvement works to the Port of Dundee and deepening of its approaches are required if it is to continue to support the industry and provide the full flexibility necessary for the arrival and departure of vessels used in the delivery of offshore renewables infrastructure projects.

[1] *https://www.gov.scot/publications/draft-updated-sectoral-marine-plan-offshore-wind-energy-2025/pages/3/*

3 Description of the Proposed Scheme

3.1 Construction Phase

3.1.1 Capital dredging

The capital dredging works would be carried out as follows:

- Deepen the approach to DunEco Quay to -6m CD (red outline on **Figure 1-2**);
- Deepen the approach to the PCW to -6.5mCD (purple outline on **Figure 1-2**);
- Widen the PCW berth pocket to 70m and deepen to -9m CD (orange outline on **Figure 1-2**);
- Extend the berth pocket 200m to the east along the PCWE and deepen to -10m CD (**Figure 1-2**); and
- Deepen a section of the Lady Shoal Approach channel to -6.5m CD (see **Figure 1-3)**.

All dredging at the Port of Dundee, with the exception of a very small area in the south-west corner of the dredge footprint, is within the Port of Dundee Limited's licenced maintenance dredge area. The proposed dredging would generate approximately 60,000m^3 of material (105,000m^3 with an over-dredge allowance of 0.5m). The dredge depth would be between approximately 0.5m to 1m, and up to 2.5m within the PCWE berth pocket dredge area. The dredge depth in the Lady Shoal Approach channel would mostly be less than 1m and would generate approximately 160,000m^3 of material (385,000m^3 with an over-dredge allowance of 0.5m). The actual dredging works would take place within the dredge footprints within the dredge areas, as shown on **Figure 1-2** and **Figure 1-3**.

Total volume of dredged material would therefore be approximately 220,000m^3 (490,000m^3 with an over-dredge allowance of 0.5m), from within the dredge footprints within the dredge areas. All dredging would be undertaken by back-hoe dredger, with the material being disposed of at the existing Middle Bank disposal site (see **Figure 1-1**) using hopper barges. A summary of the proposed dredging can be seen in **Table 3-1**.

Table 3-1 Details of proposed dredge footprints

Dredge location	Approximate Area (m^2)	Volume (m^3) (without over-dredge allowance)	Volume (m^3) (with 0.5m over-dredge allowance)
Approach to DunEco Quay	46,810	24,000	45,750
Approach to PCW	34,150	19,000	35,700
PCW berth pocket	8,105	1,500	1,800
PCWE berth pocket	13,890	15,500	21,750
Lady Shoal approach channel	458,500	160,000	385,000
Total	**561,455**	**220,000**	**490,000**

3.1.2 Improvement works to the PCW

A new piled wall would be installed immediately in the front of the existing PCW to reinforce the quay structure, consisting of 48 main piles, infilled with sheet-piles, and extending for 106m along the sea face of the quay (see **Figure 3-1** and **Figure 3-2** with new piles being shown in red). Piling would be undertaken using a combination of vibro- and impact-piling.

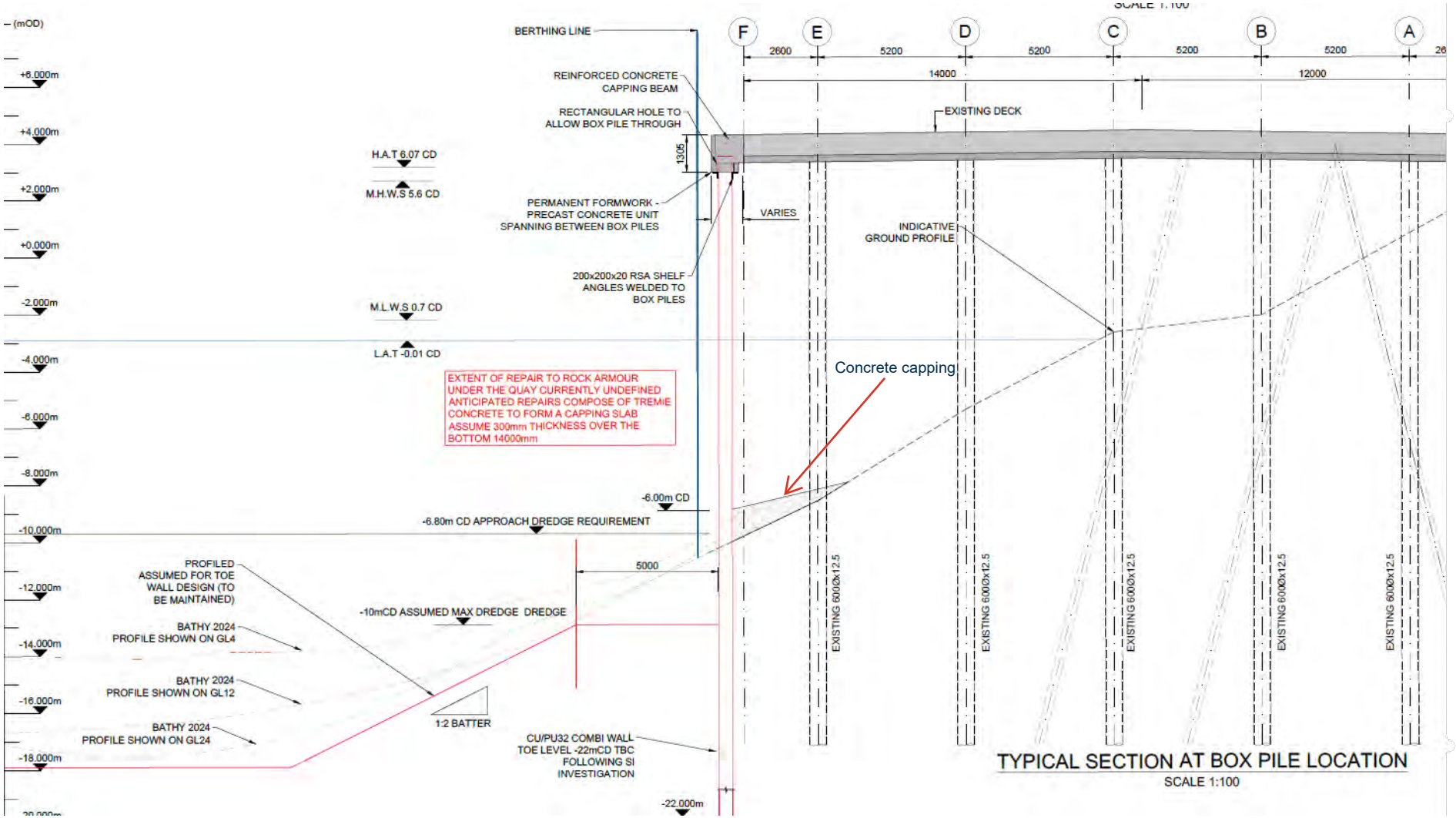


Figure 3-1 Typical cross section of the improvement works to the PCW (proposed new pile shown in red)

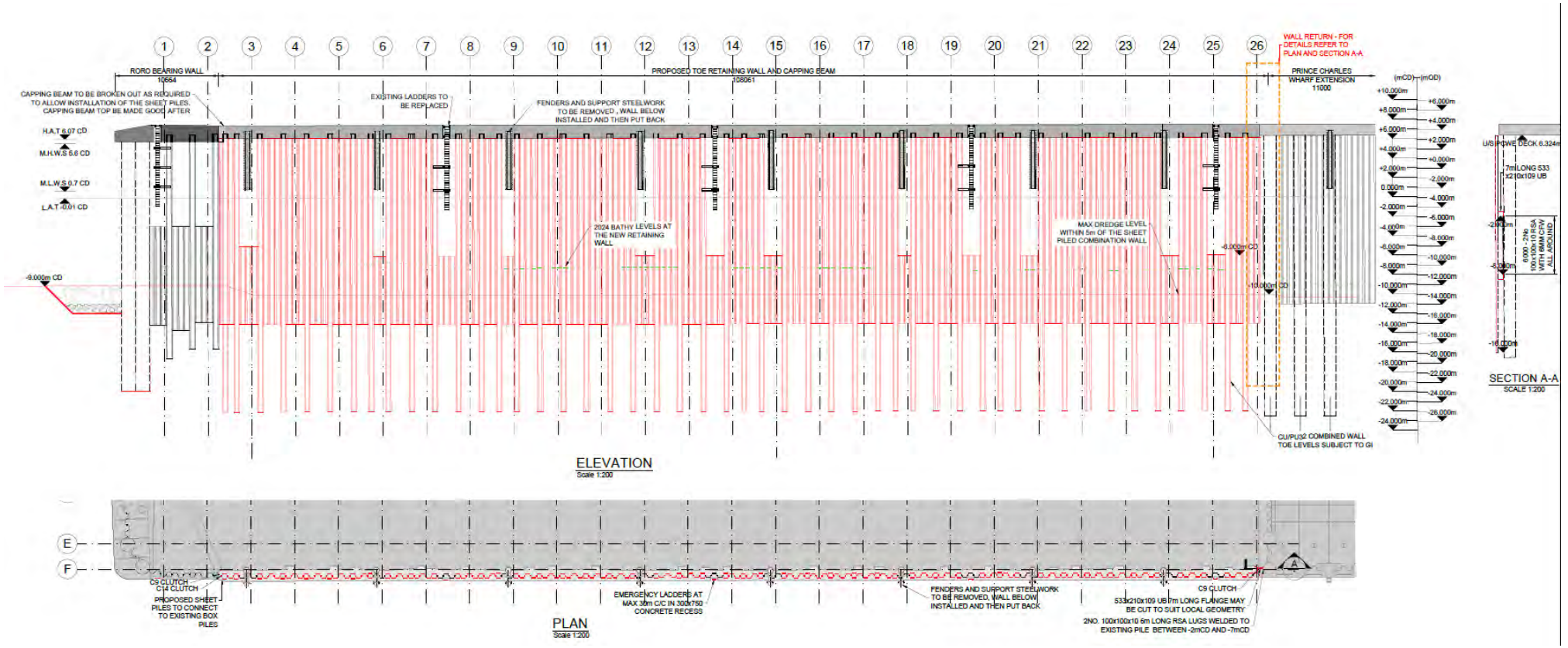


Figure 3-2 Improvement works to the PCW, elevation (top) and plan view (bottom) (Proposed Scheme are shown in red)

Localised excavation around the base of the existing quay wall may be required to remove any obstructions, using either land-based long reach excavators or dredging equipment, as appropriate, backfilling as required to maintain to a level in front of the wall of -10m CD. There is potential for concrete capping at the toe of the rock armour below the PCW where it meets the new wall of up to 300mm, which would not extend past the existing extent of rock armour (**Figure 3-1**).

A new beam would be installed at the head of the piles to facilitate the pile being tied into the existing PCW deck. Existing fenders would be cut off at existing pile locations, retained and welded back on following installation of wall. Existing ladders would be replaced (**Figure 3-2**).

3.1.3 Outline construction programme

The proposed improvement works to the PCW would take up to two months to complete, within which piling works would take approximately 35 days. The proposed dredging and disposal activities would take up to seven weeks to complete. The proposed works are planned to commence in December 2025.

3.2 Description of the Operational Phase

The Proposed Scheme would not change the number or type of vessels berthing at the Port of Dundee, rather it will ensure that the Port can continue to accommodate the vessels being used by the offshore renewables industry and components used in the construction of offshore wind farms. The Proposed Scheme would not result in any changes to the existing operations being carried out at the Port.

The proposed deepening works would not change the maintenance dredge requirement at the Port of Dundee, nor would dredging be required to maintain the deepened Lady Shoal approach channel dredge area (see **Section 7.6.1.2** for further details).

In light of the above, with the exception of any changes to estuarine processes as a result of the Proposed Scheme there are no operational effects during the operational phase.

3.3 Consideration of Alternatives

3.3.1 Do-Nothing scenario

The do-nothing scenario would mean that the Port of Dundee 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 less viable to support the offshore renewables industry. Consequently, the do-nothing scenario has been discounted.

Given that the elements of the Proposed Scheme are dictated by the requirements of the vessels that would visit the Port of Dundee, no alternatives are considered to be viable.

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, the Port of Dundee Limited 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;
- Pollution Prevention Guidance (PPG) 6: Working at construction and demolition sites;
- 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 EIAR provides details on the overarching legislative framework for the Proposed Scheme. 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*."

The dredging required for the Proposed Scheme would be undertaken under Port of Dundee's powers as statutory harbour authority (see **Section 4.1.2**) and as such does not require a Marine Licence; however, as the dredging required is a capital dredge, this EIAR includes an assessment of the potential effects of the dredging activity.

4.1.2 Dundee Harbor and Tay Ferries Order Conformation Act, 1952

Dundee Harbour and Tay Ferries Order Confirmation Act, 1952 confers the powers to undertake the Proposed Scheme to the Port of Dundee Limited as Statutory Harbour Authority.

PART VIII

(2) *The Trustees may from time to time appropriate and adapt such parts as they think fit of any such lands for the purpose of shipbuilding yards or of warehouses and generally for manufacturing trading or commercial purposes and lease such lands or any parts thereof for such periods and upon such terms and for such rent or other consideration as they think fit or sell or dispose of such lands or any parts thereof:*

Provided that nothing in this section shall empower the Trustees to cause or permit a nuisance upon any such lands.

Power to dredge

70. - (1) The Trustees may from time to time alter dredge scour deepen widen enlarge improve and maintain the docks entrances channels waterways and approaches of the harbour: Provided that materials excavated or dredged under the provisions of this section shall not be deposited in any place below

high-water mark of ordinary spring tides otherwise than in such position and under such restrictions as may be fixed by the Minister.

4.2 EIA Legislation

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

MD-LOT determined that the Proposed Scheme to be an EIA Development under Schedule 2, paragraph 10(g) of the MWRs:

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

This EIAR fulfils the requirements of an EIAR 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. This has been confirmed with MD-LOT.

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 shadow HRA has been undertaken and submitted to MD-LOT in support of the Marine Licence application.

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

[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

"*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.

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 Marine Scotland National Marine Plan

Scotland's National Marine Plan (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. Those relevant to the Proposed Scheme, along with details of how the Proposed Scheme supports these, can be seen 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 maintaining the Port's ability to accommodate components and 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.	See **Chapter 2**.
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.	The infrastructure elements of the Proposed Scheme are located within an operational port and would not result in a significant effect on the local landscape/seascape character or visual setting. This was confirmed by the DDC's Screening Opinion (see **Appendix 1-2**).
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**). There are no works proposed that would affect flood risk.
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 adverse to negligible effects, not significant in EIA terms, impacts on natural heritage (**Chapters 9** to **12**). Port of Dundee Limited is the Statutory Harbour Authority and therefore adheres and implements relevant legislation to protect the marine environment.
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. Port of Dundee Limited is the Statutory Harbour Authority and therefore adheres and implements relevant legislation to prevent the spread and introduction of invasive non-native species.
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. Port of Dundee Limited is the Statutory Harbour Authority and therefore adheres and implements relevant legislation to prevent marine litter.

General Planning Principle	Policy context	How does the Proposed Scheme comply with the Policy?
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 effects, not significant in EIA terms, impacts on water quality (**Chapter 8**). Port of Dundee Limited is the Statutory Harbour Authority and therefore adheres and implements relevant legislation to prevent and manage risks to water quality.
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 Scheme would not result in significant adverse noise impacts to the marine environment during construction (**Chapters 10** 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 will not alter the operational vessel numbers nor any operational air emissions of the existing port.
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**.

5 EIA Methodology

5.1 Introduction

This section sets out the approach for the assessment of potential impacts which has been adopted within this EIAR. 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
- Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Impact Assessment (IEMA, 2017).

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

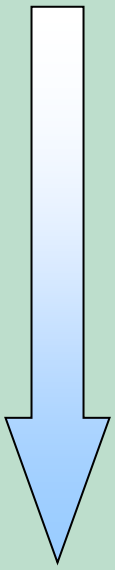
5.2.1 The EIA process

In accordance with Schedule 4 of the MWRs, this EIAR 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).
	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.
	EIAR	Production of the EIAR in accordance with EIA guidance.	EIAR.

The approach adopted for in this EIAR 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 **Sections 1.2** and **4.2** the Proposed Scheme falls under Schedule 2 10(g) of the MWRs, as:

- *Construction of harbours and port installations, including fishing harbours (unless included in schedule 1)*

Thus, an EIA Screening Report (**Appendix 1-1**) was submitted to both the DCC and MD-LOT along with requests for Screening Opinions on in January 2025. DCC's Screening Opinion was received on 14th February (**Appendix 1-2**), which determined that the Proposed Scheme was not EIA development in accordance with the TCPRs and Circular 1/2017 for the following reasons:

- The proposal does not constitute Schedule 1 development under the Regulations; and
- While the proposal does falls within the definition of 'Schedule 2 development' (10g with a site area exceeding 1ha) having screened it against the selection criteria outlined in

Schedule 3 of the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017; including the characteristics of the development, location, sensitivities and characteristics of the potential impacts, any adverse impact on the receiving environment, whilst possible, **is not considered likely to be significant**.

MD-LOT provided their Screening Opinion on 3rd April 2025 (**Appendix 1-3**). Consultation undertaken to inform MD-LOT' Screening Opinion determined the Proposed Scheme to not be EIA development with the exception of NatureScot, who considered that the Proposed Scheme had the potential to result in significant impacts specifically to:

- Benthic priority marine features (PMF) such as blue mussel beds;
- European sites (SACs and SPAs); and,
- European Protected Species (EPS) that are not specifically protected by relevant European sites, for example otter, minke whale or harbour porpoise.

NatureScot recommended that an EIA should be undertaken that focuses on the above receptors and, for this reason, MD-LOT determined that the Proposed Scheme was EIA development under the MWRs. Consequently, an EIA is required to support the Marine Licence application under the MWRs.

5.4 Scoping

The scope of this EIA has been informed by the EIA screening exercise, the HRA process and discussions with key stakeholders, including MD-LOT and NatureScot.

The topics to be considered by the EIA are those identified in MD-LOT's Screening Opinion and the same as those that are the focus of the HRA. Discussions with NatureScot have confirmed the topics to be assessed and scope of work required to inform the shadow HRA (see shadow HRA accompanying the marine licence application PC6550-RHD-XX-XX-RP-EV-0038) and therefore these discussions have been used to confirm the scope of the EIA. The following topics have been scoped into this EIA:

- Estuarine processes;
- Marine water and sediment quality;
- Marine and coastal ecology;
- Fish and shellfish ecology;
- Ornithology;
- Marine mammals; and
- Cumulative Impacts.

The assessments have been informed by the following surveys and investigations:

- Hydrodynamic and sediment dispersion numerical modelling;
- Sediment sampling and analyses;
- Benthic ecology survey;
- Bird surveys, comprising:
    - One year long survey undertaken April 2023 to March 2024; and
    - Additional overwintering bird survey including goose flight surveys, October 2024 to April 2025;
- Otter survey; and
- Underwater noise modelling.

Applying the analysis in the EIA Screening Report (**Appendix 1-1**) and conclusions in the Screening Opinions (**Appendices 1-2** and **1-3**) the following topics have been scoped out of the EIA:

- Ground conditions;
- Water resources and flood risk;
- Traffic and transport;
- Noise and vibration – human receptors;
- Air quality;
- Terrestrial ecology;
- Commercial fisheries;
- Commercial and recreational navigation
- Infrastructure and other users;
- Archaeology and cultural heritage;
- Landscape and visual impact;
- Tourism and recreation;
- Waste;
- Accidents and disasters;
- Climate change; and
- Socio-economics.

5.5 EIA 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 EIAR. 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).

5.5.2 Impact identification

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 concentrations (SSCs) 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	Receptor 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. 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 EIA, 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 EIAR 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 EIAR 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 EIAR.

5.6.2 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**.

6 Consultation

The following sections outline the consultation that has been undertaken to inform the EIA.

6.1 Stakeholder Consultation

6.1.1 MD-LOT

Initial contact was made with MD-LOT via email on the 12th of September 2024, supported by a project briefing note which included a summary of the Proposed Scheme (as it was understood at the time, though it has now since evolved and no longer includes a rock mattress) and a proposed specification of surveys required to inform the EIA (**Appendix 6-1**). This was followed by a meeting on the 17th of September. During this meeting, it was confirmed that PAC does not apply as the construction area of the Proposed Scheme within the marine area (i.e. the improvement works to the PCW) is less than 1,000m^2.

6.1.2 NatureScot

Initial contact was made with NatureScot via email on the 12th September 2024, supported by a project briefing note which included a summary of the Proposed Scheme (as it was understood at the time, though it has now since evolved and no longer includes a rock mattress)and proposed specification of surveys required to inform the EIA (**Appendix 6-1**). This was followed by a meeting on 24th September 2024. Following the meeting, NatureScot provided comments on 15th October, also provided in **Appendix 6-1** and summarised below:

- potential impacts that should be considered on designated sites and their qualifying interests;
- comments on survey specifications for marine mammals, benthic habitats and ornithology, namely the addition of an overwintering bird survey to include the marine area in front of the Port of Dundee; and
- requirement to confirm whether maintenance dredging of the Lady Shoal approach channel would be required.

Following the submission of the EIA Screening Request (see **Section 5.3** for more details) a further meeting was held with NatureScot on 12th February 2025 to discuss the approach taken to the screening for EIA, how it interacts with the HRA process, and to discuss further the information required to inform the EIA and HRA.

6.1.3 National Gas

National Gas was notified of the proposed dredging work in January 2024 and provided the Port of Dundee with their asset location data in July 2024 and an update in February 2025. The Port of Dundee met with National Gas on 11th February 2025, whereby National Gas confirmed it had no concerns over the anticipated methodology or location of the proposed work. National Gas requested the Port of Dundee provide the work methodology in advance of the work being carried out and that it may require a National Gas representative be in attendance in localised locations during the works. Consultation with National Gas will continue throughout the duration of the Proposed Scheme.

6.2 Statutory Consultation

6.2.1 EIA Screening Opinion

Details of the screening process that has been undertaken on the Proposed Scheme can be found in **Section 5.3**.

6.2.2 Planned consultation

Consultation will continue to be undertaken with both the public and stakeholders as part of the statutory Marine Licencing process.

7 Estuarine Processes

This chapter describes the existing environment in relation to hydrodynamics, wave climate and sediment transport, and details the assessment of the potential effects during construction and operational phases of the Proposed Scheme.

This chapter is informed by the following appendix:

- **Appendix 7-1**: Hydrodynamic Modelling Report

7.1 Legislation, Policy and Guidance

The following key pieces of policy are relevant to this chapter.

7.1.1 UK Marine Policy Statement

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 [estuarine] processes, including sediment movement.

7.1.2 Scotland's National Marine Plan

General Planning Policy GEN 8 Coastal Processes and Flooding of Scotland's NMP states that '*developments and activities in the marine environment should be resilient to coastal change and flooding and not have unacceptable adverse impact on coastal* [estuarine] *processes or contribute to coastal flooding*'. GEN 5 Climate change is also relevant and states that '*marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change'*.

7.2 Consultation

Specifically with respect to estuarine processes, the approach to numerical modelling was agreed with NatureScot. An overview of all consultation can be found in **Chapter 6**.

7.3 Assessment Methodology

7.3.1 Study area

For the assessment of potential impacts on estuarine processes, the study area comprises all areas of the Firth of Tay affected by changes in hydrodynamics and / or changes in SSC as a result of sediment plumes, including at the existing designated disposal site, Middle Bank.

7.3.2 Data sources

This assessment has been informed by hydrodynamic and sediment dispersal modelling, and a number of publicly available journals.

7.3.3 Impact assessment methodology

Consideration of the potential effects of the Proposed Scheme on estuarine processes was carried out over the following spatial scales:

- near-field: the area within the immediate vicinity (tens or hundreds of metres) of the Proposed Scheme; and
- far-field: the wider area that might also be affected indirectly by the Proposed Scheme (e.g. due to disruption of waves, tidal currents or sediment pathways).

Two phases of development have been considered, in conjunction with the present-day baseline. These are:

- Construction phase; and
- Operational phase.

7.3.4 Numerical modelling

To support the assessment of potential effects, numerical modelling of tidal currents and suspended sediment concentrations have been completed. Simulations were run for the baseline condition and after implementation of the Proposed Scheme. Details of the model calibration and set-up can be found in **Appendix 7-1**.

7.3.4.1 Hydrodynamic modelling

To determine if the changes to bathymetry after dredging during operation would impact tidal current speeds and bed shear stresses at the Port of Dundee and Lady Shoal approach channel, a 2D hydrodynamic model was run (**Appendix 7-1**). The calibrated model was run for a full spring-neap tidal cycle from 14th February to 16th March 2025 covering the Firth of Tay. This time was chosen because it had high tidal ranges, which produce the strongest tidal currents. The model was run for an existing bathymetry scenario and a post-dredging bathymetry scenario.

7.3.4.2 Sediment dispersion modelling

Sediment dispersion modelling was undertaken to predict the extent and duration of any resultant changes in suspended sediment and sediment deposition due to dredging at the Port of Dundee and Lady Shoal approach channel, and disposal at the existing Middle Bank disposal site.

The sediment dispersion model was built in MIKE3-MT software developed by DHI. The model was run for two scenarios based on a backhoe dredger bucket size of 35m^3 and two different production rates (fast and slow) as input (**Appendix 7-1**). To simulate suspended sediment dispersion throughout the water column, the 2D hydrodynamic model was developed into a 3D hydrodynamic model (built in MIKE-HD) by introducing a vertical mesh. The fast and slow sediment dispersion model simulations were run for a six-week and eight-week period, respectively, to cover the full duration of the proposed dredge and disposal activities and to allow the plume to fully disperse. Due to the uncertainty of the time when the dredging would take place, the worst-case scenario in terms of the tidal conditions was selected. The model was run for the period from 24th February 2025 to 10th/27th April 2025, (for the fast/slow production runs), which includes an equinox tide, which included the year's largest tidal range during spring tides and the lowest tidal range during neap tides.

The foci of the interpretation of the results were near bed for dredging and near surface for disposal, as these showed the worst cases for magnitude of increases in SSC.

7.4 Baseline Environment

This section provides an overview of the existing hydrodynamics, wave climate and sediment transport environment of relevance to the Proposed Scheme. The approach taken has been to review existing relevant data and reports for the Port of Dundee and surrounding area, including the Lady Shoal approach channel, alongside the outputs from the numerical modelling, to formulate an understanding of the baseline physical and sedimentary environments using expert-based assessment and judgement.

7.4.1 Bathymetry

7.4.1.1 Firth of Tay

The Firth of Tay extends from the confluence of the Rivers Earn and Tay, opening into the North Sea beyond Budden Ness on the north shore and Tentsmuir Point on the south shore. Buller *et al.* (1971) divided the Firth of Tay into four reaches (**Figure 7-1**). The uppermost reach was channelised for navigation in the mid-19th century. In the upper reach of the Firth of Tay, the artificially deepened channel is along the south shore and the entire north shore west of Dundee is flanked by largely stable intertidal flats of subdued relief, backed by saltmarsh. The middle reach of the Firth of Tay is unstable, with migrating channels separated by large sand banks, with small to large sand waves developed under the influence of strong tidal currents. In the lower reach, intertidal flats backed by beaches and dune ridges reappear along both the north and south shores.

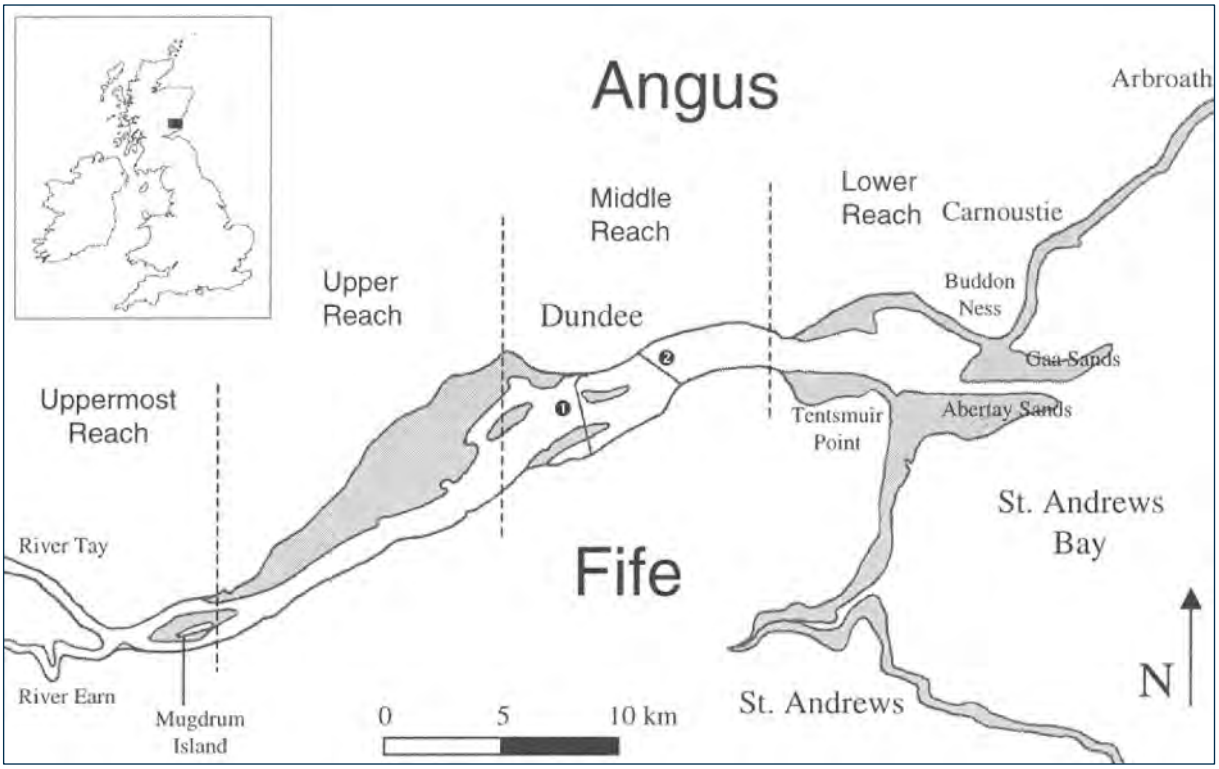


Figure 7-1 The Firth of Tay with the Rail Bridge (1) and Road Bridge (2) shown. Areas shaded in grey are intertidal. Reaches are defined according to Buller et al. (1971)

The channel of the Firth of Tay is 37km long, has a maximum width of 5km, at Invergowrie to the west of Dundee, with a maximum channel depth of 30m at Broughty Ferry (**Figure 7-2**). From the Port of Dundee to Broughty Ferry the centre of the channel is on average -11m CD to -13m CD with small pockets reaching -16m CD.

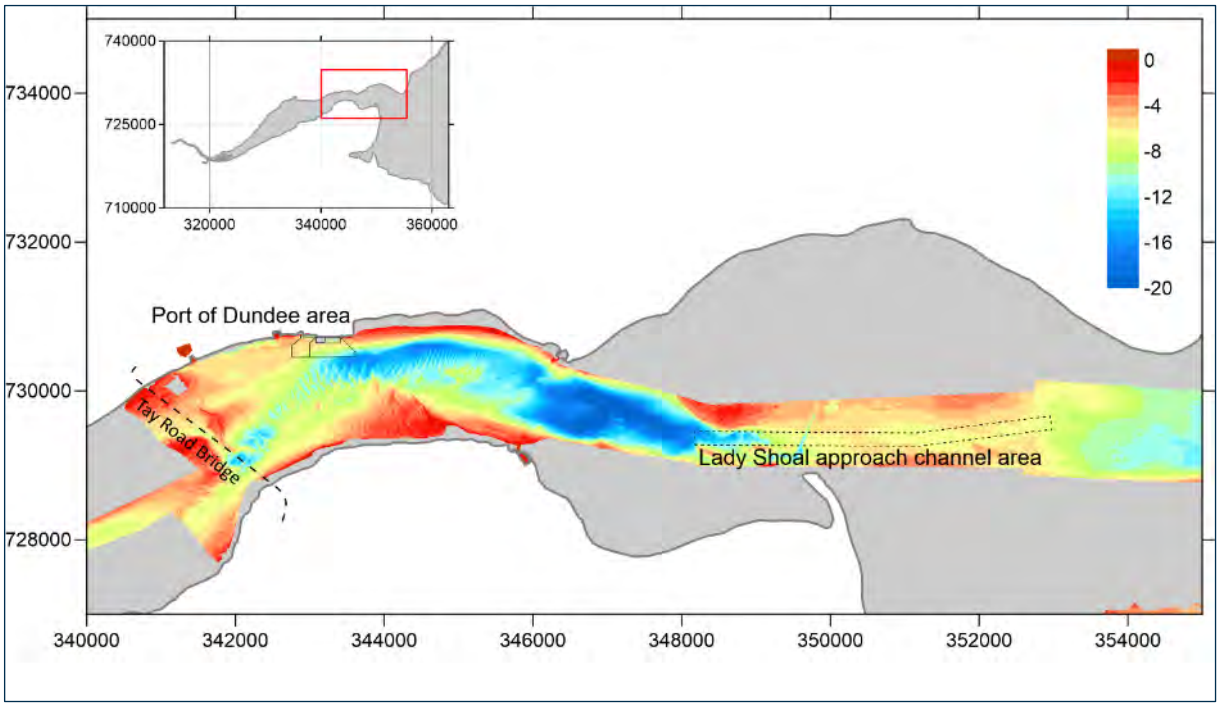


Figure 7-2 Existing bathymetry of the Middle Reach and Lower Reach of the Firth of Tay (modified 2024 survey)

7.4.1.2 Port of Dundee

A bathymetry survey completed in 2024 shows that the subtidal bed adjacent to the Port of Dundee slopes down to between -6m CD and -10m CD (**Figure 7-3**).

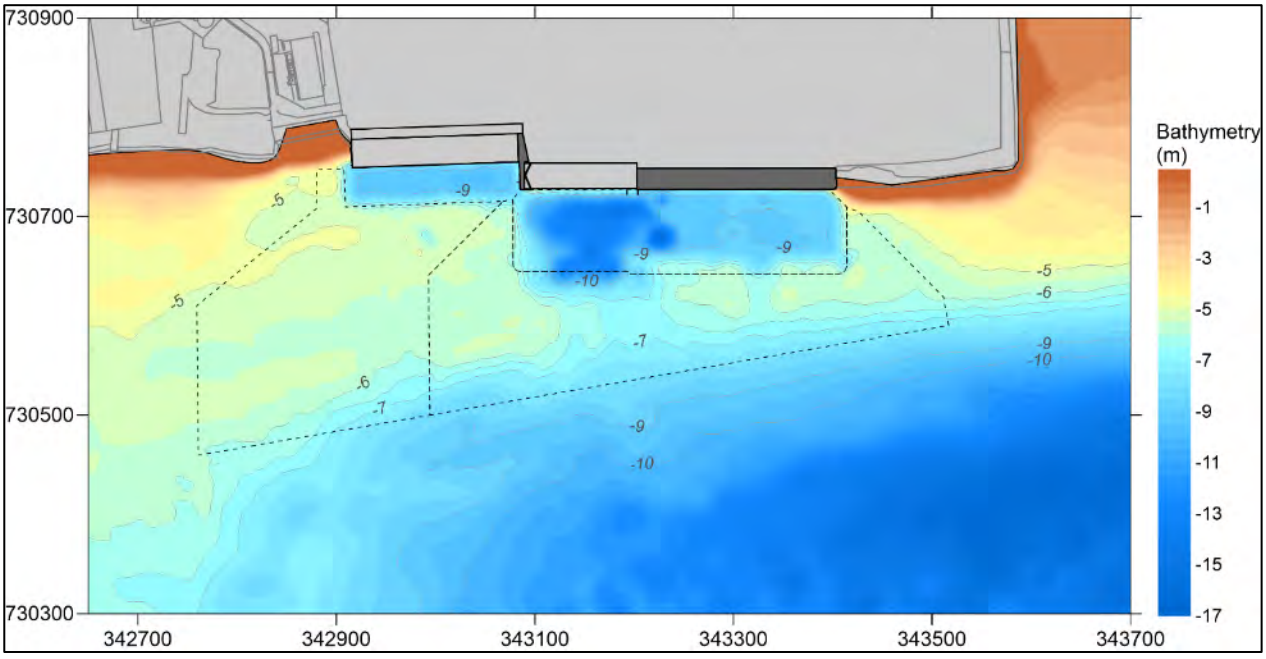


Figure 7-3 Existing bathymetry of the Port of Dundee (modified 2024 survey)

7.4.1.3 Lady Shoal approach channel dredge area

For most of its length where dredging is likely to take place, Lady Shoal approach channel has a maximum depth of approximately -7m CD (**Figure 7-4**); however, immediately beyond its western end depths of -15m CD can be reached.

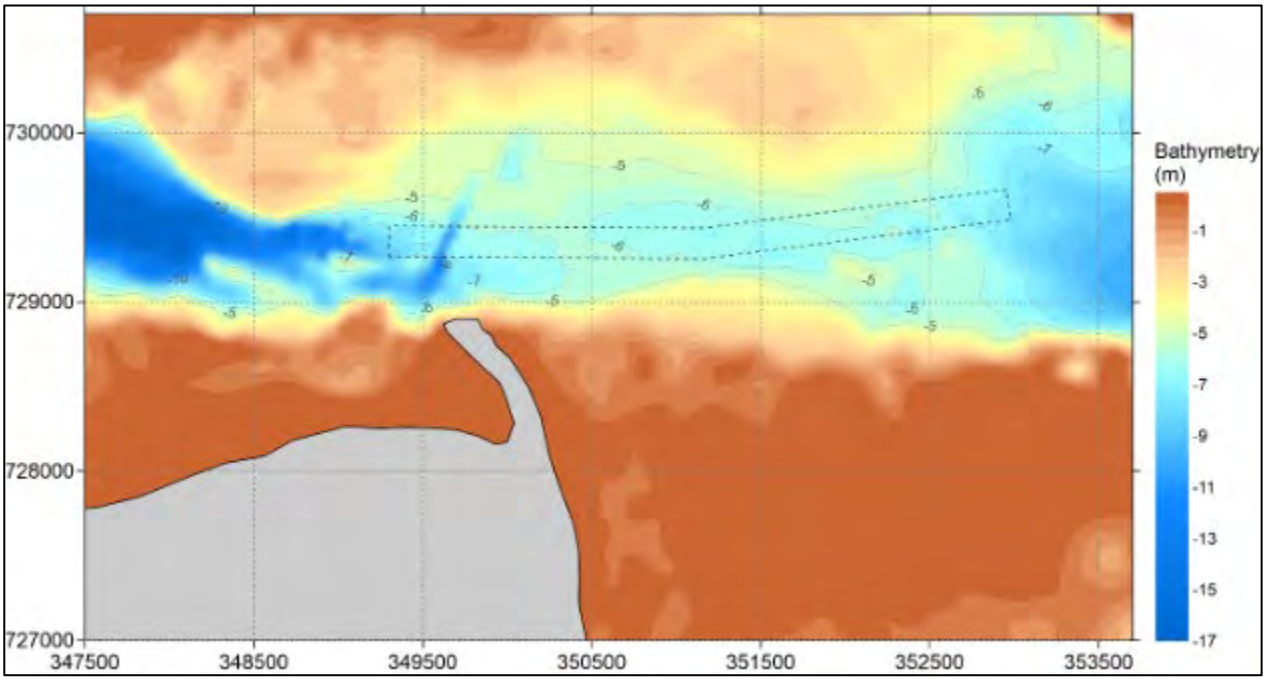


Figure 7-4 Existing bathymetry of Lady Shoal approach channel (modified 2024 survey)

7.4.2 Tidal currents

The Firth of Tay is a relatively shallow partially mixed to well mixed, macrotidal estuary (Bates *et al.*, 2004). As a result of the high freshwater influence and macrotidal nature of the estuary, the residence time of water is relatively short (2-15 days). Any sediment discharged to the Firth of Tay is rapidly diluted and discharged to sea. The mean tidal range at the Port of Dundee is 4.54m for spring tides and 2.27m for neap tides.

The Firth of Tay is characterised by powerful tidal currents (Bates *et al.,* 2004). Tidal current strength and direction are heavily influenced by the large shallow intertidal sandflats and sand banks. Maximum tidal velocities of 1.9m/s have been recorded on spring tides in the narrower channel west of Broughty Ferry. The flood tidal current tends to flow along the north side of the Firth of Tay and the ebb tidal current along the southern side.

Current speeds were measured at two sites between 23rd January 2025 and 25th February 2025 (see **Appendix 7-1**). Site 1 is near the Port of Dundee, and Site 2 is near the Lady Shoal approach channel (**Figure 7-5**). The fastest observed depth-mean currents were 1.43m/s at Site 1 and 1.86m/s at Site 2 (**Figure 7-6**).

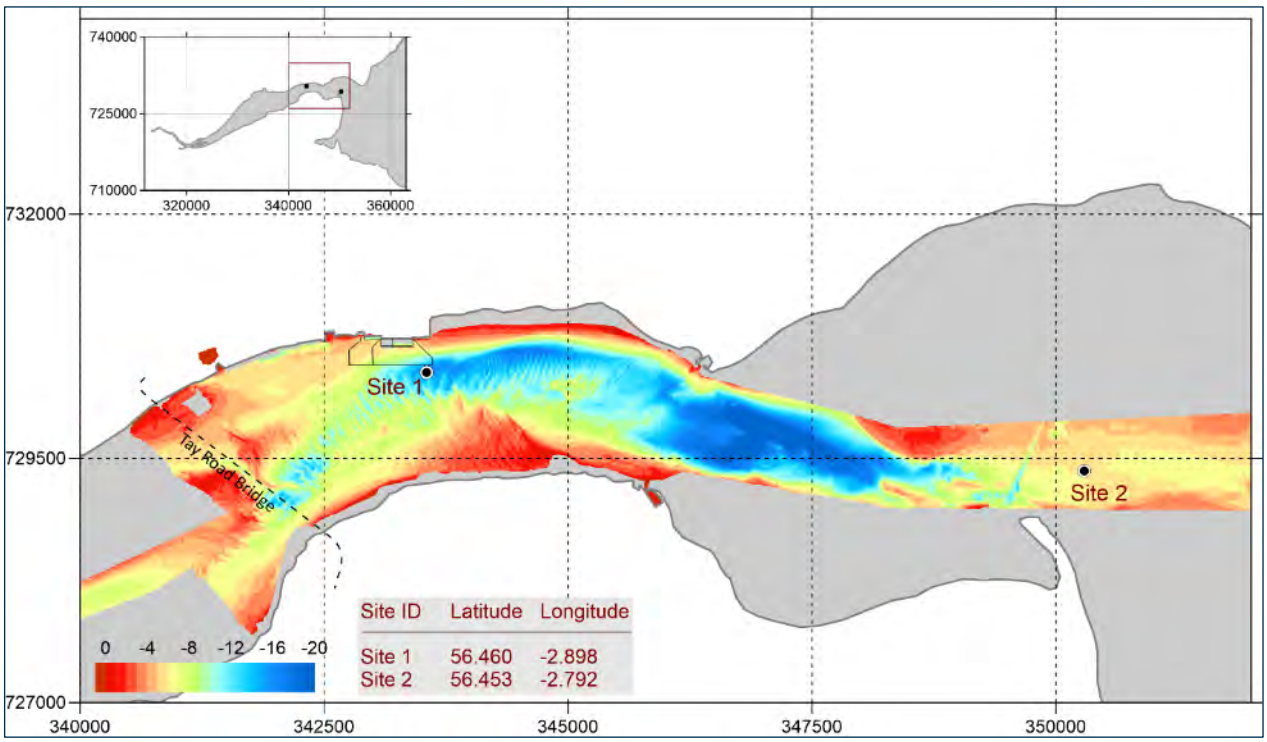


Figure 7-5 Locations of current speed measurements in January and February 2025

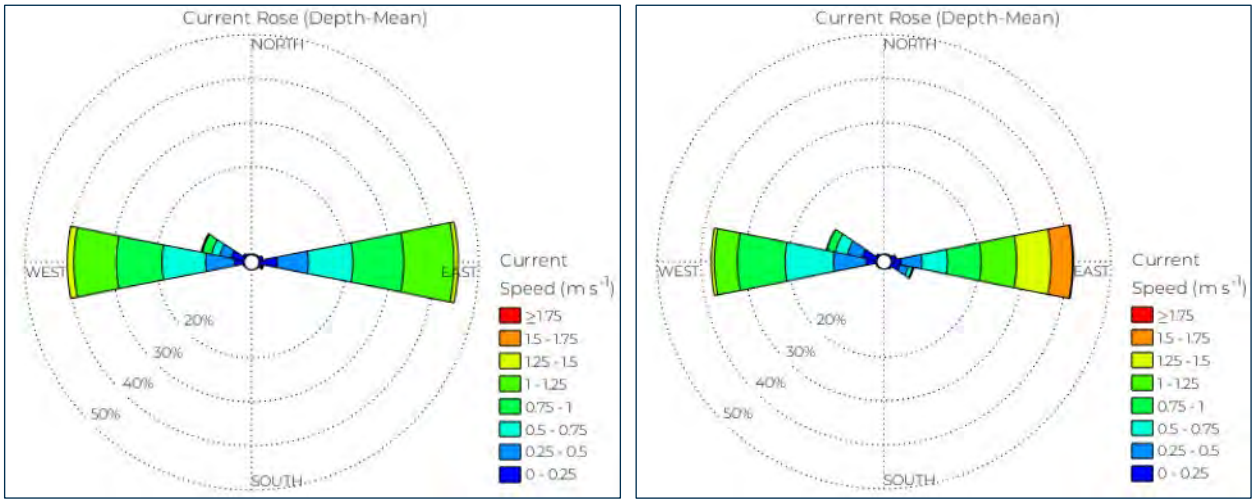


Figure 7-6 Current roses at Site 1 near the Port of Dundee (left) and Site 2 near Lady Shoal approach channel (right) from January and February 2025

The existing tidal currents were modelled at the Port of Dundee and at Lady Shoal approach channel. (**Appendix 7-1**). **Figure 7-7** shows that maximum tidal current speeds at the Port of Dundee are predicted to increase into the channel to about 1.1m/s at the southern edge of the proposed dredge areas. At Lady Shoal approach channel, maximum tidal current speeds are predicted to be about 2.4m/s along the approach channel, reducing gradually to the south and north across the Firth of Tay (**Figure 7-8**).

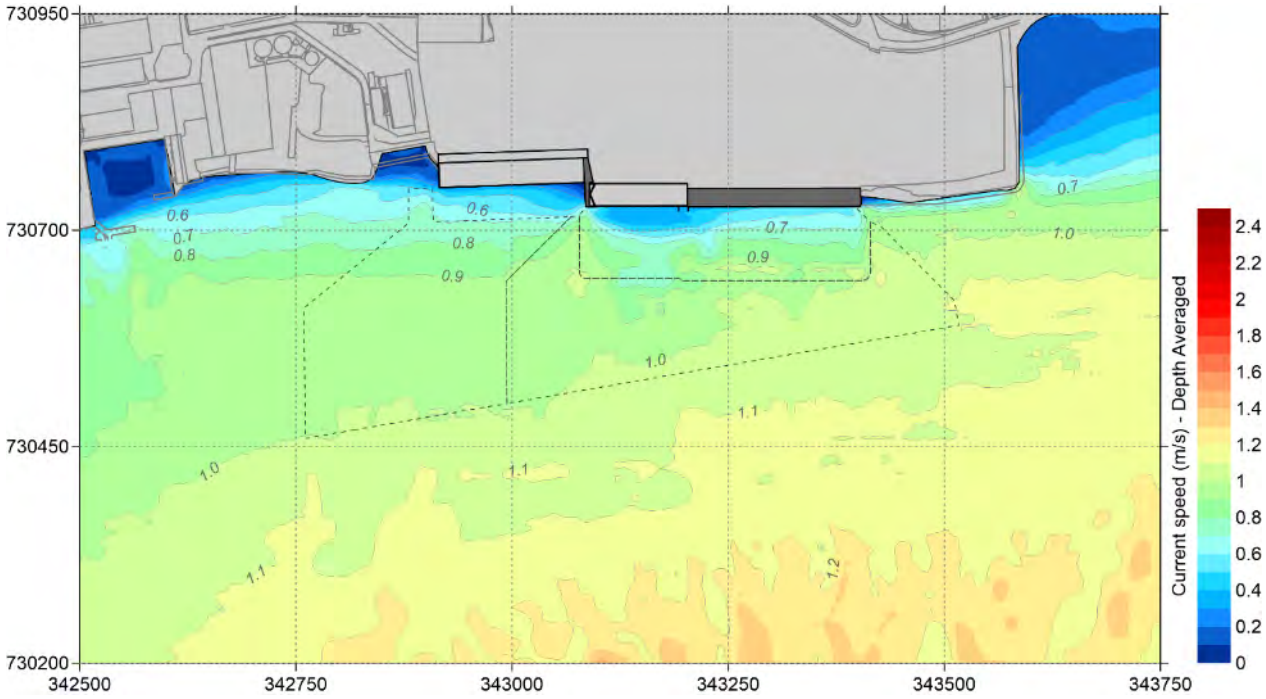


Figure 7-7 Predicted maximum current speed over a 30-day model simulation (full spring-neap tidal cycle from 14th February to 16th March 2025) at the Port of Dundee

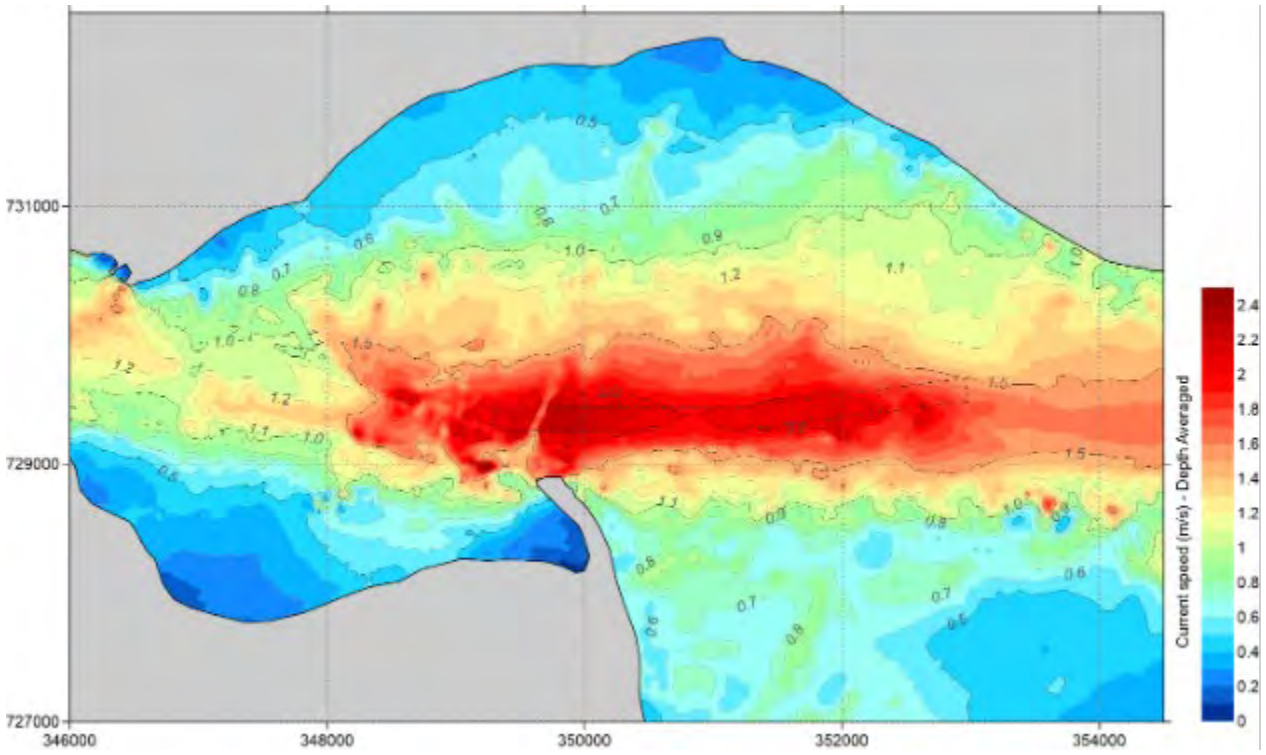


Figure 7-8 Predicted maximum current speed over a 30-day model simulation (full spring-neap tidal cycle from 14th February to 16th March 2025) at Lady Shoal approach channel

7.4.3 Bed Shear Stresses

The existing bed shear stresses at the Port of Dundee and at Lady Shoal approach channel were modelled (**Appendix 7-1**). **Figure 7-9** shows that maximum bed shear stresses at the Port of Dundee are predicted to increase into the channel from 1.0N/m^2 near the existing quay wall to about 3.0N/m^2 at the southern edge of the proposed dredge areas. At Lady Shoal approach channel, maximum bed shear stresses are predicted to be about 20.0N/m^2 (mainly up to 15.0N/m^2) along the approach channel, reducing gradually to the south and north across the Firth of Tay (**Figure 7-10**).

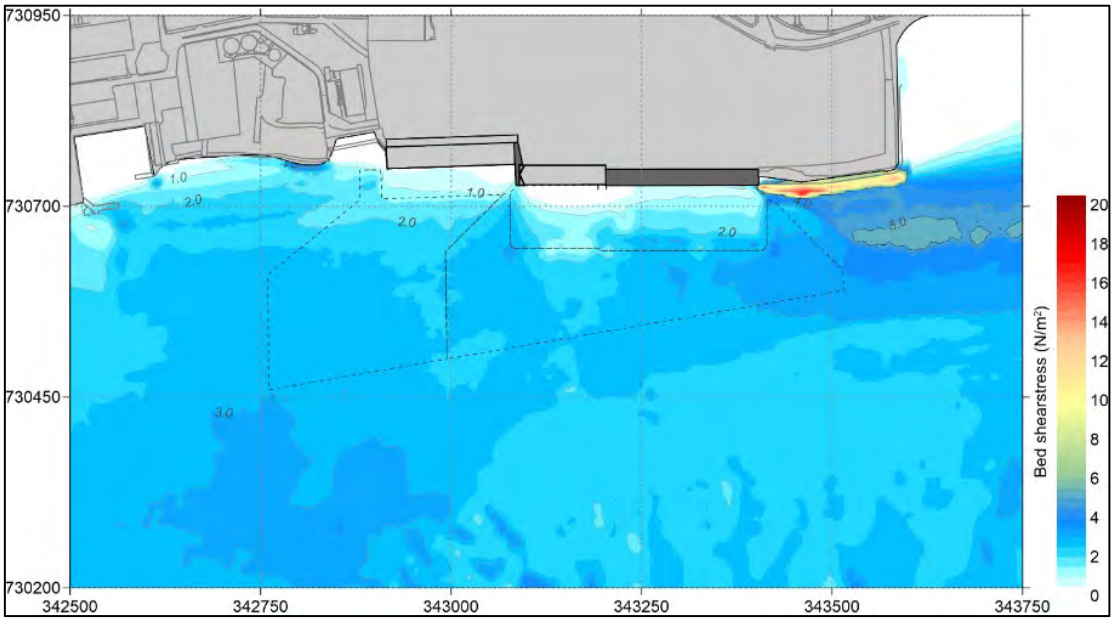


Figure 7-9 Predicted maximum bed shear stresses over a 30-day model simulation (full spring-neap tidal cycle from 14th February to 16th March 2025) at the Port of Dundee

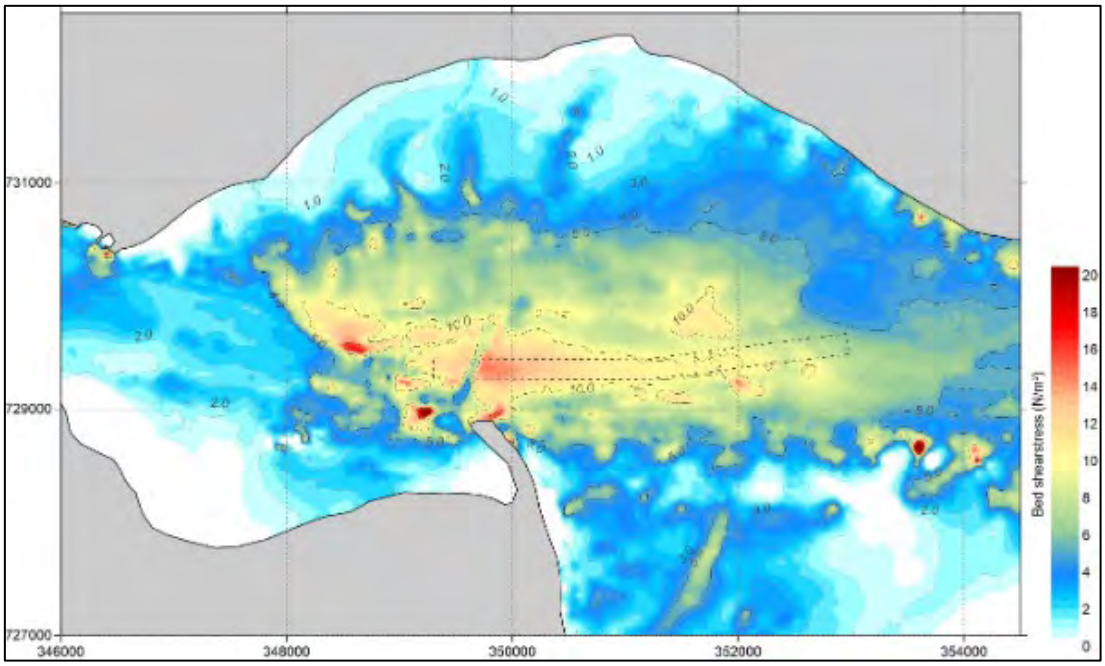


Figure 7-10 Predicted maximum bed shear stresses over a 30-day model simulation (full spring-neap tidal cycle from 14th February to 16th March 2025) at Lady Shoal approach channel

7.4.4 Waves

The inner parts of the Firth of Tay are largely sheltered from wave action, while the outer areas are exposed to strong wave activity (and strong tidal streams), giving rise to complex patterns of erosion and deposition of the sand banks at the mouth of the Firth of Tay.

7.4.5 Intertidal Flats, Saltmarsh, and Sand Dunes

Large expanses of intertidal flats with mid-channel sand banks border the channel (Bates *et al.,* 2004). For much of its length, the main channel of the Firth of Tay lies close to the south shore and the most extensive intertidal flats are on the north side, west of Dundee. Here, they are over 3km wide in places, composed of silty sand and mud. Saltmarsh occurs at or above high-water level. At the mouth of the Firth of Tay, two large sandflats and shoals extend to the east with Abertay Sands on the south shore, approximately 6km long adjacent to Lady Shoal approach channel. This sand area alongside Tentsmuir Point, is an integral component of a dynamic sand bar and sand dune system (dune ridges separated by low-lying intervening slacks) that stretches from the Firth of Tay south to the mouth of the Eden Estuary.

Morphological change along this seaward southern shore of the Firth of Tay is driven by three different physical mechanisms. Along the east-facing open coast, sediment is transported north by waves. In the mouth of the Firth of Tay, the extension of Abertay Sands to the east is driven by strong easterly flowing tidal currents, particularly along the lower intertidal areas. Large volumes of sand are supplied to Abertay Sands from the Firth of Tay and likely from the coast to the south. Sediments are also swept northwards on to Tentsmuir by a gyre in the flood tide (**Figure 7-11**), whereas ebb tides may sweep sediments south, across Abertay Sands (Ferentinos and McManus, 1981).

It is possible that the patterns of erosion and accretion along the south shore are intrinsically linked to the movements of the Firth of Tay channel and the form of Abertay Sands, and the effects that these changes have on tidal flow. The process may be a continuous feedback loop, with the changes in tidal flows (and wave conditions) themselves, promoting alterations in the position of the Firth of Tay channel and Abertay Sands.

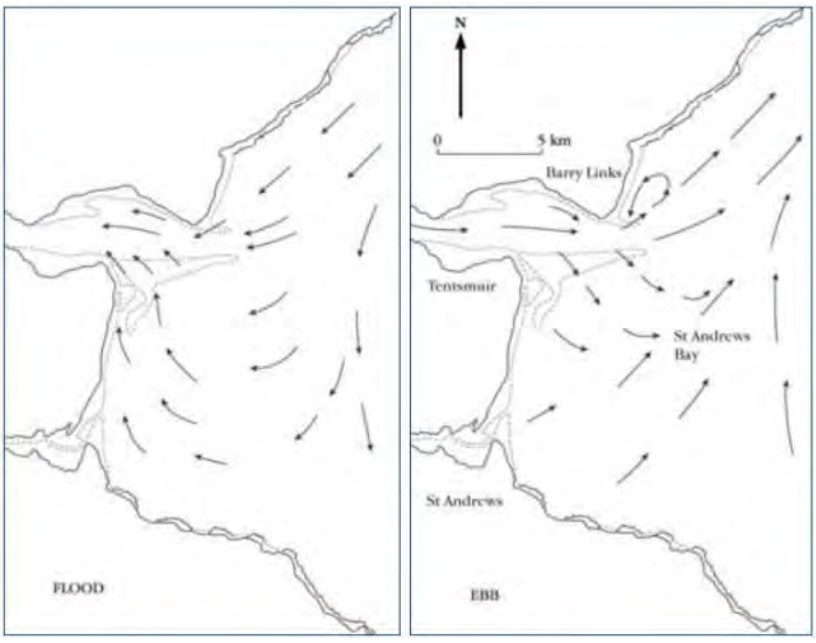


Figure 7-11 Mid-flood and mid-ebb tidal stream patterns in St Andrew's Bay based on a combination of direct measurement and hydraulic modelling (Ferentinos and McManus, 1981)

7.4.6 Sand Banks and Sand Waves

Sand banks are present within the Firth of Tay, grading into the intertidal mudflats and sandflats to form part of a dynamic sediment transport system. The sand banks are primarily located in the channel in the upper Firth of Tay and in the central section between Invergowrie and Broughty Ferry. Large areas of the Firth of Tay are sculpted into sand waves, particularly in the subtidal channel off Dundee, east of the Tay Rail Bridge and west of Broughty Ferry (**Figure 7-12**). Maximum sand wave heights reach 6m with wavelengths of 250m. To the west of the Tay Rail Bridge, the channel bed also contains small sand waves with their amplitudes generally diminishing to the west.

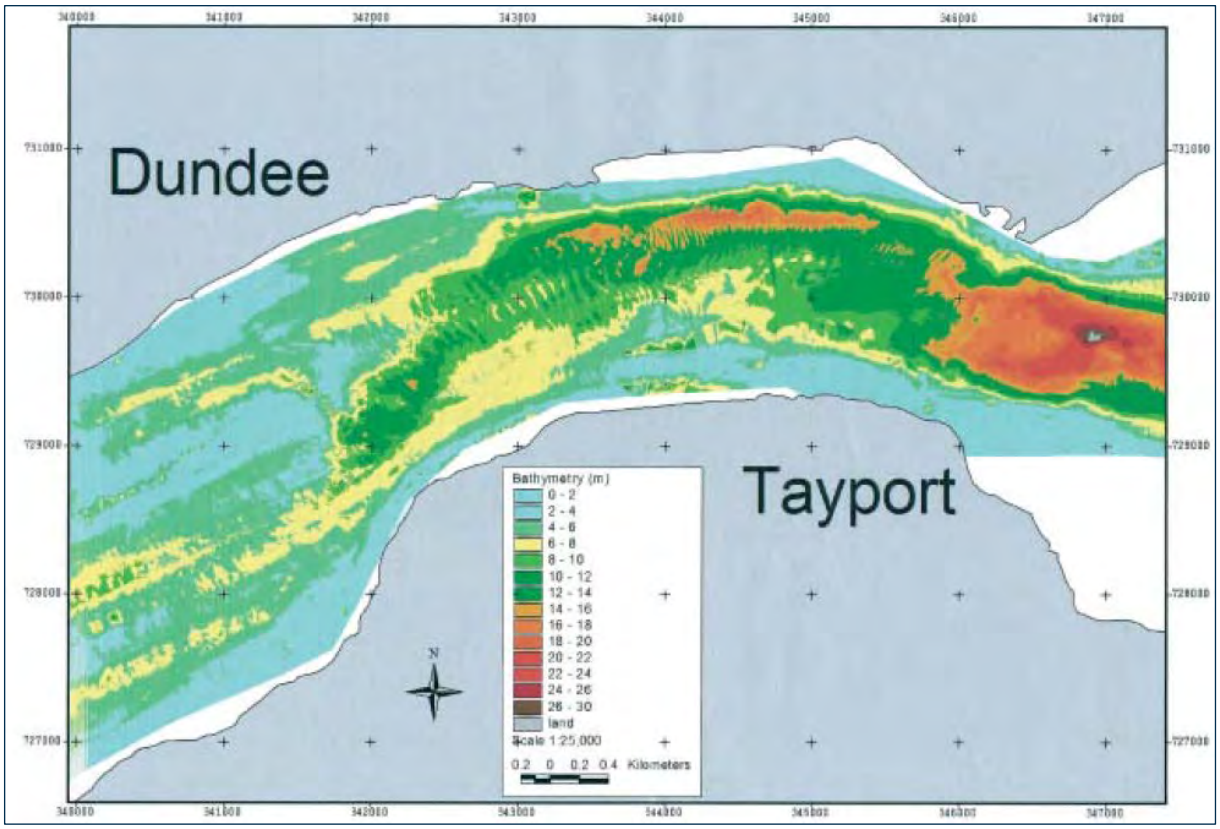


Figure 7-12 Bathymetry of the Firth of Tay between Dundee and Broughty Ferry (Bates et al., 2004)

Bates *et al.* (2004) generated a sedimentary structure map for the Firth of Tay (**Figure 7-13**) delineating four types of sedimentary feature. Three of these are different sized sand waves:

- small sand waves with amplitudes of 1-2m and wavelengths of 10-30m;
- medium sand waves with amplitudes of 2-4m and wavelengths of 30-100m; and
- large sand waves with amplitudes greater than 4m and wavelengths of 100-300m.

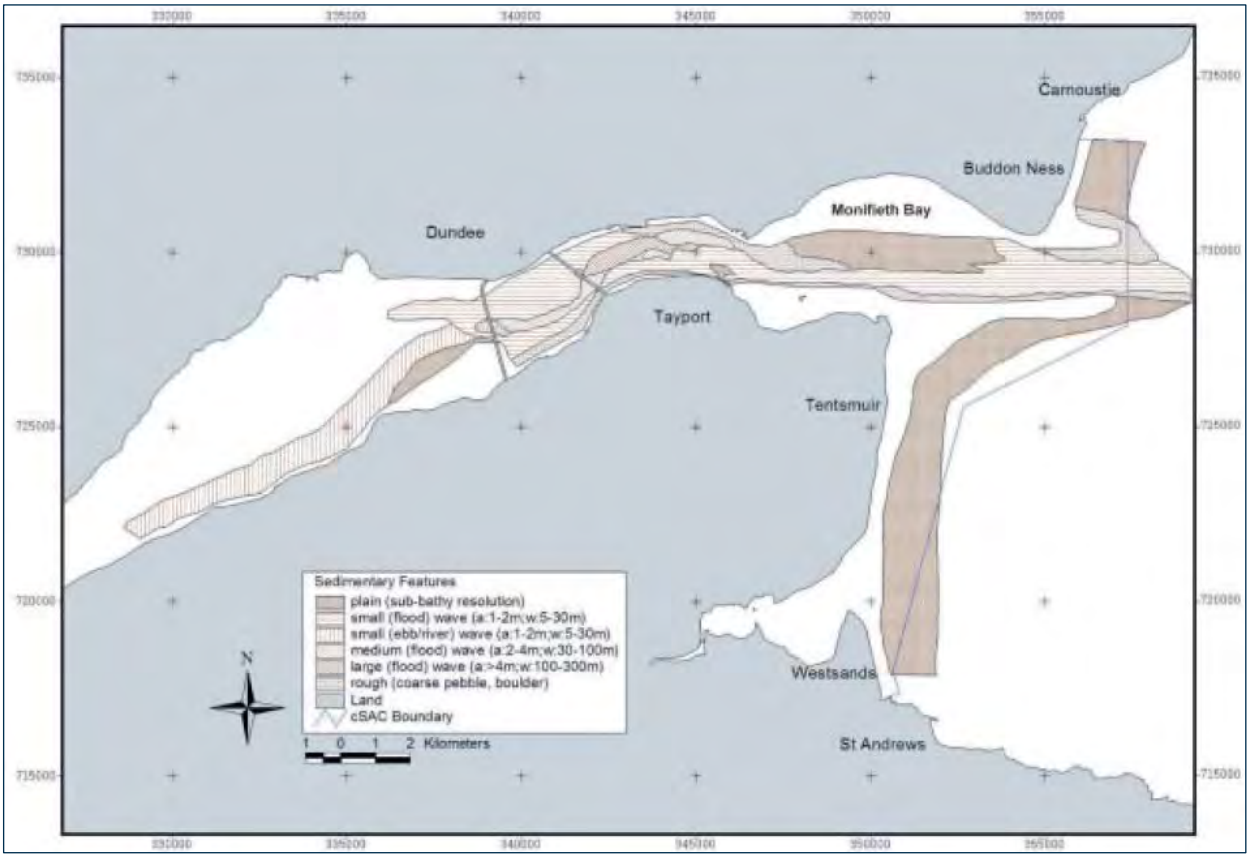


Figure 7-13 Bedform zonation in the Firth of Tay of Bates et al. (2004)

The sand waves in the central channel east of the Tay Road Bridge are asymmetrical with their steeper slopes facing the west. This indicates that net sediment transport is flood dominated. In contrast, to the north of the main channel the sand waves on the large shallow areas are in general symmetrical. To the south of the main channel between the Tay Road Bridge and Tayport the large shallow area is dominated by asymmetric waves with an ebb dominated net sediment transport. Between the Tay Road Bridge and Tay Rail Bridge, the sand waves are symmetrical with occasional zones of asymmetrical waves with the opposite sense of direction (ebb dominated near the north and south shores). To the west of the Tay Rail Bridge the sand waves are dominantly asymmetric and ebb dominant (and/or river flow dominated).

7.4.7 Sediment Sources

The Firth of Tay is fed by the rivers Tay and Earn, which provide a large volume of sediment. The estimated amount of sediment entering the Firth of Tay varies between 646,000 tons in a dry year and 1,648,000 tons in an average year (Charlton, 1980). Of this load, 3-5% of the total solids are carried as bed load and up to 85% as suspended load. As well as the sediment from freshwater sources, sediment is also deposited from the sea, transported by longshore sediment transport in both north and south directions from St Andrews Bay and Gaa Sands, respectively. Jenkins *et al.* (2002) indicated that overall contributions of sediment supplied to the Firth of Tay were 3% from the River Earn, 17% from the River Tay, 29% from the Angus coast and 51% from the Fife coast, demonstrating that the present-day sediment regime is dominated by marine sediment derivation.

7.4.8 Sediment Distribution

7.4.8.1 Port of Dundee

Five cores to a maximum depth of 5m and one bed sediment sample (BH04) were collected in the vicinity of the Port of Dundee by Causeway Geotech between 24th June and 28th June 2019 (ERM, 2019) (**Figure 7-14**). The particle size characteristics of 16 sediment samples were analysed (**Figure 7-15** and **Table 7-1**) and show high variability. The bed sediments contain a mix of mud (26-66%), sand (26-42%) and gravel (3-40%). Similarly, deeper sediments are mixed, containing 3-90% mud, 10-90% sand, and 0-87% gravel.

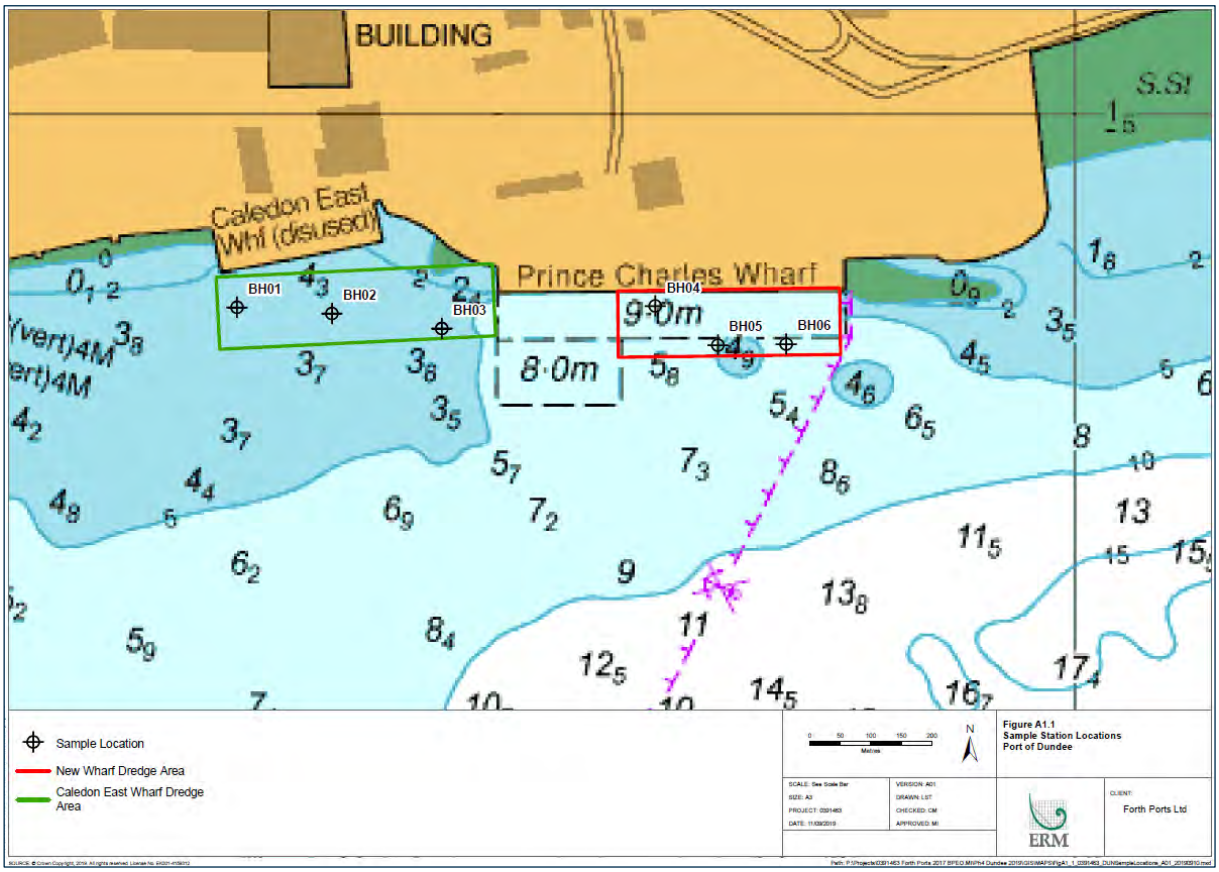


Figure 7-14 Location of vibrocores at the Port of Dundee collected in June 2019 (ERM, 2019)

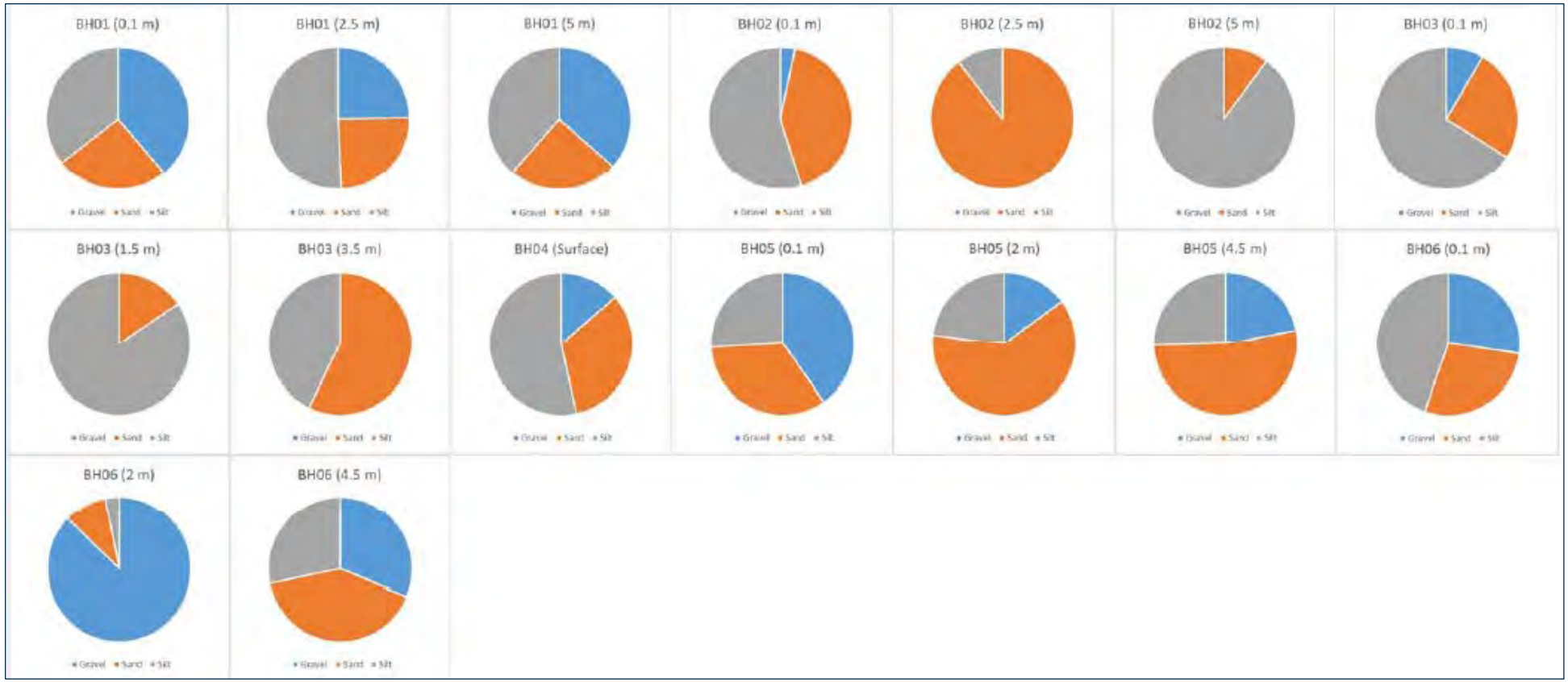


Figure 7-15 Particle size characteristics of core sediment samples at the Port of Dundee collected in June 2019 (ERM, 2019)

Table 7-1. Particle size characteristics of core sediment samples at the Port of Dundee collected in June 2019 (ERM, 2019)

Location	Depth (m)	Mud (less than 0.063mm)	Sand (0.063-2mm)	Gravel (greater than 2mm)
BH01	0.1	35.6	25.6	38.8
	2.5	50.8	24.6	24.7
	5.0	38.6	24.8	36.6
BH02	0.1	54.8	41.9	3.3
	2.5	10.5	89.5	0.0
	5.0	89.8	10.2	0.0
BH03	0.1	66.0	25.5	8.5
	1.5	84.5	15.5	0.0
	3.5	42.8	57.2	0.0
BH04	0.0	53.4	33.0	13.6
BH05	0.1	26.0	33.8	40.3
	2.0	23.1	62.0	14.9
	4.5	25.5	52.5	22.0
BH06	0.1	44.7	28.0	27.3
	2.0	3.1	9.7	87.3
	4.5	28.3	40.3	31.3

Seven vibrocores were recovered for the Proposed Scheme, within the proposed dredge areas at the Port of Dundee, on 10th and 11th February 2025 (**Figure 7-16**) (see Appendix 2 in **Appendix 7-1**). The particle size characteristics of 18 sediment samples were analysed (**Table 7-2**) and also show high variability. The bed sediments contain a mix of mud (8-66%), sand (17-78%) and gravel (4-54%). Similarly, deeper sediments are mixed, containing 12-65% mud, 32-62% sand, and 3-55% gravel.

7.4.8.2 Lady Shoal Approach channel dredge area

CMS-Geoscience collected 12 vibrocores at eight locations, and 22 grab samples at 14 locations across Lady Shoal approach channel in July 2024 (**Figure 7-17**). Preliminary logs of the vibrocores describe a variety of lithologies. The predominant lithology is silty fine to coarse sand, which may become gravelly in places. Vibrocore C01 recovered 5.4m of this sediment without reaching underlying bedrock. Other cores recovered up to 3m (C04) without reaching bedrock. The sand unit contains interbeds (0.2-0.6m thick) of fine to coarse gravel in places (C03A and C06). Vibrocores C08A and C08B recovered up to 0.6m of silty fine to coarse sand underlain by firm to stiff sandy silt (bedrock). The bed samples recovered predominantly fine to coarse gravel, which may be sandy in places, and may contain cobbles. Grab samples G03, G03A and G06A were dominantly cobbles. Grab sample G08 was predominantly shell fragments. Grab samples G09 and G14 were mainly gravelly silty fine to coarse sand.

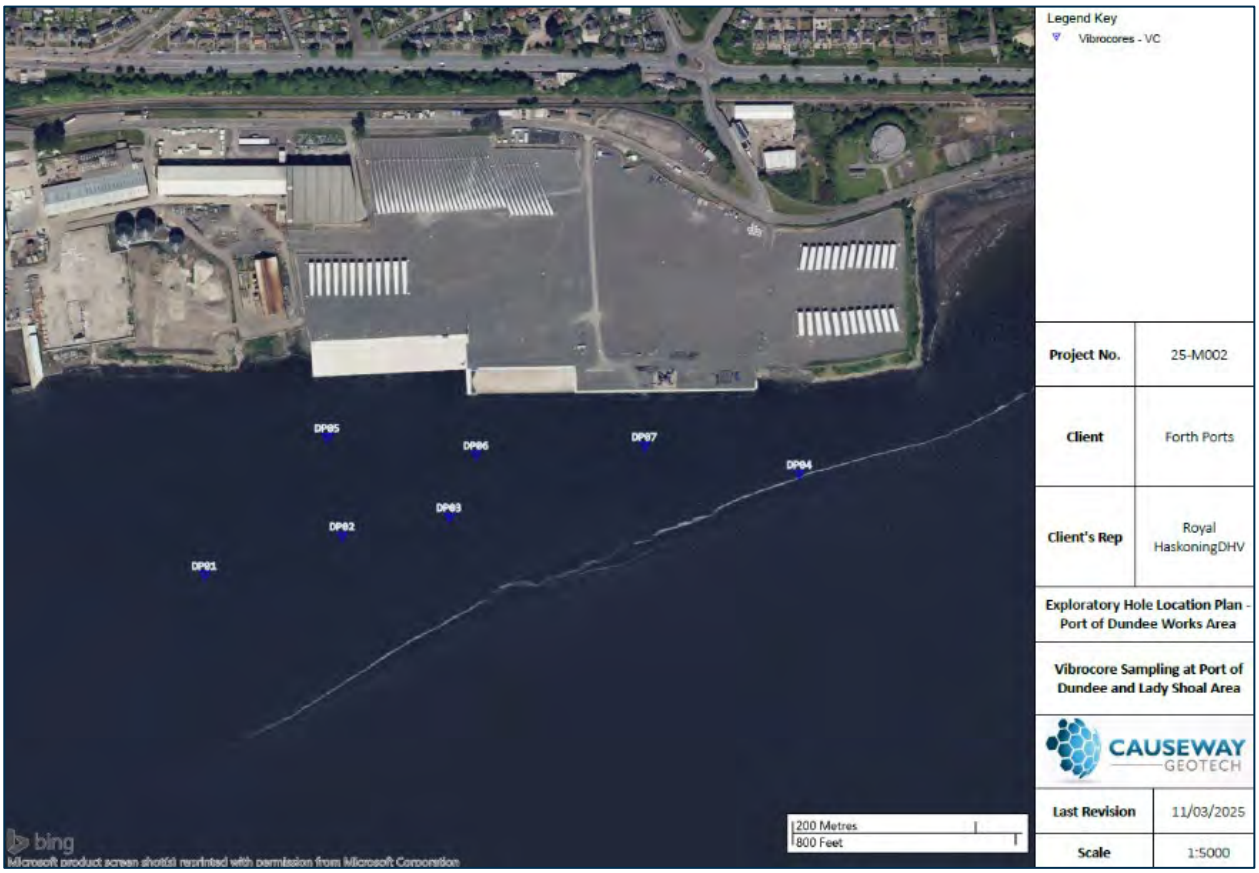


Figure 7-16 Location of vibrocores at the Port of Dundee collected in February 2025

Table 7-2. Particle size characteristics of sediment samples at the Port of Dundee collected in February 2025

Location	Depth (m)	Mud (less than 0.063mm)	Sand (0.063-2mm)	Gravel (greater than 2mm)
DP01	0.0	66.24	25.60	8.16
	0.7	11.84	33.19	54.97
DP02	0.0-0.3	8.19	37.98	53.83
DP03	0.0	45.41	16.97	37.62
	0.6	18.12	61.24	20.65
	1.15	64.53	32.29	3.18
DP04	0.0	61.90	34.01	4.09
	0.8	47.94	35.73	16.33
DP05	0.0	30.29	45.13	24.57
	0.5	22.84	49.53	27.63
	1.0	31.63	50.90	17.47
	1.35	22.46	43.05	34.49
DP06	0.0	18.58	77.71	3.70
	0.5	38.22	42.68	19.10
	1.0	24.46	41.81	33.73

Location	Depth (m)	Mud (less than 0.063mm)	Sand (0.063-2mm)	Gravel (greater than 2mm)
	1.2	18.75	62.42	18.83
DP07	0.0	33.14	27.52	39.33
	1.0	22.92	41.65	35.43

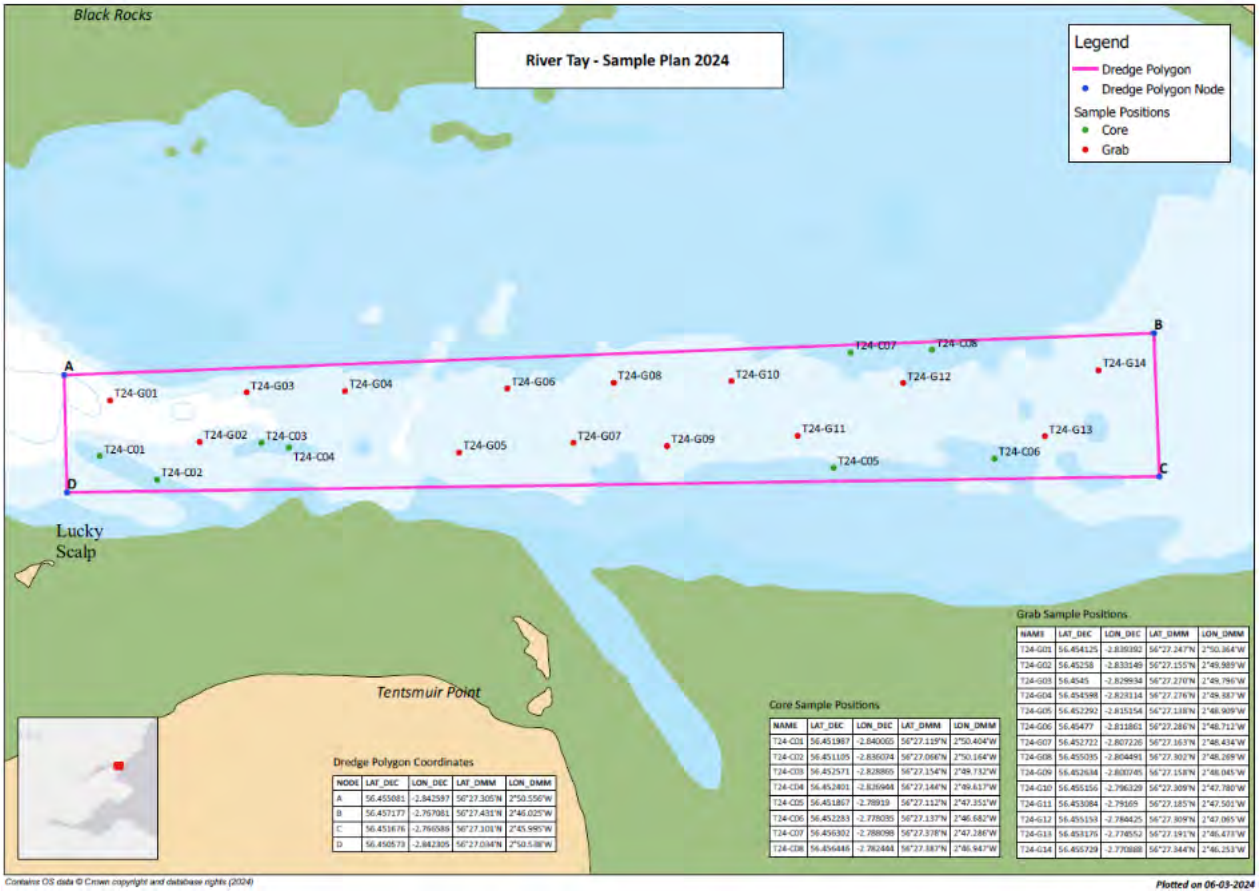


Figure 7-17 Location of vibrocores and bed sediment samples at Lady Shoal approach channel collected in July 2024 (CMS-Geoscience)

Aspect completed a sub-bottom (geophysical) profiling campaign across Lady Shoal approach channel in 2017. The shallow geology was divided into two main units. Unit 1, comprises an uppermost layer silt and sand which is present in the southern and western portions of the approach channel. This is underlain by Unit 2, comprising sediments which are more consolidated potentially represented by clay or gravel/boulders. The base of Unit 1 reaches depths between -3.1m CD and -17.7m CD. The base of Unit 2 reaches depths between -1.6m CD and -26.0m CD.

Nine vibrocores were recovered for the Proposed Scheme from the Lady Shoal approach channel dredge area on 10th and 11th February 2025 (**Figure 7-18**) (see Appendix 2 in **Appendix 7-1**). The particle size characteristics of 17 sediment samples were analysed. (**Table 7-3**) and show high variability. The bed sediments contain a mix of mud (10-86%), sand (10-55%) and gravel (1-61%). Similarly, deeper sediments are mixed, containing 3-88% mud, 10-88% sand, and 0-57% gravel.

Figure 7-18 Location of vibrocores at Lady Shoal approach channel collected in February 2025

Table 7-3 Particle size characteristics of sediment samples from Lady Shoal approach channel dredge area collected in February 2025

Location	Depth (m)	Mud (less than 0.063mm)	Sand (0.063-2mm)	Gravel (greater than 2mm)
LS01	0.0	17.87	33.21	48.92
	0.5	36.32	56.26	7.42
LS02	0.0	17.4	34.96	47.64
	0.9	3.43	88.22	8.35
LS03	0.0	29.11	9.75	61.14
	0.5	87.77	12.23	0
LS04	0.0	86.37	12.2	1.42
	0.65	86.21	10.23	3.56
LS05	0.0	13.87	34.12	52.01
	0.5	14.38	84.49	1.13
LS06	0.0	18.42	49.25	32.33
	0.4	22.61	53.96	23.43
LS07	0.0-0.3	19.06	48.41	32.53
LS08	0.0	10.17	55.17	34.65
	0.9	4.93	71.89	23.18
LS09	0.0	12.98	52.12	34.90
	0.5	5.05	37.75	57.20

7.4.9 Suspended Sediment Concentration

The Firth of Tay and Eden Estuary is characterised by powerful tidal currents which generate high suspended sediment load (Bates *et al.*, 2004). Turbidity has been measured at the same two locations as tidal current speed (**Figure 7-5**) between 23rd and 25th February 2025 (**Appendix 7-1**). At both locations, the minimum suspended sediment concentration measured was 5mg/l, with most values within the time series between 10mg/l and 100mg/l (**Figure 7-19**). The highest observed suspended sediment concentrations were 551mg/l at Site 1 and 339mg/l at Site 2.

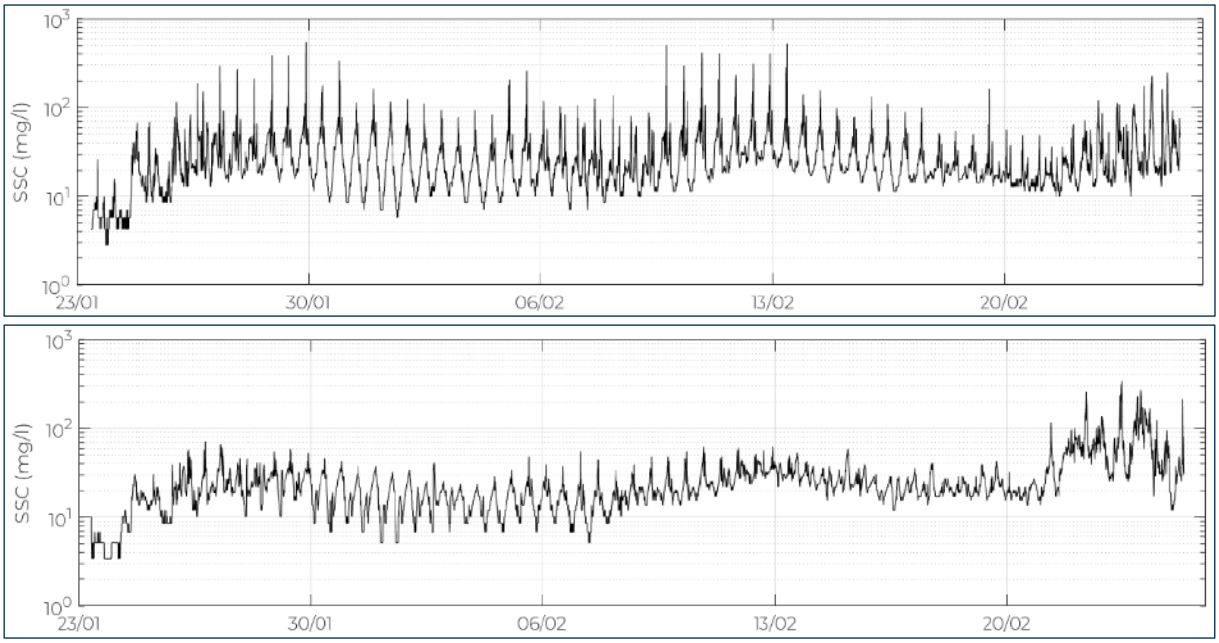


Figure 7-19 Time series of measured suspended sediment concentrations at Site 1 near the Port of Dundee (top) and Site 2 near Lady Shoal approach channel (bottom)

7.5 Prediction of Potential Effects During the Construction Phase

The potential impacts of the Proposed Scheme on estuarine processes during construction relate to the capital dredge activity at the Port of Dundee and Lady Shoal approach channel. They comprise:

- Disturbance of sediment during capital dredging and disposal, resulting in localised and short-term increases in suspended sediment concentrations in the form of a sediment plume.
- Deposition of sediment that is entrained within the plumes will have the potential to become deposited in other areas on the bed of the Firth of Tay as it settles through the water column.

7.5.1 Predicted Changes to Suspended Sediment Concentrations due to Dredging and Disposal

During dredging, the worst case maximum suspended sediment concentrations at any time throughout the simulation are near the bed of the Firth of Tay using the fast production rate. At the Port of Dundee, concentrations are predicted to reach up to about 2,000mg/l at the surface and near the bed, with the greatest concentrations restricted to within the bounds of the dredging area (**Figure 7-20**). At Lady Shoal approach channel, near the bed concentrations are also predicted to reach up to 1,000mg/l, with the greatest concentrations restricted to within the bounds of the dredging area (**Figure 7-21**). The plumes at the bed of the Firth of Tay are predicted to extend away from the dredged areas (including overlap with the plume

generated by disposal at the existing Middle Bank disposal site) (**Figure 7-22**). At its maximum extent, the plume near the bed of the Firth of Tay with maximums greater than 10mg/l would stretch 12km into, and 18km out of the Firth of Tay from the Port of Dundee (including overlap with the plume generated by disposal at the existing Middle Bank disposal site).

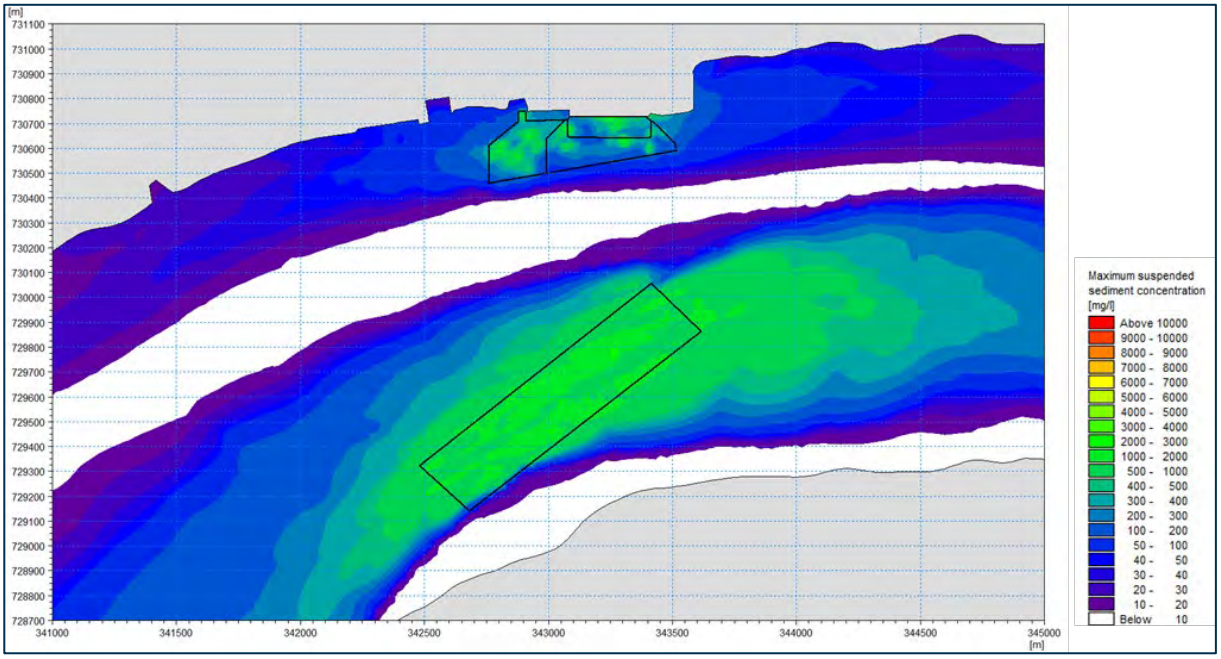


Figure 7-20 Predicted maximum suspended sediment concentrations near the bed of the Firth of Tay during the worst-case dredging at the Port of Dundee and disposal at Middle Bank disposal site

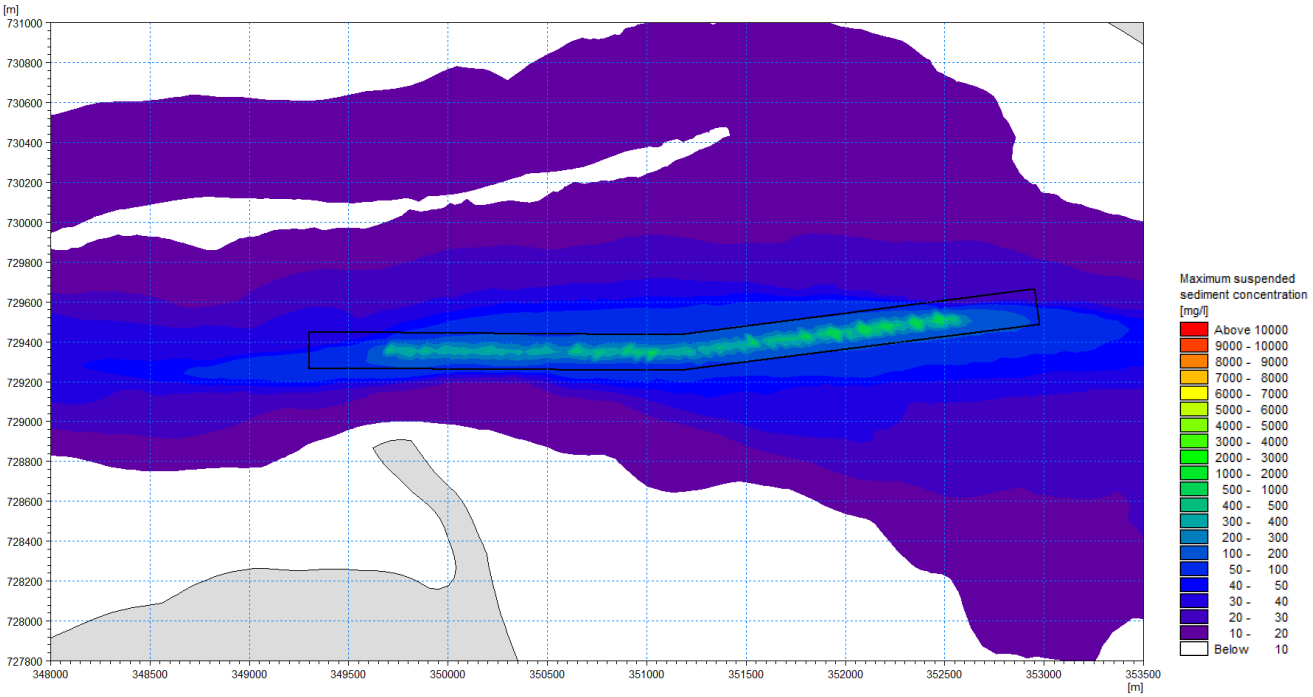


Figure 7-21 Predicted maximum suspended sediment concentrations near the bed of the Firth of Tay during the worst-case dredging at Lady Shoal approach channel

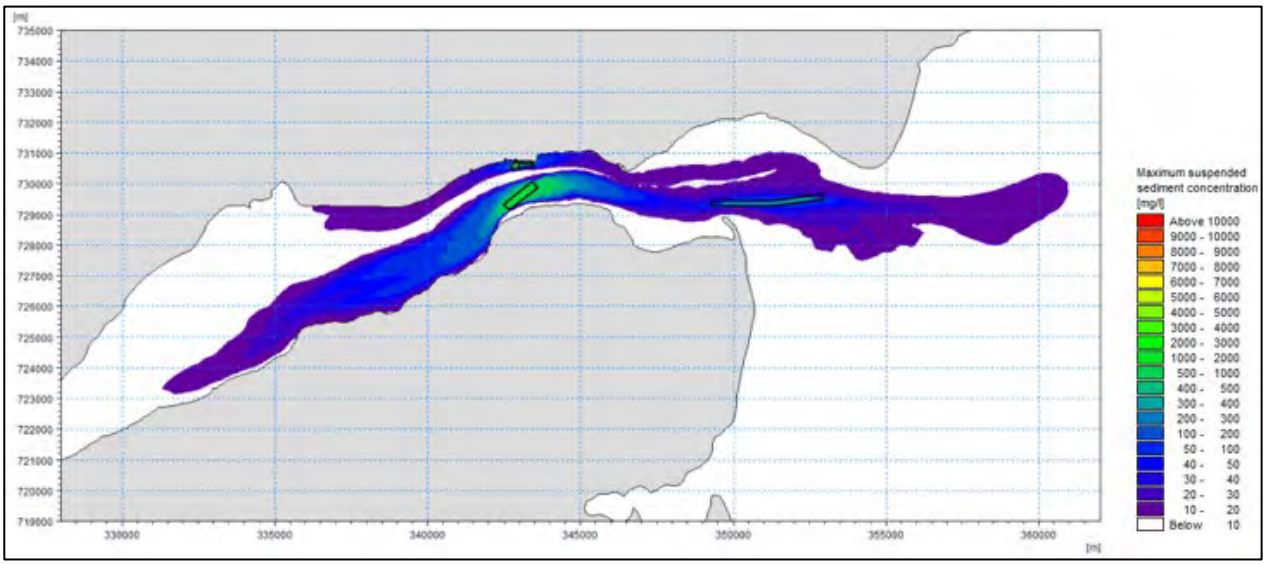


Figure 7-22 Predicted maximum suspended sediment concentrations near the bed of the Firth of Tay during the worst-case dredging at the Port of Dundee and Lady Shoal approach channel, and disposal at Middle Bank disposal site

During disposal, the worst case maximum suspended sediment concentrations at any time throughout the simulation are at the water surface using the fast production rate. At the surface, concentrations are predicted to reach up to 35,000mg/l, in localised spots and restricted predominantly within the bounds of the disposal site, reducing to a maximum of 2,000mg/l near the bed (**Figure 7-23**). At its maximum extent, the plume at the water surface with maximums greater than 10mg/l would stretch 7km into, and 10km out of the Firth of Tay from the Port of Dundee (including overlap with the plumes generated by dredging at the Port of Dundee and Lady Shoal approach channel) (**Figure 7-24**).

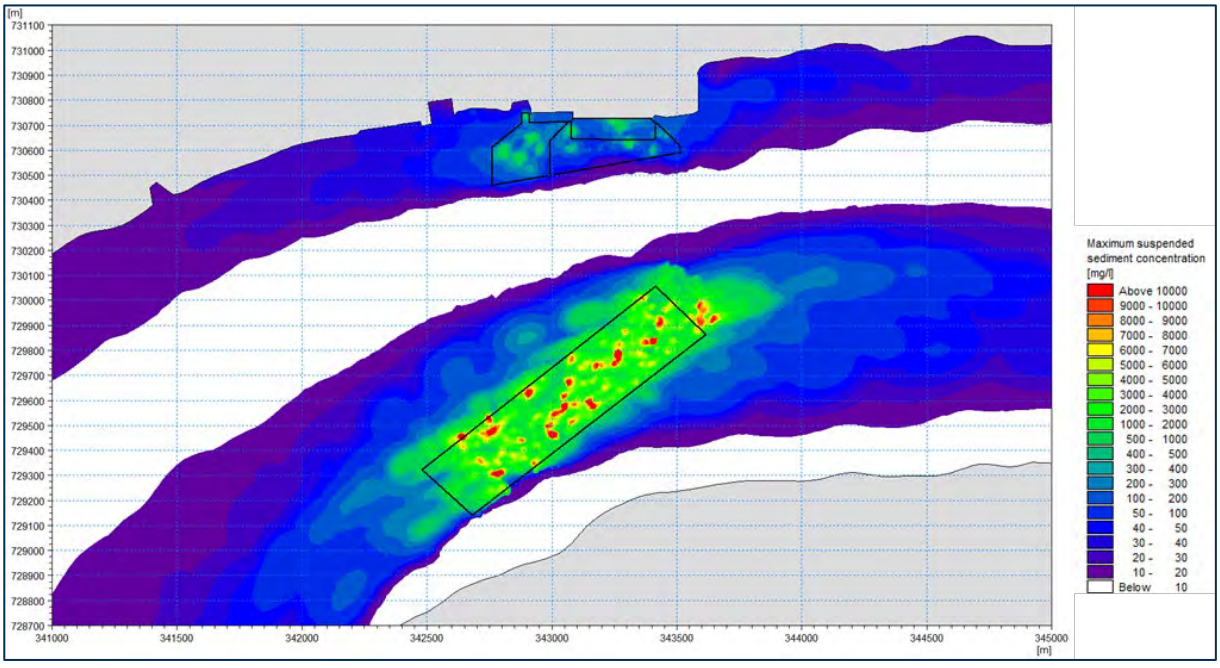


Figure 7-23 Predicted maximum suspended sediment concentrations near the water surface during the worst-case sediment disposal at the proposed Middle Bank disposal site

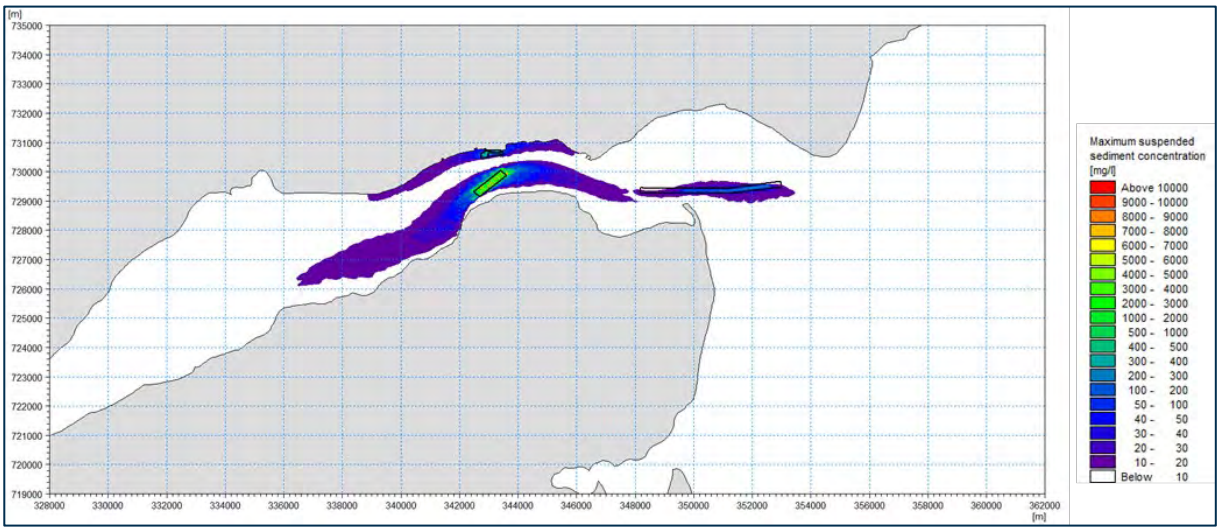


Figure 7-24 Predicted maximum suspended sediment concentrations near the water surface during the worst-case dredging and sediment disposal at Middle Bank disposal site. The simulation also combines the disposal results with those of dredging at the Port of Dundee and Lady Shoal approach channel

Figure 7-25 shows the location of three extraction points (P1, P2, and P3) to demonstrate the time series of predicted SSCs at the Port of Dundee, the existing Middle Bank disposal site, and Lady Shoal approach channel, respectively. Maximum SSCs of about 580mg/l at P1 are predicted, but only for about 1.5 hours before returning to less than ambient concentrations (less than 10mg/l) (**Figure 7-26**). A set of smaller predicted peaks (to about 300mg/l) occur either side of the main peak, with durations less than one hour. At P2, three main peaks are predicted to occur (**Figure 7-27**). The peaks reach concentrations of up to 9,700mg/l (near the water surface), but only for 30 minutes each before returning to less than ambient concentrations (less than 10mg/l). The results show that the plume is predicted to last for the entire duration of the disposal, but once disposal ceases will reduce to less than ambient conditions within 30 minutes. At P3 Lady Shoal approach channel, maximum SSCs of about 330mg/l are predicted (**Figure 7-28**); however, a group of smaller peaks are predicted to occur (mainly) before the main peak (up to 40mg/l).

Figure 7-25 Location of time series extraction points at the Port of Dundee, Lady Shoal approach channel, and the Middle Bank disposal site

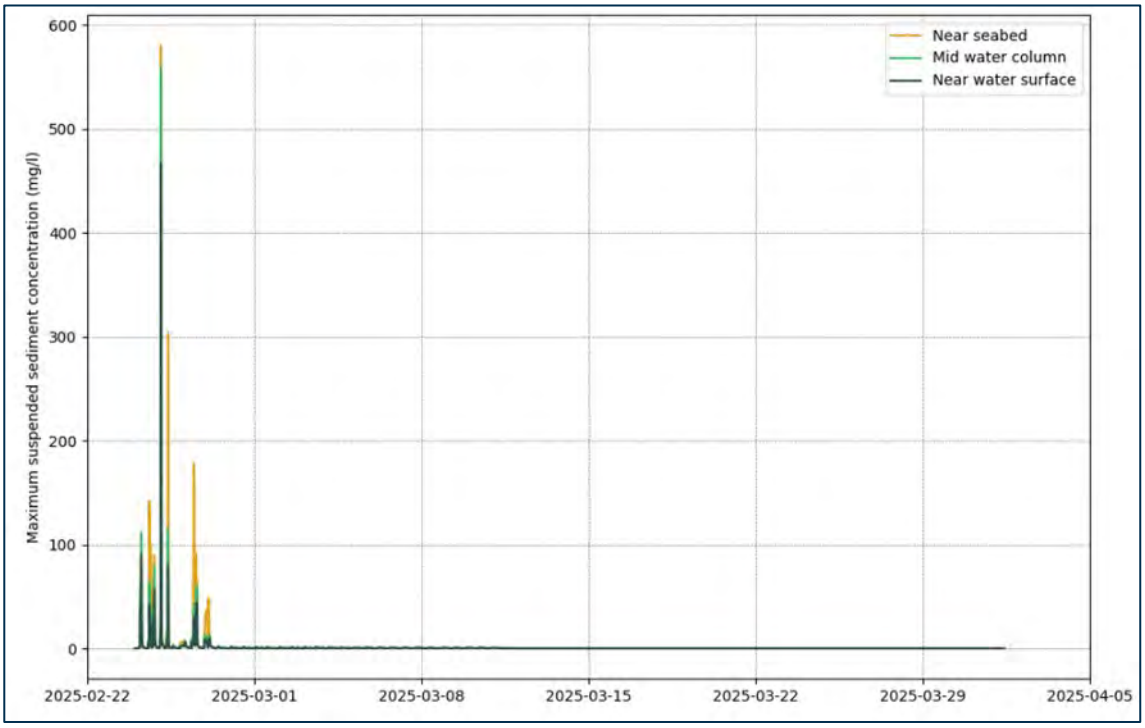


Figure 7-26 Time series of predicted suspended sediment concentrations at the Port of Dundee during dredging for plumes near the bed of the Firth of Tay, mid water column, and near the water surface

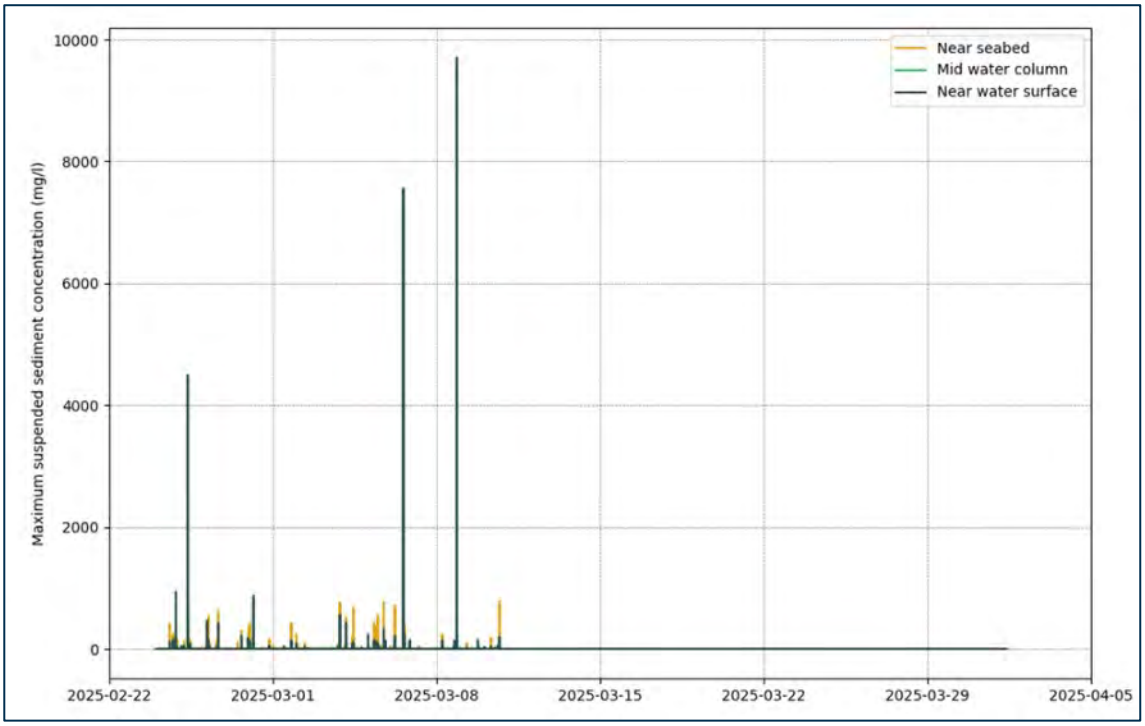


Figure 7-27 Time series of predicted suspended sediment concentrations at the proposed Middle Bank disposal site for plumes near the bed of the Firth of Tay, mid water column, and near the water surface

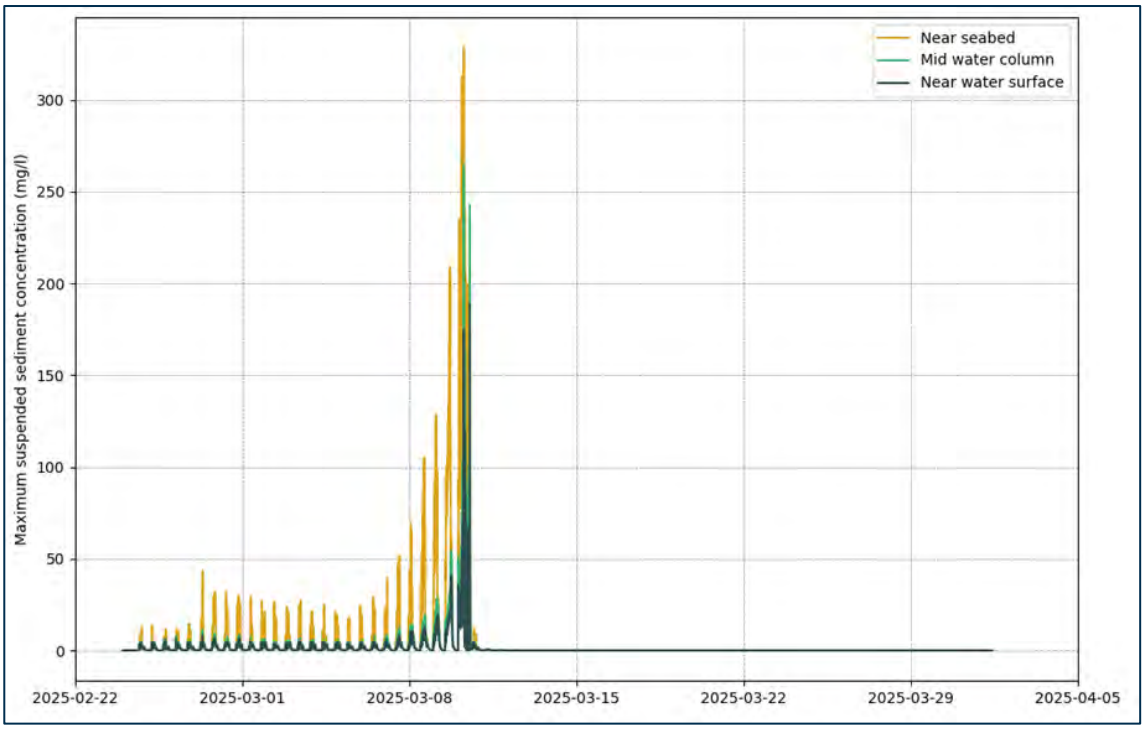


Figure 7-28 Time series of predicted suspended sediment concentrations at Lady Shoal approach channel during dredging for plumes near the bed of the Firth of Tay, mid water column, and near the water surface

7.5.1.1 Impact Magnitude

The changes in suspended sediment concentrations due to dredging and disposal would have the magnitudes of effect shown in **Table 7-4**. The overall magnitude of impact is negligible. Due to the nature of the pressure (increase in SSCs due to dredging and disposal) there is no pathway for impact to receptors so therefore they are not sensitive to this pressure. This is because the receptors are dominated by processes that are active along the seabed and not affected by suspended sediment in the water column; however, there may be impacts arising from subsequent deposition of the suspended sediment on the estuary bed and these are discussed in **Section 7.5.2**.

Table 7-4 Magnitude of impact on SSCs due to dredging and disposal

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Impact
Near-field	Small	Short	Construction only	Reversible	Negligible
Far-field	Negligible	Short	Construction only	Reversible	Negligible

7.5.2 Predicted Changes to Estuary Bed Level due to Dredging and Disposal

During dredging and disposal, the worst-case changes in bed level are for the fast production rate. Maximum deposition of 0.1m is predicted to occur at the Port of Dundee and Lady Shoal approach channel, and maximum deposition of 0.3m (mainly up to 0.15m) at the existing Middle Bank disposal site (**Figure 7-29** and **Figure 7-30**).

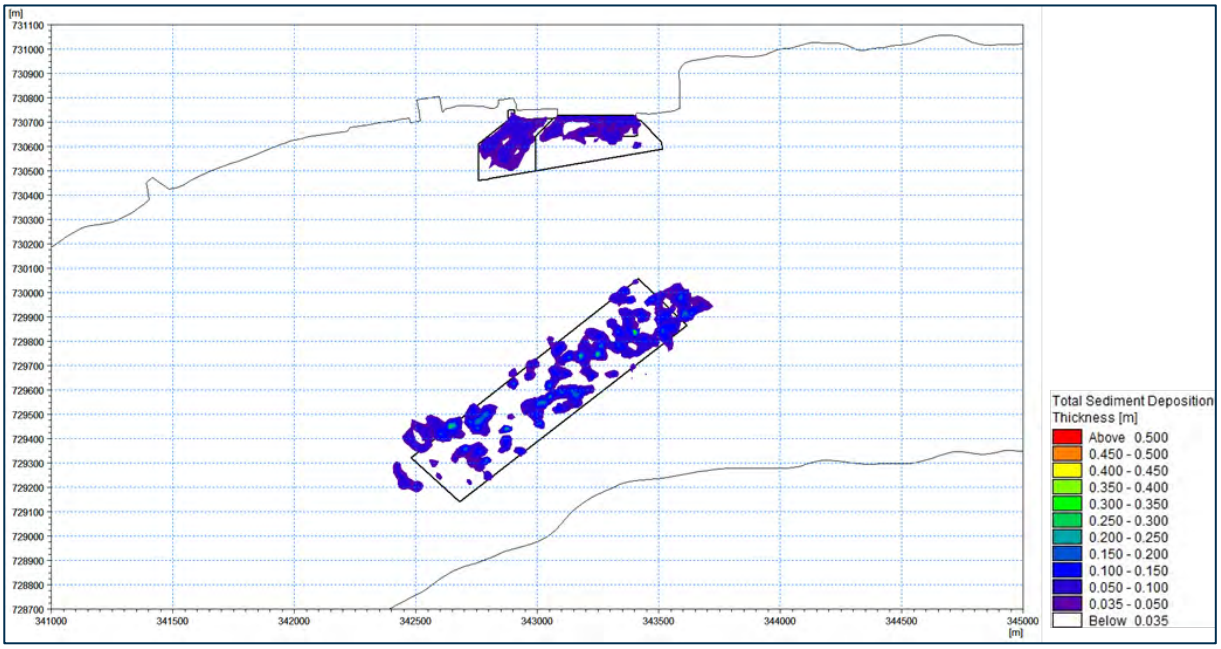


Figure 7-29 Predicted bed level change during worst case dredging and disposal at the Port of Dundee and the proposed Middle Bank disposal site

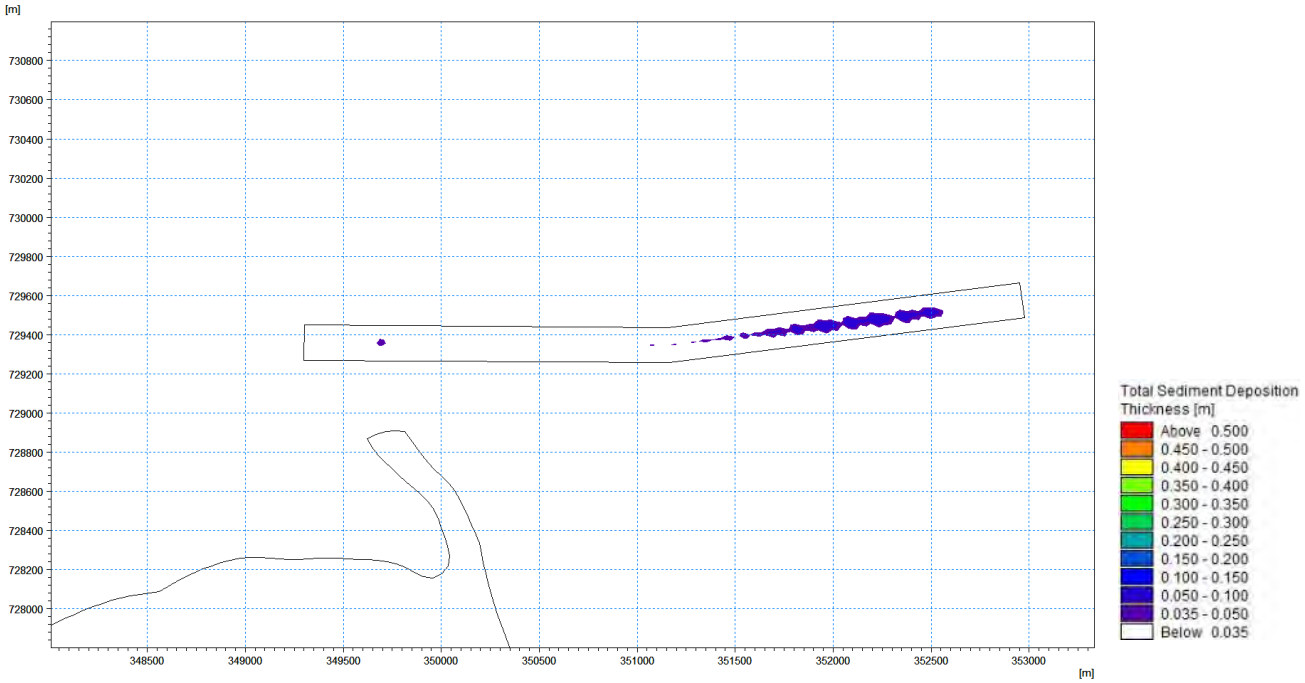


Figure 7-30 Predicted bed level change during worst case dredging and disposal at Lady Shoal approach channel

7.5.2.1 Impact Magnitude

The changes in bed level due to dredging and disposal would have the magnitudes of effect shown in **Table 7-5**. The overall magnitude of impact is negligible in the near-field. Potential impacts due to deposition from the plume would be short-term and temporary, lasting for the duration of the dredging activity only. Deposited sediment would be continually resuspended with the tidal currents and bedload transport processes following the cessation of dredging, resulting in a reversible impact. Construction impacts on processes within the Firth of Tay would therefore not be significant.

Table 7-5 Magnitude of impact on bed level change due to dredging and disposal

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Impact
Near-field	Small	Short	Construction only	Reversible	Negligible
Far-field	N/A	N/A	N/A	N/A	No impact

7.6 Prediction of Potential Effects During the Operational Phase

Potential impacts during operation relate to the presence of the deepened dredge areas and the potential requirement for changes to the maintenance dredging regimes at the Port of Dundee and the potential need for maintenance dredging at Lady Shoal approach channel. The change in geometry of the Firth of Tay may result in changes to tidal currents, which could potentially affect the sediment transport mechanisms and/or bed morphology. The enlarged approaches and berth pocket may also create an additional sink for suspended sediment.

7.6.1 Predicted Changes to Tidal Current Speeds and Bed Shear Stresses due to changes in Bathymetry

The predicted differences in overall flow distribution between the existing bathymetry and the post-dredging bathymetry are shown in **Figure 7-31** and **Figure 7-32** (see **Appendix 7-1** for more details).

At the Port of Dundee, maximum current speeds are predicted to decrease by up to 0.1m/s and increase by up to 0.05m/s (**Figure 7-31**Figure 7-31). These changes equate to maximum percentage changes of up to 15% (**Figure 7-33**Figure 7-33). Most of the changes across the entire dredge footprint are predicted to be less than 0.05m/s. Speeds are predicted to reduce along a strip aligned with the edge of the PCWE and in the northwest corner of the approach channel to the DunEco Quay. Predicted increases occur within the west side of the PCWE and immediately outside the eastern boundary of the existing PCW berth.

Along the Lady Shoal approach channel dredge area, maximum current speeds are predicted to mainly increase by up to 0.05m/s (**Figure 7-32**Figure 7-32) (less than 5% increase (**Figure 7-34**Figure 7-34)). The main changes are restricted to within the bounds of the eastern half of the dredge area.

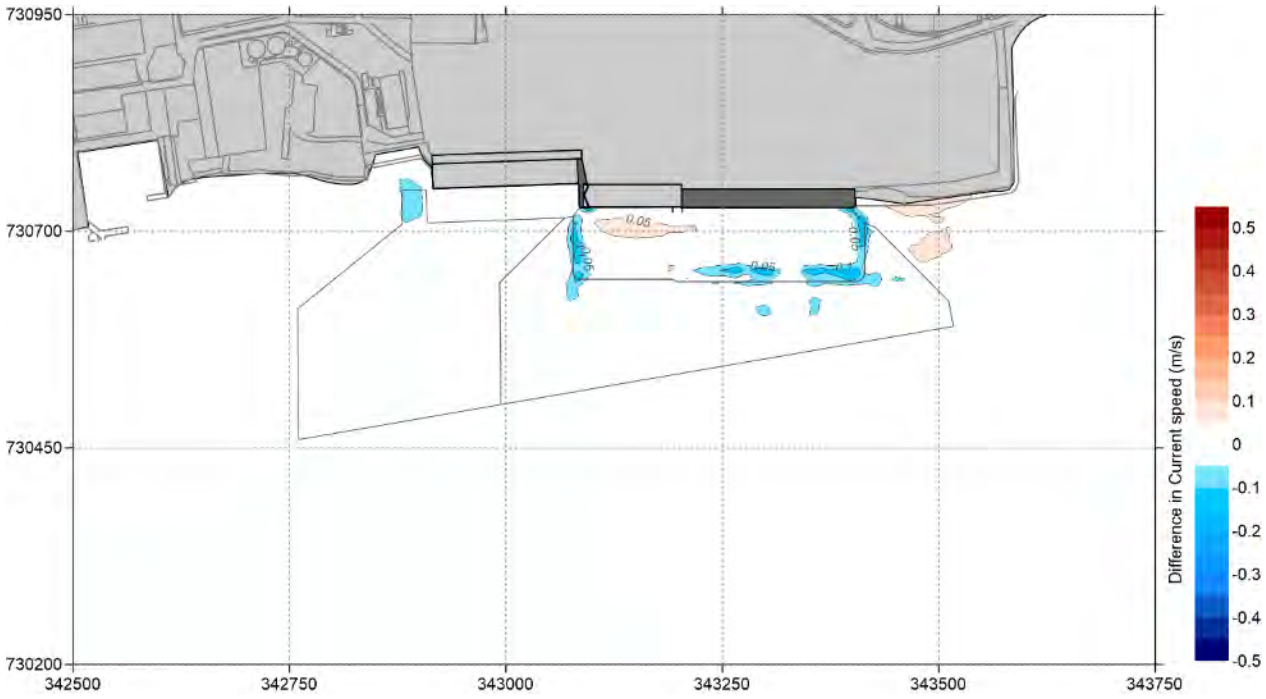


Figure 7-31 Predicted difference in maximum current speed between 'existing' and 'post-dredging' over 30 days at the Port of Dundee (positive means increase in current speed whereas negative means decrease in current speed)

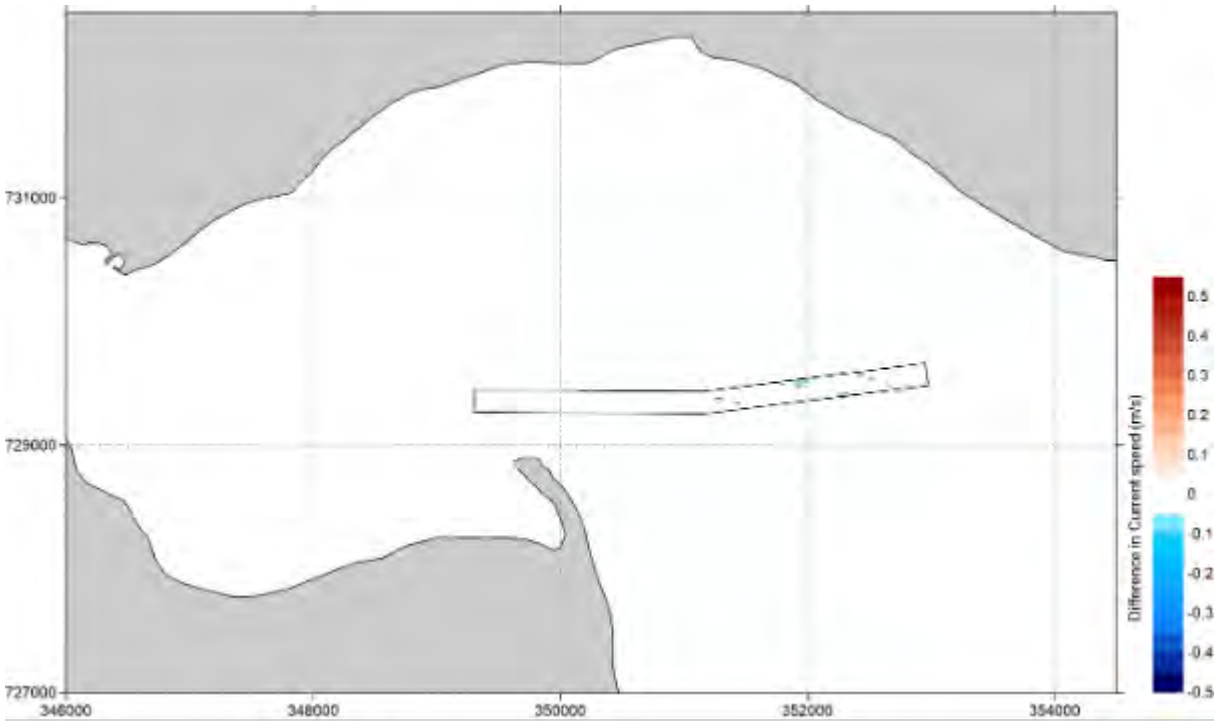


Figure 7-32 Predicted difference in maximum current speed between 'existing' and 'post-dredging' over 30 days at Lady Shoal approach channel (positive means increase in current speed whereas negative means decrease in current speed)

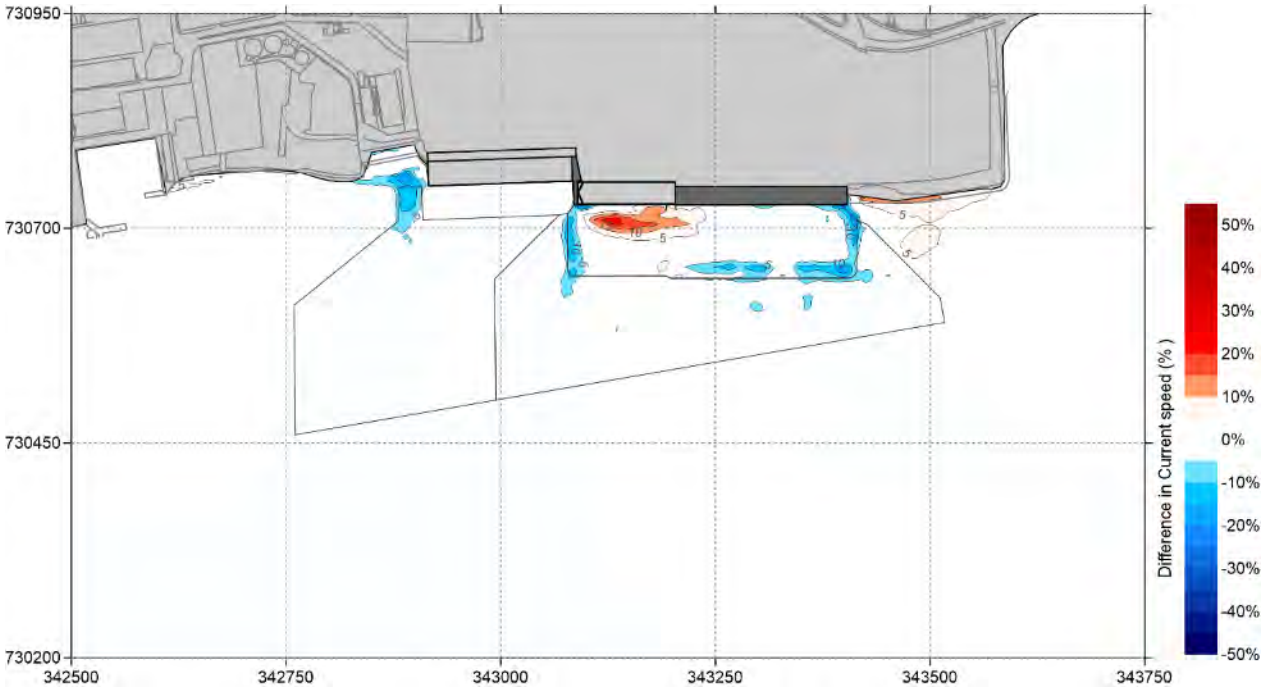


Figure 7-33 Predicted percentage difference in maximum current speed between 'existing' and 'post-dredging' over 30 days at the Port of Dundee (positive means increase in current speed whereas negative means decrease in current speed)

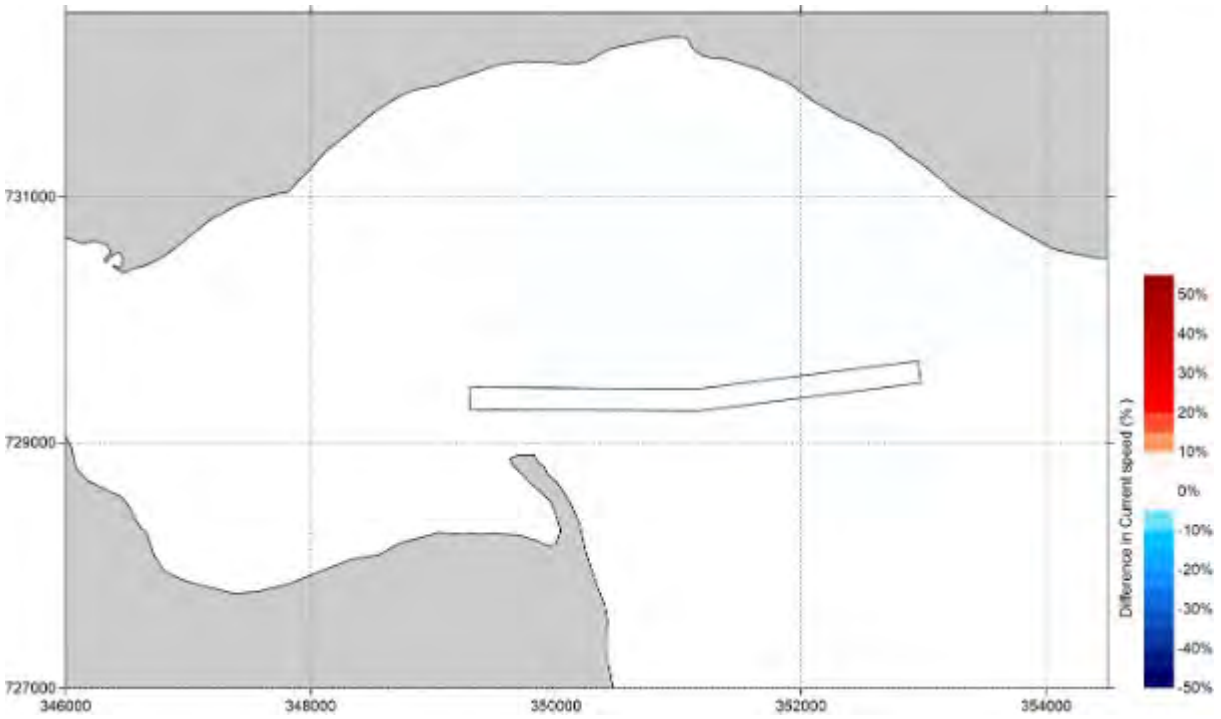


Figure 7-34 Predicted percentage difference in maximum current speed between 'existing' and 'post-dredging' over 30 days at Lady Shoal approach channel (positive means increase in current speed whereas negative means decrease in current speed)

The tidal current speeds have been transformed into bed shear stresses in the approach channel at the Port of Dundee and at the Lady Shoal approach channel dredge area. The predicted differences in bed shear stress distribution between the existing bathymetry and the post-dredging bathymetry are shown in **Figure 7-35** and **Figure 7-36**, and the percentage differences in **Figure 7-37** and **Figure 7-38**. The bed shear stress magnitudes mimic the flow speed magnitudes, whereby lower current speeds are associated with lower bed shear stresses.

At the Port of Dundee, bed shear stresses are predicted to mainly decrease across the dredge footprint, with patches where there is a predicted increase (**Figure 7-35**). Decreases of up to 0.8N/m^2 are predicted along a strip aligned with the edge of the PCWE. The largest predicted increase in bed shear stresses is adjacent to the existing Port immediately outside the eastern boundary of the PCW berth. Here, increases in bed shear stresses are predicted to reach 0.6N/m^2. These changes equate to maximum percentage changes of about 20% (**Figure 7-37**Figure 7-37). Most decreases and increases elsewhere are predicted to be less than 0.2N/m^2.

The predicted largest changes in bed shear stresses along the Lady Shoal approach channel are restricted to the proposed dredge area (**Figure 7-36**). Here areas of predicted decrease (up to 0.6N/m^2) alternate with areas of predicted increase (up to 0.6N/m^2) (up to 5% maximum percentage change (**Figure 7-38**Figure 7-38)). Outside the proposed dredge area, bed shear stresses are predicted to predominantly decrease by up to less than 0.2N/m^2 (less than 5%) decreasing with distance from the dredge area.

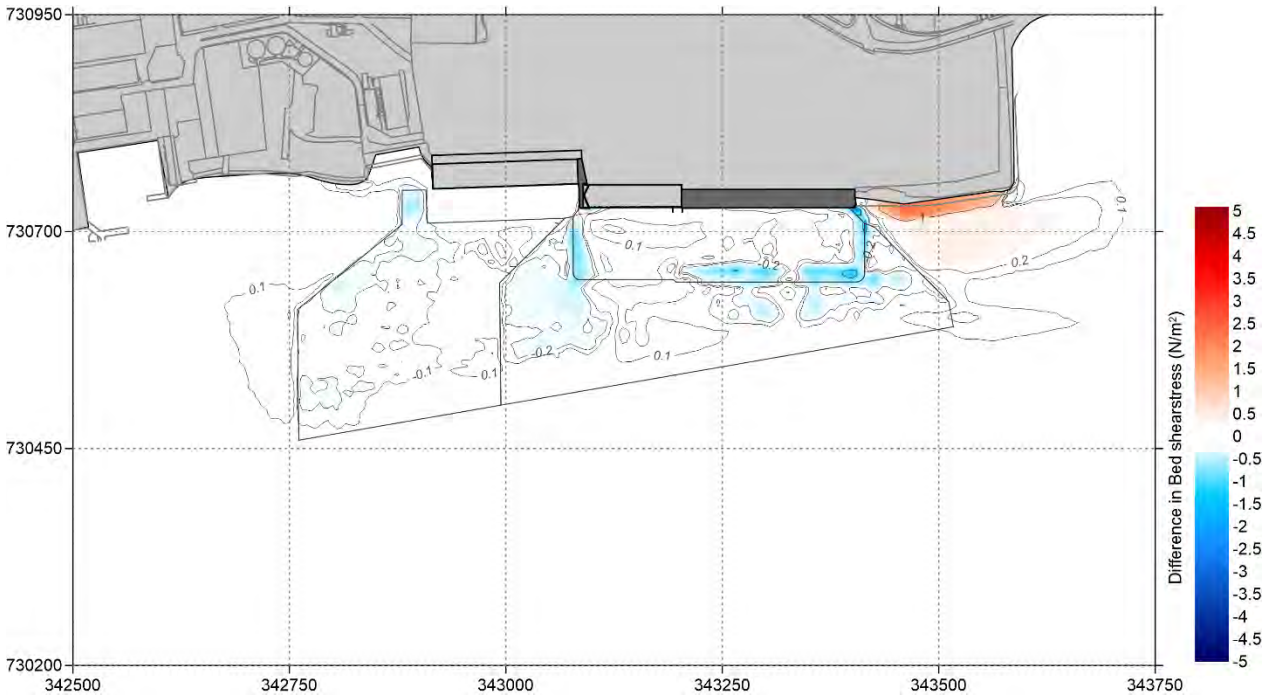


Figure 7-35 Predicted difference in maximum bed shear stresses between 'existing' and 'post-dredging' over 30 days at the Port of Dundee (positive means increase of bed shear stresses whereas negative means decrease in bed shear stress)

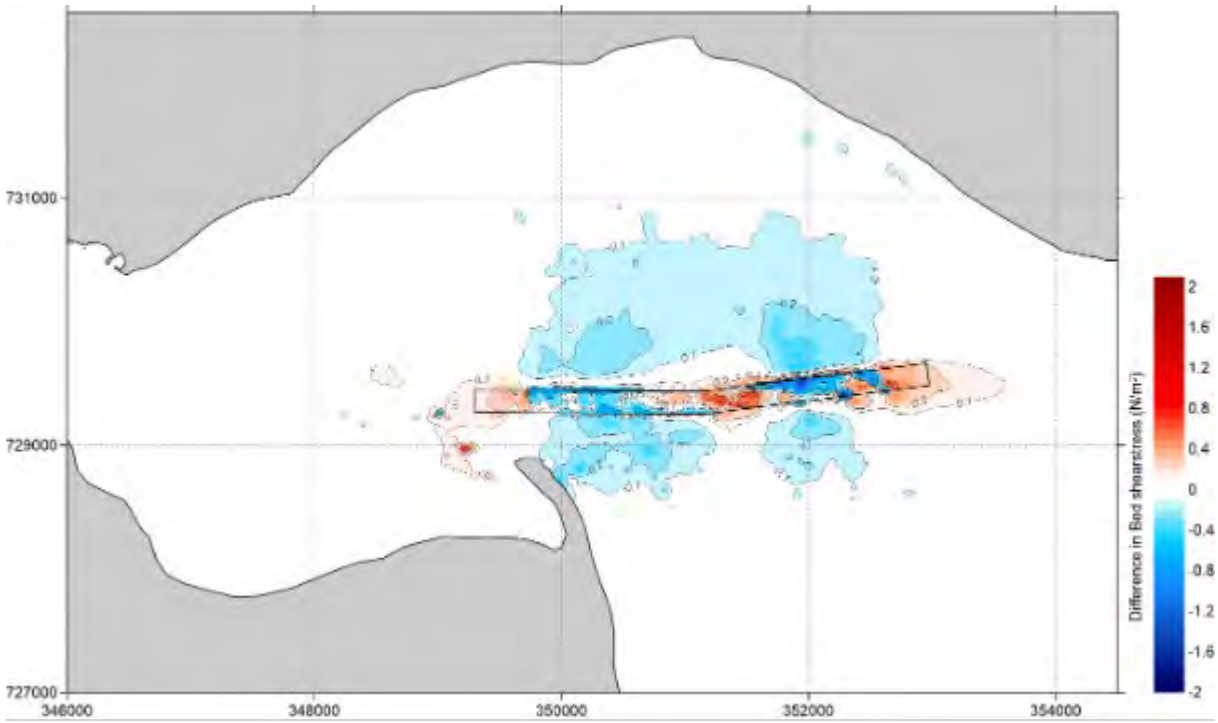


Figure 7-36 Predicted difference in maximum bed shear stresses between 'existing' and 'post-dredging' over 30 days at Lady Shoal approach channel (positive means increase of bed shear stresses whereas negative means decrease in bed shear stresses)

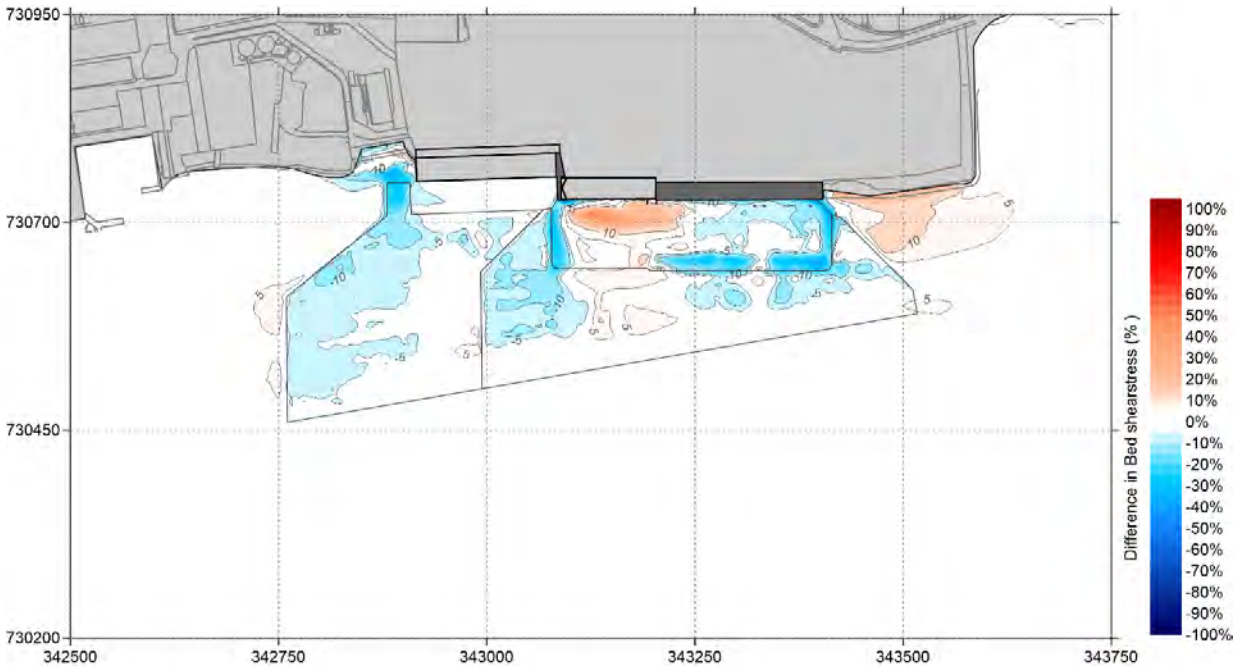


Figure 7-37 Predicted percentage difference in maximum bed shear stresses between 'existing' and 'post-dredging' over 30 days at the Port of Dundee (positive means increase of bed shear stresses whereas negative means decrease in bed shear stresses)

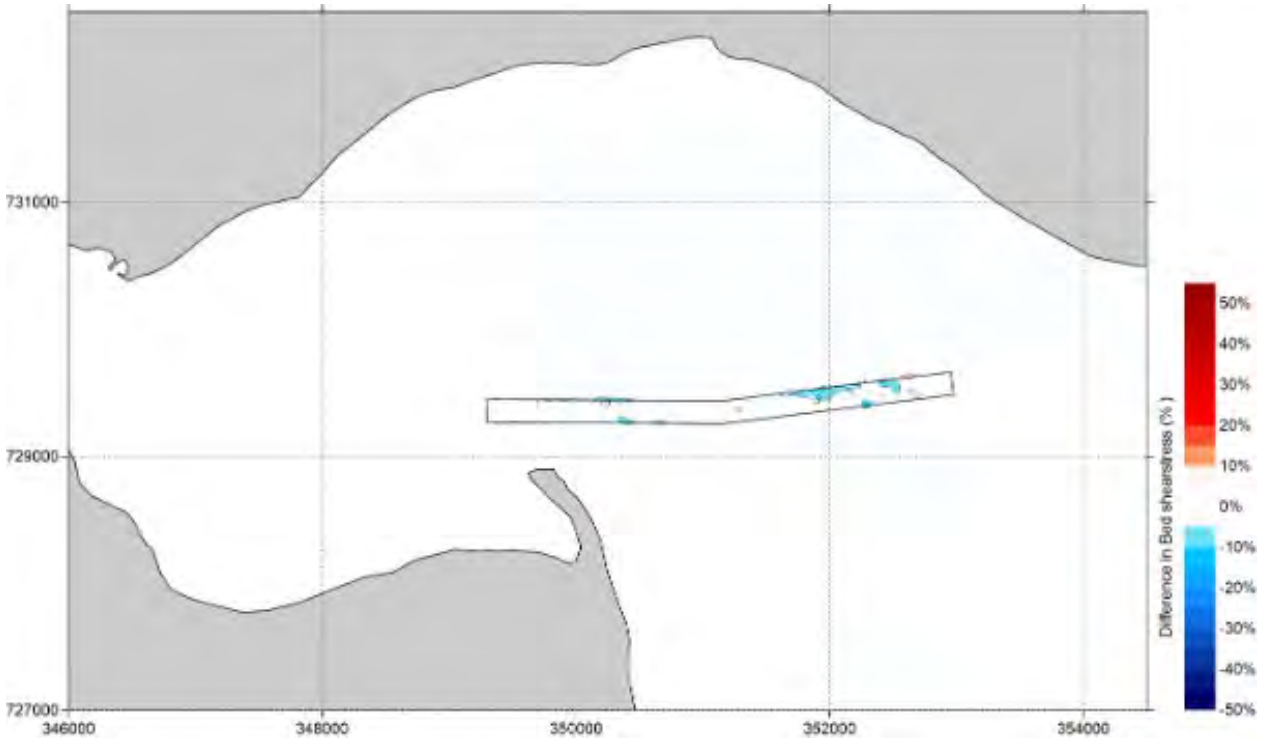


Figure 7-38 Predicted percentage difference in maximum bed shear stresses between 'existing' and 'post-dredging' over 30 days at Lady Shoal approach channel (positive means increase of bed shear stresses whereas negative means decrease in bed shear stresses)

7.6.1.1 Impact Magnitude

The changes in tidal currents and bed shear stresses due to changes in bathymetry would have the magnitudes of effect shown in **Table 7-6**. The overall magnitude of impact is negligible in the near field.

Table 7-6 Magnitude of impact on tidal currents and bed shear stresses due to changes in bathymetry

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Impact
Near-field	Small	Ongoing	Continuous	Reversible	Negligible
Far-field	N/A	N/A	N/A	N/A	No impact

7.6.1.2 Implications for Maintenance Dredging

How currents transfer energy to the bed is measured by bed shear stress. It is a measure of the tangential frictional resisting force per unit area (N/m^2) of bed and can be used to determine the threshold of sediment movement (or conversely deposition) driven by the physical movement of water. Deposition occurs when the force of gravity acting on the particles is sufficient to overcome the fluid forces causing movement. For bedload, particles of a certain size will be deposited once the bed shear stresses fall below the critical shear stress that was needed to start them moving.

Along the Lady Shoal approach channel dredge area, the existing maximum bed shear stresses are predicted to be around $15N/m^2$. These magnitudes are large enough to drive transport of all sand-sized and much of the gravel-sized sediment and prevent deposition of finer sediment. This is evidenced by the types of sediment recovered in Lady Shoal approach channel dredge area, which are predominantly fine to coarse gravel, which may be sandy in places, and may contain cobbles.

The predicted changes in bed shear stress as a result of the deepened Lady Shoal approach channel are restricted to within the bounds of the deepened approach channel, with increases and decreases of up to $0.6N/m^2$. A maximum reduction of $0.6N/m^2$ would not significantly alter the depositional potential of sediment in Lady Shoal approach channel. This is because the predicted magnitude of bed shear stresses post-dredging would still be high enough to maintain transport of sediment of similar sizes to those at present, and finer sediment deposition would continue to be inhibited. It is therefore anticipated that the change in geometry of Lady Shoal approach channel would not lead to a requirement to maintenance dredge the approach channel in the future.

At the Port of Dundee, the existing maximum bed shear stresses are predicted to be $1\text{-}3N/m^2$ gradually increasing seaward. Magnitudes of $1N/m^2$ are large enough to drive transport of mud and fine-medium sand, whereas magnitudes of $3N/m^2$ can move all sand and smaller gravel. Reductions in bed shear stress of up to (mainly) $0.2N/m^2$ create new bed shear stresses that are up to 10% less than the existing bed shear stresses. A minor reduction in bed shear stresses of this magnitude will have little effect on the sediment transport potential across the dredged area. This means that the requirement for future maintenance dredging is negated because finer sediment deposition would continue to be inhibited by the post-scheme bed shear stresses.

7.7 Summary

Table 7-7 summarises the significance of the potential impacts to estuarine processes. Negligible and minor adverse effects are not significant in EIA terms.

Table 7-7 Summary of potential impacts to *estuarine processes as a result of the Proposed Scheme*

Potential effect	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Construction					
Predicted changes to suspended sediment concentrations due to dredging and disposal	Negligible	Negligible	Negligible	None	Negligible
Predicted changes to estuary bed level due to dredging and disposal	Negligible	Negligible (Near-field) No Impact (Far-field)	Negligible (Near-field) No Impact (Far-field)	None	Negligible (Near-field) No Impact (Far-field)
Operation					
Predicted changes to tidal current speeds and bed shear stresses due to changes in bathymetry	Negligible	Negligible (Near-field) No Impact (Far-field)	Negligible (Near-field) No Impact (Far-field)	None	Negligible (Near-field) No Impact (Far-field)

8 Marine Water and Sediment Quality

This chapter 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**: Estuarine Processes
- **Appendix 8-1**: Sediment Sampling Plan and MD-LOT's Approval
- **Appendix 8-2:** Sediment Analyses Results

8.1 Legislation, Policy and Guidance

8.1.1 Legislation

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

Table 8-1 Summary of the 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 Scheme 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 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) Regulations 2008 (as amended	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 the WFD. This Directive is transposed into Scottish law through the Bathing Waters (Scotland) Amendment Regulations 2012.

8.1.2 Policy and Plans

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

8.1.2.1 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."

8.1.2.2 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.

8.1.3 Best Practice and Guidance

This impact assessment takes account of the following guidance:

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

8.1.3.1 Marine Directorate'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 Marine Directorate's ALs, as presented in **Table 8-2**.

Table 8-2 Marine Directorate'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 (PCBs)	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.

8.2 Consultation

A sediment sampling plan requests were submitted to MD-LOT for approval. These requests and MD-LOT's approvals can be found in **Appendix 8-1**.

8.3 Assessment Methodology

8.3.1 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 determined by sediment dispersion modelling of the dredging and disposal activities, which predicted the maximum extent over which effects of the sediment plume are predicted to occur as 12km into, and 18km out of the Firth of Tay from the Port of Dundee (see **Section 7.5.1**).

8.3.2 Data Sources

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/; and
- BPEO Report for Port of Dundee Maintenance Dredge Licence and Marine Licence Application (ERM, 2023).

A site-specific sampling was undertaken in February 2025 during which sediment samples were collected 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).

Samples were analysed by SOCOTEC and the results were received in March 2025, and are presented in **Appendix 8-2**. It should be noted that there is a formatting error in the template. Results which are below the Limit of Detection are shown as exceeding AL1 values when they are not.

8.3.3 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.

8.3.3.1 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.

8.3.3.2 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 8-3**.

Table 8-3 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.

8.4 Baseline Environment

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

- The Proposed Scheme is located within the Lower Tay Estuary transitional waterbody (ID: 200438) which holds a chemical status of 'Pass', an ecological status of 'Good' and an overall status of 'Good';
- There are two Bathing Waters within 2km of the plume extent: Broughton Ferry (Excellent) and Monifieth (Excellent) (**Figure 8-1**);
- There are no Shellfish Waters within the Firth of Tay;
- Turbidity data acquired from in February 2025 (see **Chapter 7**); and
- Sediment quality data from the site-specific sampling undertaken in February 2025.

Figure 8-1 Designated bathing waters within 2km of the Proposed Scheme

8.4.1 WFD Waterbody Classification

The Proposed Scheme is within the Lower Tay Estuary transitional waterbody (ID: 200438), which has an overall status of Good and an ecological status of Good[3]. The water body is expected to maintain this status in 2027. Full classification details of this waterbody are provided in **Table 8-4**.

[3] *https://informatics.sepa.org.uk/WaterClassificationHub/*

Table 8-4 2023 Classification status of Lower Tay Estuary waterbody (ID: 200438)

Parameter	Status
Overall Status	*Good*
Pre-Highly Modified Water Body Status	*Good*
Physico-chem	*Good*
Dissolved oxygen	*Good*
Dissolved inorganic nitrogen	*Good*
Biological elements	*High*
Fish	*High*
Specific pollutants	*Pass*
Unionised ammonia	*Pass*
Hydromorphology	*Good*
Morphology	*Good*
Water quality	*Good*

8.4.2 Suspended Sediment Concentration

Baseline SSCs – typical of an estuarine environment – were highly variable, with ambient levels of around 10mg/l and 100mg/l. The highest observed suspended sediment concentration was 551mg/l. See **Section 7.4.9** for further details.

8.4.3 Sediment Quality

8.4.3.1 Historic sediment quality

Data on sediment quality from between 1989 and 2023 are summarised in **Table 8-5** and **Table 8-6** (ERM, 2023). Whilst average concentrations of metals were below AL1 for all but Hg and Pb (**Table 8-5**), concentrations did exceed AL1 for all metals except As and Cd. There were no exceedances of AL2.

Table 8-5 Historic metal concentrations from the Port of Dundee (mg/kg) 1989-2023

	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Mean	9.2	0.2	39.8	29.8	0.4	29.9	50.9	122.3
Range	3.6-20.4	0.1-0.5	23.2-66.4	17.5-54.0	0.1-2.8	21.9-61	27.5-193.8	76.5-250.3

The mean concentration of TBT was reported to be <0.01044mg/kg between 2017 and 2023. Concentrations of ICES 7 PCBs were found to vary between 0.0019 and 0.240mg/kg between 1993 and 2023. Mean concentrations of PCBs were below AL1, save for one in 2000 with a concentration of 0.0240mg/kg. There were no exceedances of AL2 (ERM, 2023). A comparison of mean concentrations of PAHs from samples collected between 2006 and 2023 showed that PAH concentrations for the majority of individual PAHs were well above AL1 (**Table 8-6**); there is no AL2 for PAHs.

Table 8-6 PAH concentrations from the Port of Dundee (ug/kg) 2006-2023

	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BENZGHIP	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PHENANT	PYRENE
Mean	8.59	9.71	33.14	114.50	146.49	127.79	122.56	25.28	217.27	16.81	136.91	170.24	103.67	223.94

Metals and PCB concentrations recorded from the existing Middle Bank disposal site can be seen in **Table 8-7**.

Table 8-7 Metals and ICES 7 PCB congeners concentrations recorded from the Middle Bank Tay disposal site

Site Name	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
Middle Bank (Tay) 2007	8.9	BDL	31.6	12.6	0.3	19.9	29.2	57.0	-
(n=6)									

8.4.3.2 Overview

16 vibrocores were collected from within the proposed dredge areas (**Figure 7-16** and **Figure 7-18**). Cores were vibrated through the soft-surface sediments until refusal. Sediment samples were then taken from the cores and sent to SOCOTEC for chemical and physical analyses. Results of the sediment analyses are presented in **Tables 8-5** to **8-9**.

8.4.3.3 Particle Size Analysis

PSA results show that the sediment present within dredge areas is high variability, with bed sediments containing a mix of mud (10-86%), sand (10-55%) and gravel (1-61%). Similarly, deeper sediments are mixed, containing 3-88% mud, 10-88% sand, and 0-57% gravel. (**Table 8-8**).

Table 8-8 PSA of vibrocore samples

Sample ID	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)
DP01 (ES1)	0	74.5	8.16	25.60	66.24
DP01 (ES2)	0.7	80.4	54.97	33.19	11.84
DP02 (ES1)	0	83.4	53.83	37.98	8.19
DP03 (ES1)	0	78.3	37.62	16.97	45.41
DP03 (ES2)	0.6	78.3	20.65	61.24	18.12
DP03 (ES3)	1.15	67.9	3.18	32.29	64.53
DP04 (ES1)	0	59.4	4.09	34.01	61.90
DP04 (ES2)	0.8	72.5	16.33	35.73	47.94
DP05 (ES1)	0	84.1	24.57	45.13	30.29
DP05 (ES2)	0.5	84.5	27.63	49.53	22.84
DP05 (ES3)	1	84.5	17.47	50.90	31.63
DP05 (ES4)	1.35	86.5	34.49	43.05	22.46
DP06 (ES1)	0	80.1	3.70	77.71	18.58
DP06 (ES2)	0.5	77.3	19.10	42.68	38.22
DP06 (ES3)	1	79.2	33.73	41.81	24.46

Sample ID	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)
DP06 (ES4)	1.2	80.4	18.83	62.42	18.75
DP07 (ES1)	0	77.6	39.33	27.52	33.14
DP07 (ES2)	1	83.9	35.43	41.65	22.92
LS01 (ES1)	0	83.4	48.92	33.21	17.87
LS01 (ES2)	0.5	60.6	7.42	56.26	36.32
LS02 (ES1)	0	83.5	47.64	34.96	17.40
LS02 (ES2)	0.9	80.8	8.35	88.22	3.43
LS03 (ES1)	0	85.3	61.14	9.75	29.11
LS03 (ES2)	0.5	80.0	0.00	12.23	87.77
LS04 (ES1)	0	81.0	1.42	12.20	86.37
LS04 (ES2)	0.65	80.4	3.56	10.23	86.21
LS05 (ES1)	0	88.6	52.01	34.12	13.87
LS05 (ES2)	0.5	82.3	1.13	84.49	14.38
LS06 (ES1)	0	85.5	32.33	49.25	18.42
LS06 (ES2)	0.4	84.2	23.43	53.96	22.61
LS07 (ES1)	0	82.6	32.53	48.41	19.06
LS08 (ES1)	0	81.1	34.65	55.17	10.17
LS08 (ES2)	0.9	74.9	23.18	71.89	4.93
LS09 (ES1)	0	83.4	34.90	52.12	12.98
LS09 (ES2)	0.5	83.1	57.20	37.75	5.05

8.4.3.4 Metals and Organotins

Concentrations of metals Cr, Cu, Ni and Zn were found at levels marginally exceeding AL1 (**Table 8-9**). No samples exceeded AL2. There were no exceedances of any AL1 for organotins.

Table 8-9 Metal results (mg/kg) compared to Marine Directorate's ALs (AL1 exceedance shown in blue)

Sample ID	Sample depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
DP01 (ES1)	0	4.6	0.06	16	5.2	<0.01	12.2	4.3	26.7	<0.001	<0.001
DP01 (ES2)	0.7	9.4	0.07	29.2	8.9	<0.01	22.1	4.4	50.7	<0.001	<0.001
DP02 (ES1)	0	6.4	0.13	31.2	11.4	0.03	28.4	5.0	37.8	<0.001	<0.001
DP03 (ES1)	0	11	0.12	33.9	10.4	<0.01	24.8	8.8	53.8	<0.001	<0.001
DP03 (ES2)	0.6	4.3	0.05	17.1	5.1	<0.01	12.9	4.2	29.1	<0.001	<0.001
DP03 (ES3)	1.15	4.9	0.07	20.8	6.2	<0.01	15.7	5.2	34.6	<0.001	<0.001
DP04 (ES1)	0	8.5	0.14	32.7	10.9	<0.01	23.7	8.4	55.5	<0.001	<0.001
DP04 (ES2)	0.8	4.5	0.06	14.7	4.3	<0.01	11.3	3.6	24.2	<0.001	<0.001

Sample ID	Sample depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
DP05 (ES1)	0	6.4	0.07	27.5	9.9	<0.01	21.3	4.5	33.6	<0.001	<0.001
DP05 (ES2)	0.5	6.8	0.12	21.9	11.6	<0.01	18.7	5.6	31.7	<0.001	<0.001
DP05 (ES3)	1	5.8	0.09	28.6	22.3	<0.01	25.6	4	37.1	<0.001	<0.001
DP05 (ES4)	1.35	5.7	0.1	27.3	8.9	<0.01	21.5	4.8	32.9	<0.001	<0.001
DP06 (ES1)	0	4.2	0.08	31.8	76.2	<0.01	14.7	17.9	313.0	<0.001	0.002
DP06 (ES2)	0.5	5.7	0.10	31.7	70.6	0.02	16.3	25.6	249.0	<0.001	0.002
DP06 (ES3)	1	6.0	0.10	35.1	87.9	<0.01	15.4	27.0	283.0	<0.001	0.001
DP06 (ES4)	1.2	6.1	0.09	33.5	85.0	0.08	16.4	20.6	230.0	<0.001	0.002
DP07 (ES1)	0	7.1	0.10	31.1	14.7	0.03	25.4	8.4	49.6	<0.001	<0.001
DP07 (ES2)	1	6.0	0.09	20.9	11.1	<0.01	18.9	6.2	35.3	<0.001	<0.001
LS01 (ES1)	0	4.9	0.05	14.8	6.8	<0.01	12.5	6.4	27.7	<0.001	<0.001
LS01 (ES2)	0.5	5.1	0.08	17.8	6.4	<0.01	14.9	5.8	28.3	<0.001	<0.001
LS02 (ES1)	0	6.3	0.09	20.9	8.1	0.02	15.0	7.8	37.4	<0.001	<0.001
LS02 (ES2)	0.9	3.0	0.06	16.7	7.6	0.04	14.5	4.0	22.8	<0.001	<0.001
LS03 (ES1)	0	7.0	0.13	43.8	22.3	0.02	44.1	8.3	57.5	<0.001	<0.001
LS03 (ES2)	0.5	7.6	0.12	39.0	20.2	<0.01	36.4	7.9	51.1	<0.001	<0.001
LS04 (ES1)	0	11.0	0.13	53.9	26.8	<0.01	55.8	10.7	69.4	<0.001	<0.001
LS04 (ES2)	0.65	6.3	0.16	44.7	24.7	<0.01	46.0	9.1	67.4	<0.001	<0.001
LS05 (ES1)	0	7.0	0.05	12.1	5.5	0.03	11.9	10.6	23.8	<0.001	<0.001
LS05 (ES2)	0.5	2.0	0.10	20.3	10.1	<0.01	19.0	4.3	27.5	<0.001	<0.001
LS06 (ES1)	0	6.5	0.05	13.9	6.5	0.03	13.2	6.5	33.1	<0.001	<0.001
LS06 (ES2)	0.4	4.4	0.10	30.5	17.5	<0.01	27.9	8.9	48.9	<0.001	<0.001
LS07 (ES1)	0	13.3	0.09	19.7	12.2	<0.01	18.4	6.2	34.9	<0.001	<0.001
LS08 (ES1)	0	3.5	0.08	18.8	12.4	<0.01	16.2	4.5	25.4	<0.001	<0.001
LS08 (ES2)	0.9	2.2	0.06	16.0	7.2	<0.01	13.6	3.8	20.5	<0.001	<0.001
LS09 (ES1)	0	7.2	0.06	15.9	9.4	<0.01	14.0	5.3	32.4	<0.001	<0.001
LS09 (ES2)	0.5	7.4	0.06	10.9	6.1	<0.01	9.8	3.9	20.6	<0.001	<0.001

8.4.3.5 PAHs

Levels of all PAHs were found to be below AL1 for the vast majority of samples (**Table 8-10**). There is no AL2 for PAHs.

Table 8-10 PAH results (ug/kg) compared to Marine Directorate's ALs (AL1 exceedance in blue)

Sample ID	Sample depth (m)	Acenaphthene	Acenaphy	Acenaphthylene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo (ghi) perlyene	Benzo (k) fluoranthene	Chrysene	Dibenzo (ah) anthracene	Fluorantene	Fluorene	Indeno (1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
DP01 (ES1)	0.	5.54	<1	<1	<1	<1	1.36	1.99	<1	<1	<1	1.52	2.03	<1	3.76	3.42	1.81
DP01 (ES2)	0.7	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.67	1.97	<1
DP02 (ES1)	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.03	1.70	<1
DP03 (ES1)	0	<1	<1	1.41	6.28	9.83	9.04	8.18	8.11	8.64	1.31	12.7	<1	7.42	4.28	5.47	13.7
DP03 (ES2)	0.6	<1	<1	<1	<1	<1	<1	1.50	<1	<1	<1	<1	2.04	<1	2.82	2.95	<1
DP03 (ES3)	1.15	2.02	<1	<1	<1	<1	2.47	1.89	<1	2.25	<1	2.83	2.22	<1	4.43	5.89	3.42
DP04 (ES1)	0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	14.40	13.10	<5
DP04 (ES2)	0.8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.41	3.55	1.64
DP05 (ES1)	0	<1	<1	<1	1.48	1.90	2.65	3.82	1.96	3.74	<1	1.99	3.82	1.33	3.78	9.39	2.65
DP05 (ES2)	0.5	<1	<1	<1	1.50	1.95	2.98	3.21	1.30	3.22	<1	1.92	2.44	1.48	4.48	6.89	2.48
DP05 (ES3)	1.	<1	<1	<1	1.95	2.26	3.09	4.61	1.72	2.62	<1	2.62	1.60	1.57	4.71	6.58	3.28

Sample ID	Sample depth (m)	Acenaphthene	Acenaphy	Acenaphthylene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo (ghi) perlyene	Benzo (k) fluoranthene	Chrysene	Dibenzo (ah) anthracene	Fluorantene	Fluorene	Indeno (1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
DP05 (ES4)	1.35	<1	<1	<1	<1	<1	1.19	1.91	<1	1.50	<1	<1	1.49	<1	3.97	3.95	1.68
DP06 (ES1)	0	4.02	3.78	9.60	30.90	35.00	32.20	19.50	29.60	35.40	3.19	63.70	6.94	16.40	6.98	38.50	78.40
DP06 (ES2)	0.5	4.82	2.25	6.35	16.60	17.80	20.10	13.30	18.90	18.90	1.64	30.80	5.41	11.20	17.10	18.00	51.70
DP06 (ES3)	1	2.39	17.10	41.00	84.70	124.00	83.20	72.60	79.00	85.50	12.60	208.00	11.20	69.50	18.30	69.20	249.00
DP06 (ES4)	1.2	109.00	560.00	2,270.00	1,600.00	1,190.00	926.00	562.00	1,080.00	1,940.00	178.00	7,820.00	489.00	402.00	368.00	5,100.00	8,630.00
DP07 (ES1)	0	<1	<1	1.43	2.70	3.47	5.44	8.28	4.08	4.55	<1	3.88	2.98	3.29	5.93	9.43	5.91
DP07 (ES2)	1	<1	<1	<1	1.30	1.30	1.95	2.55	1.25	2.00	<1	1.77	1.68	1.04	4.02	4.85	2.04
LS01 (ES1)	0	4.25	1.47	1.35	3.79	4.77	6.98	4.92	5.47	4.61	<1	7.07	2.01	4.36	2.83	4.55	8.15
LS01 (ES2)	0.5	<1	1.48	1.99	4.57	5.87	8.73	9.80	3.85	6.92	<1	5.66	7.73	4.74	11.00	18.50	8.20
LS02 (ES1)	0	4.32	4.70	11.00	27.50	34.50	44.40	31.50	30.10	27.70	5.52	35.00	8.32	28.50	23.50	26.30	50.60
LS02 (ES2)	0.9	<1	<1	<1	<1	<1	<1	<1	<1	1.21	<1	<1	2.24	<1	4.73	4.58	<1
LS03 (ES1)	0	<1	<1	1.2	2.17	2.62	2.72	2.07	3.24	2.92	<1	3.52	1.70	1.64	5.91	4.84	6.55

Sample ID	Sample depth (m)	Acenaphthene	Acenaphy	Acenaphthylene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo (ghi) perlyene	Benzo (k) fluoranthene	Chrysene	Dibenzo (ah) anthracene	Fluorantene	Fluorene	Indeno (1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
LS03 (ES2)	0.5	<1	<1	<1	2.13	2.54	3.98	3.42	1.52	4.18	<1	3.27	2.69	1.44	5.39	10.10	5.47
LS04 (ES1)	0	<1	<1	<1	<1	<1	1.47	<1	1.89	2.14	<1	1.53	2.17	<1	7.83	5.97	2.58
LS04 (ES2)	0.65	<1	<1	<1	1.10	<1	1.47	1.00	<1	2.48	<1	1.39	3.41	<1	6.64	6.38	2.37
LS05 (ES1)	0	<1	<1	<1	1.60	1.56	2.26	1.33	1.85	2.85	<1	2.47	4.09	1.31	12.4	8.02	3.01
LS05 (ES2)	0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.25	<1	4.03	3.15	<1
LS06 (ES1)	0	4.50	1.04	1.30	2.30	3.16	4.16	3.50	3.99	2.96	<1	4.38	2.12	2.89	4.40	4.78	5.15
LS06 (ES2)	0.4	<1	<1	<1	1.71	1.40	2.82	3.03	1.90	3.17	<1	4.95	1.76	1.22	3.13	5.69	5.63
LS07 (ES1)	0	<1	2.08	3.52	8.55	11.40	15.40	16.9	18.10	11.20	2.16	14.50	4.27	13.70	8.33	12.50	17.20
LS08 (ES1)	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.69	1.39	<1
LS08 (ES2)	0.9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.05	<1	<1
LS09 (ES1)	0	<1	1.76	1.32	1.86	2.31	2.10	2.44	2.14	4.12	<1	4.84	5.69	1.86	14.20	11.60	4.81
LS09 (ES2)	0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.45	<1	5.67	5.35	<1

8.4.3.6 PCBs

Levels of the sum total of ICES 7 PCB congeners were found to be lower than AL1 in all samples but one (**Table 8-11**). There was no exceedance of AL2.

Table 8-11 ICES 7 PCB congeners results (ug/kg) compared to Marine Directorate's ALs (AL1 exceedance in blue)

Sample ID	Sample depth (m)	Sum of ICES 7 PCB congeners
DP01 (ES1)	0	<0.56
DP01 (ES2)	0.7	<0.56
DP02 (ES1)	0	<0.56
DP03 (ES1)	0	<0.56
DP03 (ES2)	0.6	<0.56
DP03 (ES3)	1.15	<0.56
DP04 (ES1)	0	<0.56
DP04 (ES2)	0.8	<0.56
DP05 (ES1)	0	3.22
DP05 (ES2)	0.5	<0.56
DP05 (ES3)	1	<0.56
DP05 (ES4)	1.35	<0.56
DP06 (ES1)	0	41.46
DP06 (ES2)	0.5	0.65
DP06 (ES3)	1	0.60
DP06 (ES4)	1.2	0.57
DP07 (ES1)	0	<0.56
DP07 (ES2)	1	<0.56
LS01 (ES1)	0	0.58
LS01 (ES2)	0.5	<0.56
LS02 (ES1)	0	0.78
LS02 (ES2)	0.9	<0.56
LS03 (ES1)	0	<0.56
LS03 (ES2)	0.5	0.58
LS04 (ES1)	0	<0.56
LS04 (ES2)	0.65	<0.56
LS05 (ES1)	0	<0.56
LS05 (ES2)	0.5	<0.56
LS06 (ES1)	0	<0.56

Sample ID	Sample depth (m)	Sum of ICES 7 PCB congeners
LS06 (ES2)	0.4	0.58
LS07 (ES1)	0	<0.56
LS08 (ES1)	0	<0.56
LS08 (ES2)	0.9	<0.56
LS09 (ES1)	0	<0.56
LS09 (ES2)	0.5	<0.56

8.4.3.7 Average for the Total Dredge Area

Table 8-12 Average concentrations across total dredge area

Parameter	Unit	Average
Total Solids	%	79.80
Gravel (>2mm)	%	26.37
Sand (63-2000 µm)	%	42.96
Silt (<63 µm)	%	30.67
Arsenic	mg/kg	5.10
Cadmium	mg/kg	0.07
Chromium	mg/kg	20.7
Copper	mg/kg	15.6
Mercury	mg/kg	0.01
Nickel	mg/kg	16.9
Lead	mg/kg	6.50
Zinc	mg/kg	51.5
DBT	mg/kg	<0.001
TBT	mg/kg	0.001
Acenaphthene	ug/kg	4.51
Acenaphthylene	ug/kg	14.60
Anthracene	ug/kg	55.10
Benzo(a)anthracene	ug/kg	42.70
Benzo(a)pyrene	ug/kg	35.00
Benzo(b)fluoranthene	ug/kg	28.60
Benzo(ghi)perylene	ug/kg	19.20

Parameter	Unit	Average
Benzo(k)fluoranthene	ug/kg	28.60
Chrysene	ug/kg	51.30
Dibenzo(ah)anthracene	ug/kg	5.70
Fluoranthene	ug/kg	191.00
Fluorene	ug/kg	14.10
Indeno(1,2,3-c,d)pyrene	ug/kg	14.50
Naphthalene	ug/kg	14.40
Phenanthrene	ug/kg	126.00
Pyrene	ug/kg	213.00
THC	ug/kg	13,720
Sum of ICES 7 PCB congeners	ug/kg	1.49

Given there is no AL2 for individual PAHs, an indication of potential toxicity of the levels recorded can be provided by applying the Canadian Interim Sediment Quality Guidelines (ISQG). The ISQGs were developed by the Canadian Council of Ministers of the Environment for evaluating the potential for adverse biological effects in aquatic systems (CCME, 1999). They have been derived from available toxicological information, reflecting the relationships between sediment concentrations of chemicals and any adverse biological effects resulting from exposure to these chemicals. They are not statutory standards; however, in the absence of suitable alternatives, these guidelines can provide an indication of whether there is likely to be a toxicological effect.

ISQGs comprise two assessment levels. The lower level is referred to as the Threshold Effects Level (TEL) and represents a concentration below which adverse biological effects are expected to occur only rarely (for example in some sensitive species). The higher level, the Probable Effect Level (PEL), defines a concentration above which adverse effects may be expected in a wider range of organisms. The three ranges of chemical concentrations (<TEL, between TEL and PEL, and >PEL) indicate those concentrations that are rarely, occasionally and frequently associated with adverse biological effects, respectively. **Table 8-13** presents the 2025 sediment data, comparing these to the Canadian ISQGs, showing that some of the PAHs are exceeding TEL but are well below the PEL.

Table 8-13 Sediment sampling data and comparison to the Canadian ISQGs (ug/kg) (TEL exceedance in blue)

Substance	ISQG / TEL	PEL	Incidence (%ISQG)	Incidence (ISQG<%<PEL)	Incidence (%PEL)	Sediment Sampling Average Value
Acenaphthene	6.71	88.9	8	29	57	4.51
Acenaphthylene	5.87	128.0	7	14	51	14.6
Anthracene	46.90	245.0	9	20	75	55.1
Benzo(a)anthracene	74.80	693.0	9	16	78	42.7
Benzo(a)pyrene	88.80	763.0	8	22	71	35.0

Substance	ISQG / TEL	PEL	Incidence (%ISQG)	Incidence (ISQG<%<PEL)	Incidence (%PEL)	Sediment Sampling Average Value
Chrysene	108.00	846.0	9	19	72	51.3
Dibenzo(ah)anthracene	6.22	135.0	16	12	65	5.7
Fluoranthene	113.00	1,494.0	10	20	80	191.0
Fluorene	21.20	144.0	12	20	70	14.1
Naphthalene	34.60	391.0	3	19	71	14.4
Phenanthrene	86.70	544.0	8	23	78	126.0
Pyrene	153.00	1,398.0	7	19	83	213.0

8.5 Prediction of Potential 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.

8.5.1 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.

Sediment samples indicate that, when averaged, the sediment to be dredged does not contain significantly elevated concentrations of contaminants. There are a number of PAHs which, when averaged, still exceed AL1 (**Appendix 8-2**); however, these have been shown to not pose a risk of harm to the marine environment and are within levels that have been disposed of at Middle Deep in the past (as shown by **Table 8-6**). As such, the material is considered suitable for offshore disposal with regards to its contaminant content.

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 predicted that the sediment plume would remain localised to the dredging locations and the disposal site and peaks in SSC would only be short-term returning to baseline within 1.5 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. 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 considered to be high given the open nature of the water, the presence of nature conservation designations, and the presence of two bathing water designations. Given the reversibility of the impact, the magnitude of impact is assessed to be negligible; therefore, the potential effect is of **minor adverse,** which is **not significant in EIA terms**.

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is minor adverse significance, which is not significant in EIA terms.

8.6 Prediction of Potential Effects During the Operation Phase

There is no change in maintenance dredging requirement as a result of the Proposed Scheme, therefore no impacts to marine water and sediment quality would occur during the operational phase.

8.7 Summary

Table 8-14 summarises the significance of the potential effects to marine water and sediment quality assessed in this chapter. Negligible and minor adverse effects are not significant in EIA terms.

Table 8-14 Summary of potential impacts to marine water and sediment quality as a result of the Proposed Scheme

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

9 Marine and Coastal Ecology

9.1 Introduction

This chapter considers the potential impacts of the Proposed Scheme on marine and coastal 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 effects are presented together with the likely residual impacts after these measures have been adopted. Fish and shellfish ecology is assessed in **Chapter 10**, ornithology in **Chapter 11** and marine mammals in **Chapter 12**. Whilst features of European and Ramsar sites are assessed in this chapter, the assessment on these sites is presented in the accompanying shadow HRA.

This chapter is informed by the following chapters and appendices:

- **Chapter 7**: Estuarine Processes
- **Chapter 8**: Marine Water and Sediment Quality
- **Appendix 9-1**: Benthic Ecology Survey
- **Appendix 9-2**: Otter survey target notes

9.2 Legislation, Policy and Guidance

9.2.1 Legislation

The following legislation is relevant to marine and coastal ecology:

- Conservation (Natural Habitats, &c.) Regulations 1994, as amended ('the Habitats Regulations');
- Nature Conservation (Scotland) Act 2004 (as amended); and
- Wildlife and Countryside Act 1981 (as amended) (includes amendments made via the Wildlife and Natural Environment (Scotland) Act 2011).

9.2.2 Policy

9.2.2.1 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 and coastal ecology in the context of 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)".

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 SACs (and SPA, Ramsar Sites and Sites of Special Scientific Interest (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 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.

9.2.3 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 1/2013: Environmental Impact Assessment (Scottish Government, 2013).
- Scottish Biodiversity List (Biodiversity Scotland, undated).
- Planning Advice Note (PAN) 60 (Planning for Natural Heritage) (Scottish Government, 2000).
- Scottish Natura Heritage website: guidance on protected species (https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-species) (SNH, 2019).
- GB Non-native Species Secretariat (2015) Species Information.
- CIEEM (2013). Competencies for Species Survey: Eurasian Otter.
- Chanin P (2003) Monitoring the otter (*Lutra lutra*). Conserving Natura 2000 Rivers, Ecology Series No. 10. English.
- Standing advice for planning consultations - Otters | NatureScot.

9.3 Consultation

Advice received during the EIA Screening process (**Section 5.3**) and from consultation with NatureScot (**Chapter 6**) have been taken into account in undertaking the assessment presented in this chapter.

9.4 Assessment Methodology

9.4.1 Study Area

The study area for marine and coastal ecology comprises the predicted maximum extent over which potentially significant environmental impacts of the Proposed Scheme may occur. This includes the footprint of the Proposed Scheme, the disposal site, and the extent of the sediment plume as modelled by sediment dispersion modelling (see **Chapter 7**).

9.4.2 Data Sources

The assessment of marine ecology has been informed through a desk-based review of available information, including:

- A site-specific benthic ecology survey undertaken between 4th and 7th November 2024 during which Drop Down Video (DDV) was used for feature identification and benthic grabs for faunal analysis (**Appendix 9-1**).
- Acoustic data collected in April/May 2025 used to create benthic habitat maps.
- An otter survey was undertaken between 31st March and 5th May 2025 (Target notes presented in **Appendix 9-2**).
- EUSeaMap. 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).
- Scottish Government National Marine Plan interactive (NMPi) map.
- Marine Life Information Network (MarLIN).

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 construction phase of the Proposed Scheme.

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 9-1** 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, the 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 9-1 Definitions of Sensitivity Levels for Marine and Coastal 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 9-2**.

Table 9-2 Definitions of nature conservation Value for Marine and Coastal Ecology 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).
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 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

Definitions of the magnitude levels are given in **Table 9-3**.

Table 9-3 Definitions of Magnitude levels for Marine and Coastal Ecology

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.
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.
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 particular receptors character or distinctiveness.
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 Marine benthic ecology

9.5.1.1 Benthic habitats

The EUSeaMap broadscale habitat mapping shows a mosaic of coarse sediment and sand habitats within the Tay Estuary. Large areas of blue mussel beds are shown, primarily in the outer estuary, with small areas of mixed sediment and mud habitats on the northern shore between Dundee and Broughty Ferry.

EUSeaMap mapping from within the Port of Dundee dredge area predicts the area to be predominantly A5.14 'Circalittoral coarse sediment' and MC42 'Atlantic circalittoral mixed sediments' with a small area of MC2235 '*Mytilus edulis* beds on Atlantic sublittoral sediment' in the north west corner. EUSeaMap mapping from within the Lady Shoal dredge area predicts the area to be MC32 'Atlantic circalittoral coarse sediment', MC223 'Bivalve reefs in the Atlantic circalittoral zone, MC2235 '*Mytilus edulis* beds on Atlantic sublittoral sediment' (**Figure 9-1**).

Bates *et al.* (2004) summarised the Tay (and Eden) Estuary as: "*characterised by powerful tidal currents and a high suspended sediment load. It is overwhelmingly dominated by sediment biotopes. The subtidal sediments of the main river channels tend to be mobile with a relatively impoverished fauna. In the middle and outer Tay there are areas of dense mussel bed. In parts of the outer Tay there is an unusually abundant sponge fauna. Intertidal areas within the estuaries tend to be muddy and are commonly dominated by typical estuarine species such as the ragworm* Hediste diversicolor*. The sediments of more exposed shores in the outer part of the site tend to be cleaner, better drained and are commonly dominated by amphipods. Many shores in the outer Tay and in the Eden are composed of mosaics of lugworm dominated muddy sediments, beds of mussels and fucoid algae and transient mats of the green algae* Enteromorpha sp*. These shores also support sparse beds of the eelgrass* Zostera noltii*.*"

A benthic ecology survey, comprising DDV and benthic grabs, was undertaken in November 2024 by Ocean Ecology. (**Appendix 9-1**). Analysis of the DDV imagery from 17 transects across the survey area identified three Level 4 habitats complexes: EUNIS MC124 'Faunal communities on variable salinity Atlantic circalittoral rock', EUNIS MC32 'Atlantic circalittoral coarse sediment', EUNIS MC42 'Atlantic circalittoral mixed sediment' and three Level 5 biotopes: EUNIS MC1241 'Cushion sponges and hydroids on turbid tide-swept sheltered Atlantic circalittoral rock, EUNIS MC3211 '*Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles' and EUNIS MC2235 'Mytilus edulis

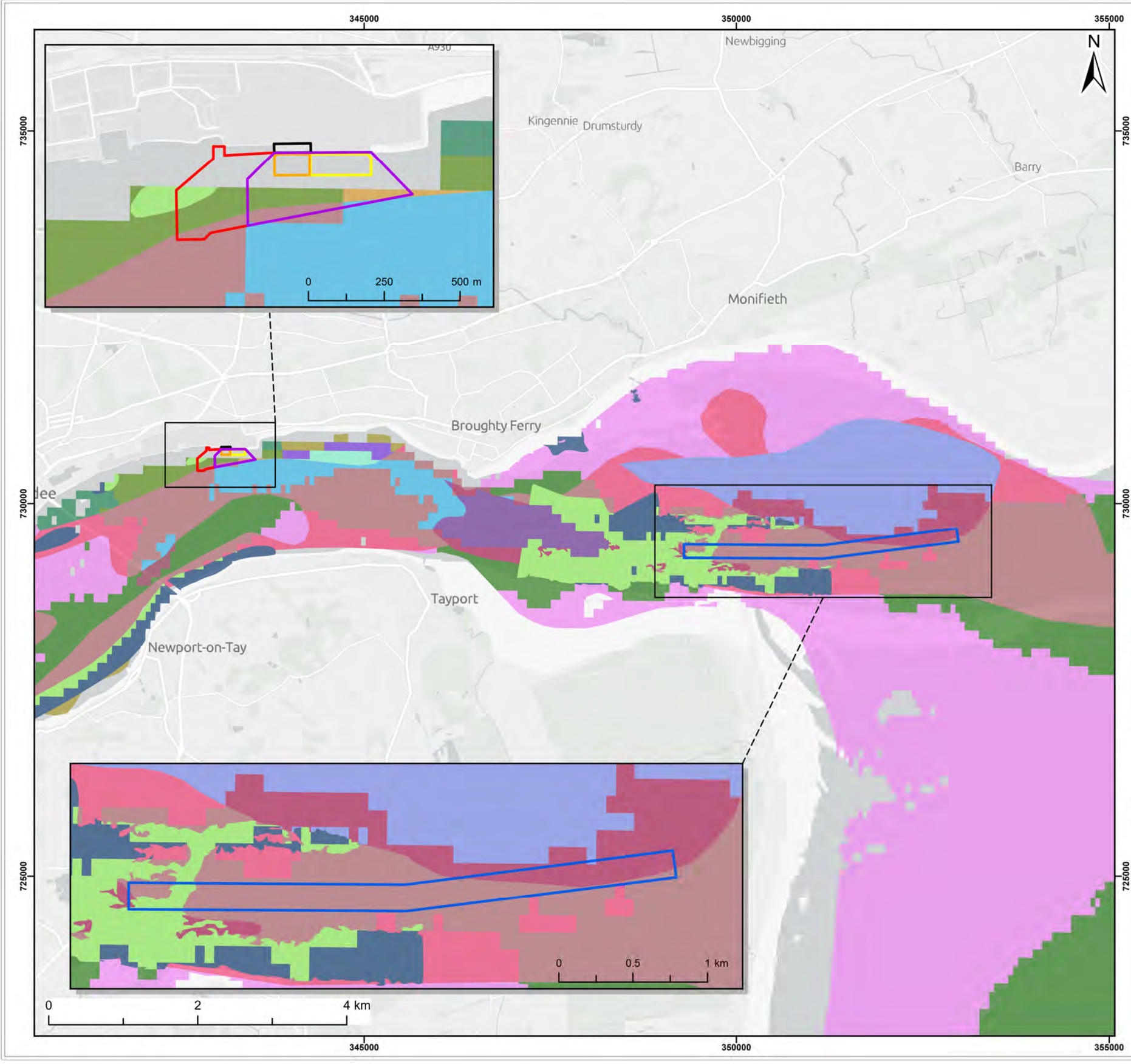
beds on Atlantic circalittoral sediment'. The most commonly occurring epifauna observed in the seabed imagery across the survey area was the sea star *Asterias rubens*, identified in 194 of the 457 images with a maximum count of 63 individuals observed along TR015. This was followed by the blue mussel, identified in 161 images with a maximum count of 126 individuals observed along transect TR015, and the true crab *Carcinus maenas*, identified in 87 images with a maximum count of three individuals observed along transects TR015 and TR005. The maximum diversity recorded by the DDV survey was along T004, outside of the dredge footprint, where 12 taxa were identified.

DDV imagery was used to classify several areas as the Annex I habitat 'stony reef'; however, these were borderline classifications based on sparse cobbles and boulders, with some of the coarse sediments interspersed with rocky substrates forming mosaic habitats. The classifications therefore are of low confidence and the habitat is considered only in the context of the EUNIS classifications.

Faunal analysis of the grab samples collected from 15 stations across the survey area reported a mean of 52 taxa per sample and a mean abundance of 1,848 per sample. The univariate diversity indices for the samples are presented in **Table 9-4**. The highest number of taxa and abundance were recorded at stations ST004 and ST007, at the western end of the Lady Shoal approach channel dredge area. Based on the various diversity indices, samples ST012 and ST017 on the southern edge of the Lady Shoal approach channel dredge area show the lowest diversity and have a small number of dominant species with lower abundance of other species.

Table 9-4 Univariate analyses of benthic grab samples

Station	No. taxa	Abundance	Margalef's species richness (d)	Pileou's Evenness (J')	Shannon Wiener Diversity (H'(loge))	Simpson's Diversity (1-λ)	In / out of dredge area
ST001	25	655	3.393	0.684	2.144	0.845	In
ST002	28	474	3.895	0.743	2.391	0.860	In
ST003	40	877	4.722	0.651	2.275	0.849	In
ST004	79	3,411	7.745	0.513	2.135	0.787	Out
ST005	54	2,274	5.693	0.448	1.704	0.672	In
ST006	60	541	8.104	0.623	2.460	0.798	Out
ST007	78	6,151	7.221	0.424	1.762	0.696	In
ST010	67	3,152	6.827	0.445	1.790	0.608	Out
ST011	70	2,400	7.195	0.462	1.868	0.720	In
ST012	52	3,154	5.710	0.288	1.107	0.361	In
ST013	38	360	5.946	0.656	2.350	0.797	In
ST014	59	1,781	7.081	0.533	2.127	0.791	Out
ST015	35	575	4.721	0.525	1.802	0.673	Out
ST016	65	1,083	7.728	0.518	2.077	0.754	In
ST017	28	827	4.019	0.299	0.995	0.355	Out



Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Remedial Quay Works
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area

EUSeaMap (2023) Habitat Types (EUNIS, 2019)

- MB222
- MB2223
- MB32
- MB42
- MB52
- MB62
- MC223
- MC2235
- MC32
- MC42
- MC52
- MC62
- MD22
- MD32
- MD42
- MD52
- MD62

Client: Port of Dundee Limited

Project: Port of Dundee Capital Dredge and Quay Improvement Works

Title: Distribution of broadscale habitats in Firth of Tay (EUSeaMap, 2023)

Figure: 9-1

Drawing No: PC6550-RHD-XX-XX-D-EV-0056

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	03/07/2025	JH	RG	A3	1:50,000

Co-ordinate system: British National Grid

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Nematodes were the most abundant taxa accounting for 46% of all individuals recorded. This taxon accounted for the maximum abundance and average density per sample. Nematodes were also one of the most frequently occurring taxa across the survey area along with the polychaete *Pholoe inornata*, Nemertea, and the barnacle *Balanus crenatus*, occurring in 100% of the samples. *M. edulis* was recorded in 86.7% of samples, accounting for 2.8% of total abundance; however, abundance was much greater in one sample, ST014 (abundance 535) north-east of the Lady Shoal approach channel dredge area, compared to all other samples (abundance 0 – 43). Juvenile mussels were recorded in all grab samples; however, as they are subject to high post settlement mortality and would skew the data in favour of an ephemeral component of the community, these were removed from the dataset prior to analyses, in accordance with OSPAR (2004) guidance.

Multivariate analysis of the grab sample data identified four statistically significant groups, with three outlier stations (**Figure 9-2**). The three stations within the Port of Dundee dredge area belonged to one group. These stations were characterised by the presence of the oligochaete species *Tubificoides benedii* and *T. insularis*, Nematodes, the polychaete *Mediomastus fragilis*, the amphipod species *Melita palmata* and *Gammarus salinus*, and the barnacle *B. crenatus*.

Five stations in the western half of the Lady Shoal dredge area belonged to a second group, characterised by the presence of Nematodes, several barnacle species (*B. crenatus, Verruca stroemia*, and *Austrominius modestus*), the sea snails *Onoba semicostata* and *O. aculeus*, numerous polychaete species (*Spirobranchus lamarcki*, *P. inornata*, *Eulalia ornata*, *Dipolydora coeca* and *Myrianida* spp.), *M. edulis*, the oligochaete *T. benedii*, and Nemerteans. The eastern half of the Lady Shoal dredge area contained two groups each with two stations. One group charaterised by the presence of Nematodes, numerous polychaete species (*S. lamarcki, Psamathe fusca, D. coeca, M. fragilis and Capitella* spp.), the amphipod *M. palmata*, the oligochaete *T. benedii*, and the barnacle *B. crenatus.* The other charaterised by Nematodes, the sea snails *O. semicostata* and *O. aculeus*, numerous polychaete species (*S. lamarcki, P. fusca, P. inornata, Eteone longa, Scoloplos armiger, Cirriformia tentaculata and M. fragilis*), the barnacle *B. crenatus*, the gastropod *Steromphala cineraria*, the oligochaete *T. benedii*, the brittlestar *Amphipholis squamata*, and Nemerteans.

Two invasive non-native species (INNS) were identified from the grab samples. The Darwin's barnacle *Austrominius modestus* was found in 9 of the 15 grab stations across both the Port of Dundee and the Lady Shoal approach channel dredge areas, with a total of 145 individuals counted and a maximum abundance of 58 individuals at station ST005. The other INNS was the sand-gaper *Mya arenaria* which was only found at station ST014, outside the dredge areas, with a total of four individuals. Both species are widespread throughout the UK marine environment and have been present in the Tay Estuary for several decades (Tyler-Walters, 2003; Avant, 2007; JNCC, 2025).

Acoustic data, gathered in April / May 2025, has been used in conjunction with the survey data to produce benthic habitat maps (**Figure 9-3** and **Figure 9-4**). These maps were developed by Envision Ltd. using habitat modelling software, which used the benthic sample data as 'training sites' to model the distribution of biological habitat classes identified. These training sites were then superimposed on the layers of acoustic data to identify corresponding statistical signatures in the acoustic data, and thus develop a habitat map of the dredge area. The habitat maps broadly align with the EUSeaMap data.

There are areas of seabed within the dredge areas that are already below the required dredged depth. As such, these areas would not be dredged and the habitats present would remain. The actual area of dredging (the dredge footprint) can be seen on **Figure 9-3** and **Figure 9-4**, and which has been used to calculate the area of habitats that would be lost as a result of the proposed dredging, as presented in **Table 9-5**.

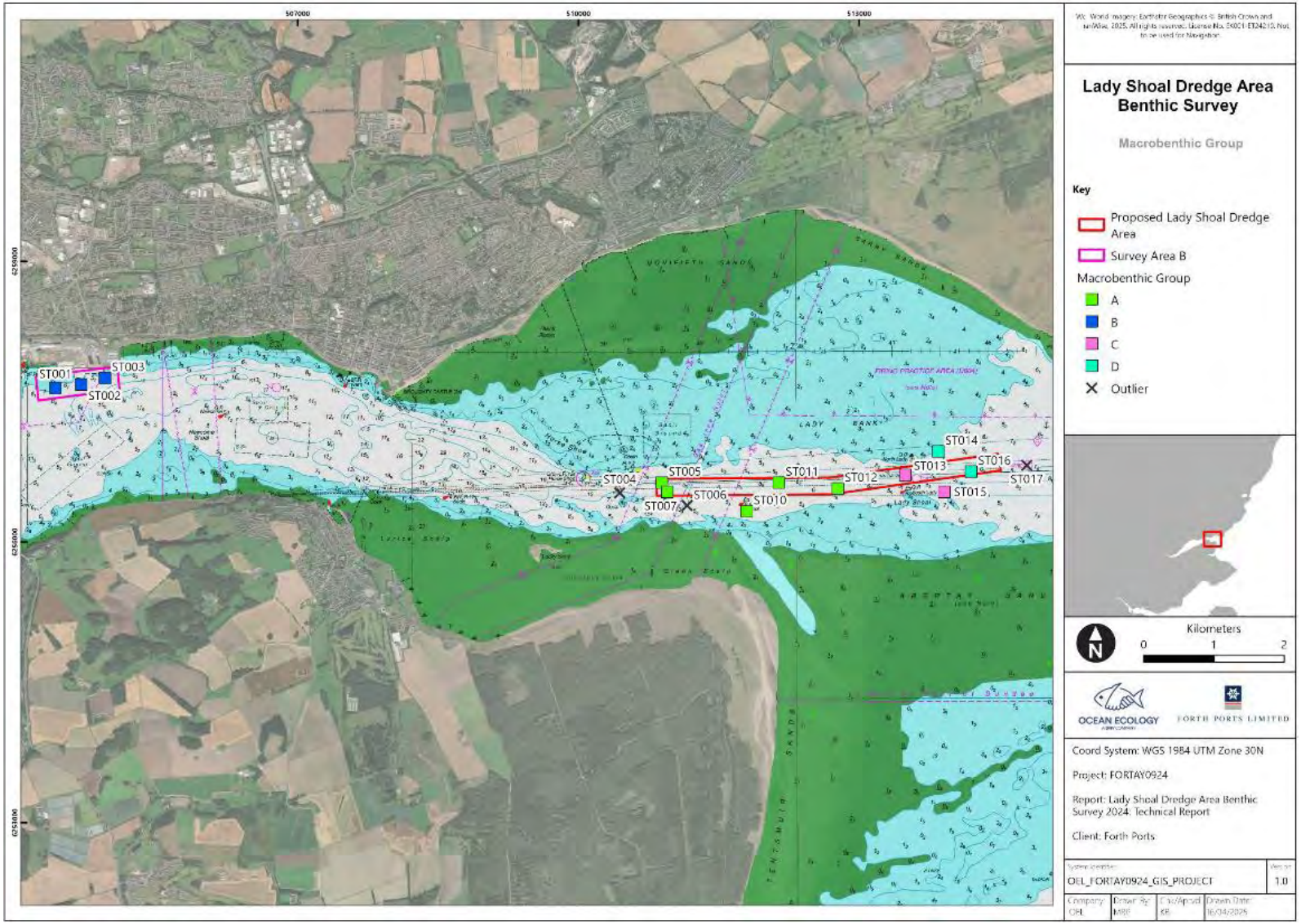
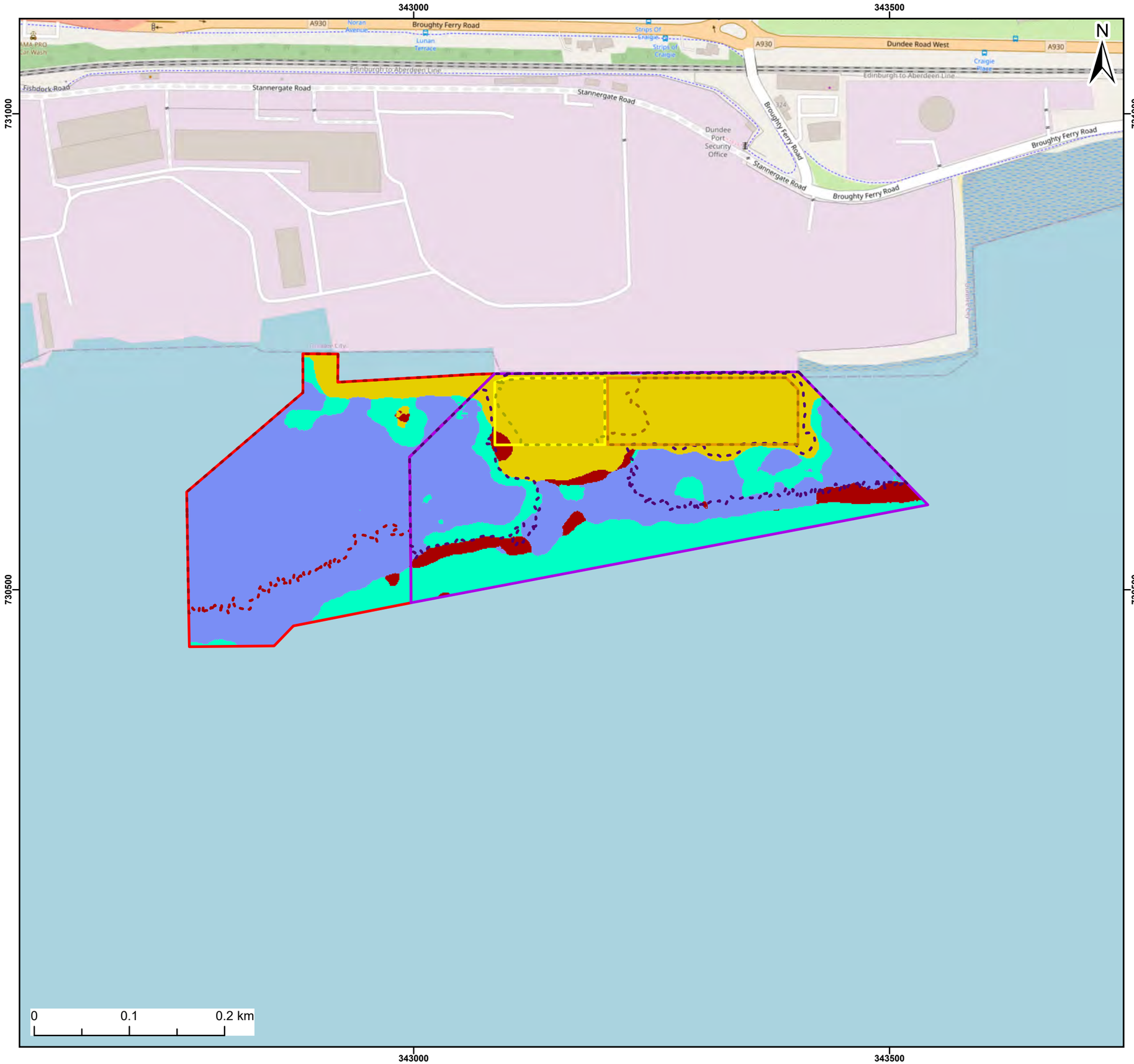


Figure 9-2 Macrobenthic groups identified by multivariate analysis of grab sample



Legend:

Proposed Extension to PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Existing PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Prince Charles Wharf Approach Channel
- Dredge Area
- Dredge Footprint

DunEco Quay Approach Channel
- Dredge Area
- Dredge Footprint

Eunis Habitat (2022)
- MB5/MC5 - (Infralittoral/Circalittoral sand (Dredged Area)
- MC2235 - Mytilus edulis beds on Atlantic circalittoral sediment
- MC32 - Atlantic circalittoral coarse sediment
- MC42 - Atlantic circalittoral mixed sediment

Client:	Project:
Port of Dundee Limited	Port of Dundee Laydown Area and Quay Improvement Works

Title: Benthic survey habitat map of Port of Dundee

Figure:	Drawing No:
9-3	PC6550-RHD-XX-XX-D-EV-0071

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	18/08/2025	JH	RF	A3	1:4,000

Co-ordinate system: British National Grid

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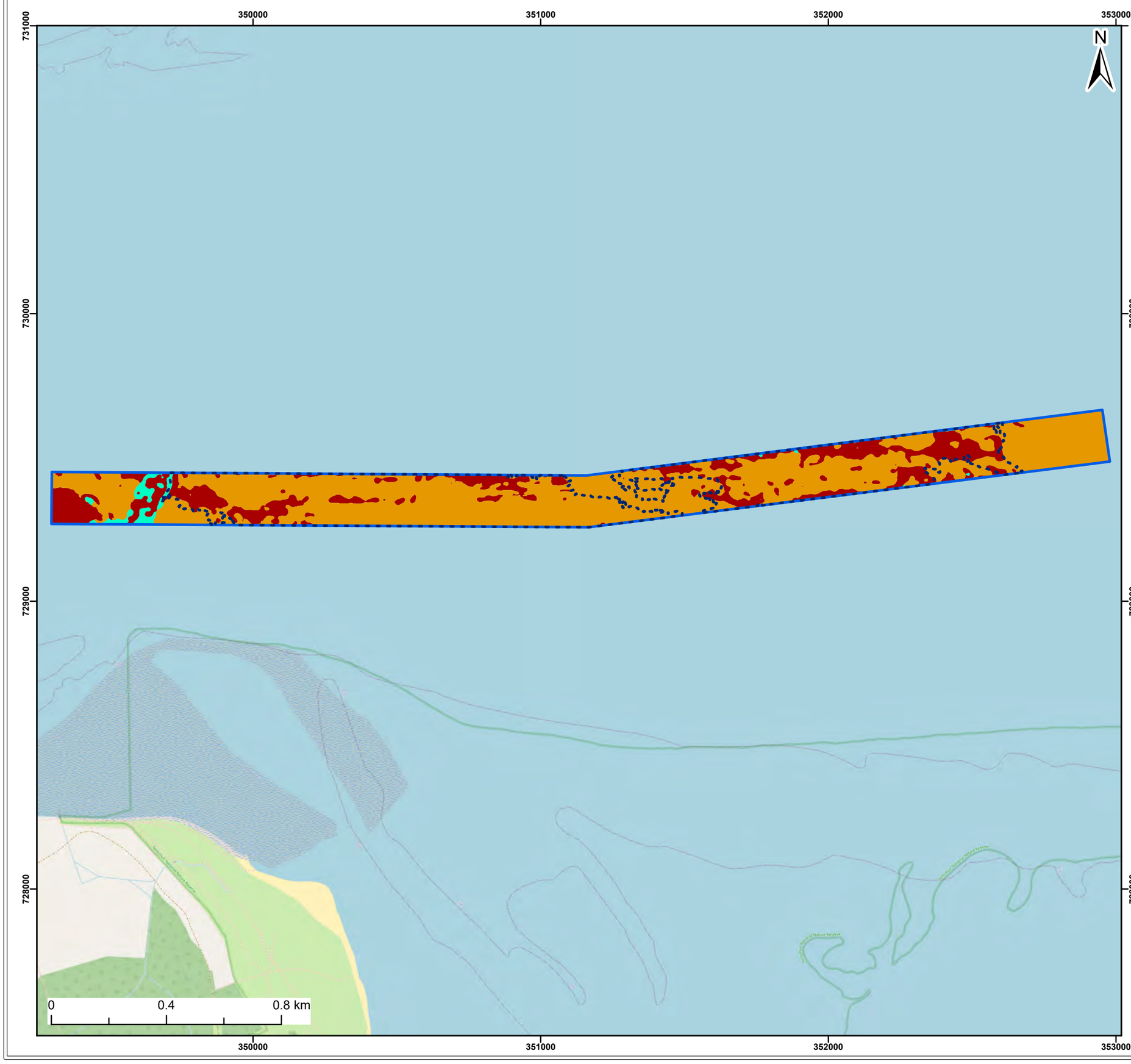

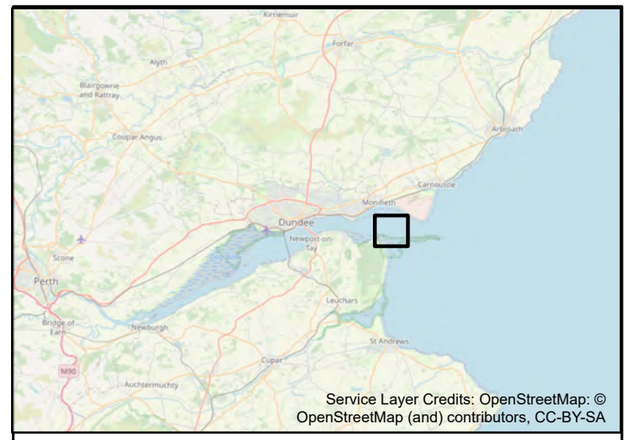

Legend:

Lady Shoal Approach Channel

- Dredge Area
- Dredge Footprint

Eunis Habitat (2022)

- MC2235 - Mytilus edulis beds on Atlantic circalittoral sediment
- MC32 - Atlantic circalittoral coarse sediment
- MC3211 - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles

Client:	Project:
Port of Dundee Limited	Port of Dundee Laydown Area and Quay Improvement Works

Title:

Benthic survey habitat map of Lady Shoal Approach Channel

Figure:	Drawing No:
9-4	PC6550-RHD-XX-XX-D-EV-0072

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	18/08/2025	JH	RF	A3	1:13,000

Co-ordinate system: British National Grid

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57,712m^2 of Atlantic circalittoral coarse and mixed sediment habitats are present within the Port of Dundee dredge footprint, with 25,724m^2 of sand habitat predicted closer to the port. Small areas of blue mussel bed are predicted throughout the dredge footprint (totalling 10,681m^2).

Habitats throughout the Lady Shoal approach channel dredge footprint are predominantly *Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobles and pebbles sediment (332,617m^2) and Atlantic circalittoral coarse sediment (123,714m^2). Small areas of blue mussel beds (totalling 1,361m^2) are located within the eastern extent of the dredge footprint.

Table 9-5 Areas of habitat identified within the Port of Dundee and Lady Shoal Approach Channel dredge footprints

Habitat	Total Area of Habitat within Dredge Footprint (m^2)
Port of Dundee	
MB5/MC5 – Infralittoral / Circalittoral sand	25,754
MC2235 – Mytilus edulis beds on Atlantic circalittoral sediment	10,681
MC32 – Atlantic circalittoral coarse sediment.	439
MC42 – Atlantic circalittoral mixed sediment	57,273
Lady Shoal Approach Channel	
MC2235 – *Mytilus edulis* beds on Atlantic circalittoral sediment	1,361
MC32 – Atlantic circalittoral coarse sediment.	123,714
MC3211 – *Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobles and pebbles.	332,617

9.5.1.2 Priority Marine Features

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. Distribution of intertidal / subtidal PMFs in Scottish waters is presented through Marine Scotland's National Marine Planning Interactive (NMPi) tool. Data available on the NMPi indicates that the PMFs present in the Tay Estuary are intertidal mudflats, primarily upstream of the Tay Bridge, blue mussel beds and seagrass beds, both primarily downstream of Broughty Ferry and Tayport.

Results of the benthic survey identified blue mussel beds in three of the DDV transects, two within the Port of Dundee dredge area and one to the south east of Lady Shoal approach channel, outside the dredge area. The survey confirmed that only sample TR015, located outside of the dredge area, was considered to represent a PMF (**Appendix 7-1**). No other PMFs were identified within the survey area.

9.5.2 Otters

Otter are fully protected from deliberate or reckless injury or disturbance under the Habitats Regulations. The species is also listed as a Priority Species under the Biodiversity Action Plan for Dundee 2020-2030,and is feature of the River Tay SAC. An otter survey was undertaken at the Port of Dundee on 31st March 2025. During the survey, four potential otter resting sites (RS 1-4) were identified (**Figure 9-5**). To determine the activity status of these sites, camera monitoring was subsequently carried out between 7th April and 5th May 2025.

9.5.2.1 Field Survey

All areas of suitable otter habitat within the 200m Study Area were surveyed (**Figure 9-5**). A comprehensive search for characteristic signs of the presence of otters (including resting sites, spraint, footprints and slides) was made. Resting sites were categorised as either 'holts' or 'couches'. The term holt is applied to an otter resting site which is located within an enclosed cavity, where the back of the structure cannot be seen and the presence of an animal at the time of the survey cannot be ruled out. Couches are features that can be viewed fully, are usually above ground features where otters can lie up or groom, often within long grass, reeds etc.; however, for the purposes of this report, couch has also been used for above ground resting sites within rock armour for example.

Where a potential resting site was found, presence of supporting field sign had to be present in association with the feature in order to suggest it was being used by otters for shelter. This was particularly pertinent for this site due to the main resting site habitat being long sections of rubble piles and rock armour creating a labyrinth of holes and crevices that may harbour resting sites. In order to narrow this down, professional judgement was used where spraint was present in the locality of suitable entrances together with pathways to them, although the latter was often absent due to the nature of the habitat. Therefore, all resting sites have been labelled 'potential' and camera monitoring of the features has been completed to confirm resting sites' status.

9.5.2.2 Camera Monitoring

Camera monitoring was undertaken at four potential resting sites (RS1 – RS4) identified during the initial survey for a period of 28 days which was considered a sufficient time period in order to confirm the activity status. The cameras were installed on the 7th April and uplifted on the 5th May with an interim visit on the 18 April to check the cameras, change SD cards and batteries.

The results confirmed RS3 as a non-breeding holt, with a single otter observed resting diurnally at the location. Several additional single otter passes were also documented throughout the monitoring timeframe.

9.5.2.3 Results

Habitats

The initial field survey was undertaken on 31st March 2025 during warm, sunny weather conditions and with no rainfall in the days leading up to the survey.

Areas of suitable resting site habitat within the Study Area comprised the shoreline of the River Tay alongside the port where the banks consisted of rubble piles / rock armour above the high tide line, particularly where set into neighbouring earth banks and scrub. This was mainly along the bank of the River Tay adjacent to the western development area and the bank in the eastern region of the Study Area. The River Tay itself offers a good foraging and commuting resource.

342500 343000 343500

N

RS3

RS4

0 0.25 0.5 km

Legend:

- Potential Holt
- Couch / Potential Holt
- Proposed Scheme Area
- 200m Study area
- No access

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Otter Study Area and Results

Figure: 9-4 | DrawingNo: PC6550-RHD-XX-XX-D-EV-0051

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	05/06/2025	JH	RG	A3	1:5,000

Co-ordinate system: British National Grid

Haskoning
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The remaining areas along the shoreline within the Study Area were considered unsuitable for otters, being quayside or dock areas built from vertical sections of sheet piling or concrete, straight into the water, with no ledges or features suitable for use as resting sites. Some areas of the sheet piling had degraded with holes and cavities but were wet and silty and flooded at high tide. In addition, such areas were busy with port activities such as boat traffic creating disturbance and the water quality appeared to be poor and turbid.

No suitable otter habitat was considered to be present outwith the shoreline within the Study Area with most areas being hardstanding, some brownfield areas with demolished buildings, storage areas and the operational port. The A930 main road and railway passes through the northern section of the Study Area.

No further watercourses or waterbodies were noted within the Study Area or surrounding areas. The nearest marked watercourse on the OS map for the area was the Dighty Burn at Broughty Ferry, a tributary of the River Tay approximately 8km to the east of the Site. A burn and small waterbody west of the airfield was noted on the OS map around 8km to the west of the site along the coast. All areas to the north were Dundee City and heavily built up.

Freshwater is essential to coastal otters to wash fur free of salt to maintain insulation so the lack of freshwater waterbodies in the vicinity of the Study Area may lessen the suitability of the resting sites to be used for breeding females and may be more suitable for otters sheltering whilst foraging in the area. However, otters are known to travel long distances, with females ranging to around 20km and males much larger distances, so the watercourses described above are within this range (Harris & Yalden, 2008). The disturbed location of the site does suggest less of likelihood for breeding with breeding females favouring undisturbed areas (Liles, G., 2003).

Resting sites

Otter survey Target Notes are provided in **Appendix 9-2**. One potential couch/holt and three potential holts were found as a result of the survey. RS1 – RS3 were potential holts located within rubble piles embedded into earth banks and scrub adjacent to the western development area. All had spraint associated with possible entrances into the bank behind. The remaining resting site was a possible couch (RS4) found within the top of the rock armour in the eastern region of the Study Area where a pile of recent and old spraint was found on top of a large flat boulder. The spraint pile may also be a marker for a holt that may lie within the network rocks that lies beneath and cannot be fully viewed.

Camera monitoring

Of the four resting sites subject to camera monitoring, RS3 was confirmed as a non-breeding holt and RS4 a non-breeding couch / potential holt. RS1 was confirmed as not being currently used as a resting site as only two otter passes were recorded over the monitoring period and no entries/exits from the feature observed. RS2 was not a resting site and being used by common rat (*Rattus norvegicus*).

The footage of RS3 showed a single otter emerging from one of the previously identified entrances in the rubble pile at dusk on 27th April at 20:44 and with dry fur, confirming diurnal resting at the feature. Further footage showed a possible entry from a single adult otter into a previously unidentified entrance in the feature at dawn on 26th April at 05:19, but only a tail can be seen as it is obscured by the rubble. If this was an entry, it is likely connected under the rubble pile to the aforementioned entrance. Timings of both pieces of footage further support diurnal resting at RS3. Nine further otter passes were noted over the 28 days with single otters visiting the area through the night to spraint and scent mark. The infrequent use of the feature with one, potentially two, entries into RS3 over the 28 day monitoring period by single otters, with no cubs observed, confirms the resting site to be non-breeding.

RS4 footage showed one entry by a single otter into the rock armour above the couch on 18th April at 21:38. Ten further otter passes were noted over the 28 days with single otters mainly commuting along the shoreline overnight, sprainting and scent marking on occasion. As for RS3 above, due to the infrequency of use of the resting site, RS4 can also be confirmed as a nonbreeding resting site. Due to the complexity of the rock armour around the couch, to which the extents cannot be fully seen, the feature may also be a holt. Other mammal species noted on the footage were common rat, rabbit (*Oryctolagus cuniculus*), fox (*Vulpes vulpes*), wood mouse (*Apodemus sylvaticus*), grey squirrel (*Sciurus carolinensis*), domestic cats (*Felis catus*) and a beaver (*Castor fiber*) was noted on one occasion passing by RS4.

9.6 Potential Impacts on Benthic Habitats

9.6.1 Direct loss of benthic habitat as a result of the proposed dredging

The footprint of the proposed capital dredge activities would result in the loss of benthic communities. As stated in **Section 3.2** there would be no change in maintenance dredging required at the Port of Dundee dredge area, nor a requirement for maintenance dredging at the Lady Shoal approach channel.

The dominant habitat types identified within the dredge areas are widespread throughout the estuary. The species of the communities found in the dredge areas are mainly species that are opportunistic settlers, capable of relatively rapid recolonisation provided that suitable substrate is available. PSA demonstrates that sediments throughout the dredge areas remain mixed with increasing depth (**Section 8.4.3.3**); therefore, following completion of the dredge activity, sediment suitable for recolonisation will be available, and as the habitats are widespread, source populations will also be available.

While the majority of the habitats within the dredge areas have low to medium sensitivity to habitat loss (removal of substrate) according to the MarLIN sensitivity review (Tillin *et al*., 2024), blue mussel beds are reported to have high sensitivity; however, this is based on the removal of the entire bed. In the case of the Proposed Scheme, only small-isolated patches of beds would be removed.

Between the Lady Shoal approach channel and the Port of Dundee, the combined area of mussel beds that would be lost equates to 12,042m^2, representing approximately 0.3% of the estimated area of blue mussel beds in the Firth of Tay[4]. Recoverability is considered to be high and therefore the sensitivity is assessed as medium. As the overall effect would be temporary and affect a small proportion of the habitat within the estuary, the magnitude of effect is considered to be low. Direct habitat loss has therefore been considered to be a **minor adverse** which is **not significant in EIA terms**.

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is minor adverse significance, which is not significant in EIA terms.

9.6.1.1 Increases in SSCs and smothering of benthic habitats as a result of the proposed dredging and disposal

The capital dredging would cause disturbance of the seabed and suspension of sediment into the water column. This sediment will subsequently disperse and eventually settle into the seabed. The location of the settlement and the volume of the material settling are dependent on a number of factors, primarily the particle size and hence the settling of characteristics of the material suspended and the prevailing tidal currents.

[4] Based upon the extent of mussel beds in the Tay being around 4 million m^2, as provided by NatureScot (see accompanying shadow HRA)

The settlement of material that is suspended during dredging and disposal has the potential to affect benthic communities. In the short term, excessive deposition of the material can have a detrimental impact on benthic communities because their ability to migrate vertically through the sediment may not be sufficient if the rate of sedimentation is high. In this situation, there can be adverse effects due to smothering. This effect is likely to be most pronounced for the most sensitive species within the community, such as filter feeding organisms (for example bivalves) whose feeding apparatus can become blocked under conditions of excessive sedimentation and those with limited mobility. Sediment dispersion and deposition have been modelled and are discussed in detail in **Chapter 7**.

The Firth of Tay and Eden Estuary is characterised by powerful tidal currents and a high suspended sediment load (NatureScot, 2024) and therefore the habitats and species within the estuary will be adapted to withstand high SSC. The MarLIN sensitivity review for the communities identified by the benthic surveys considers these communities as not being sensitive to increased suspended sediment and any impact will be negligible. This includes blue mussel beds, which are considered to be more tolerant than other suspension feeders and have been shown by some studies to increase growth rates in response to increased SSC (Tillin *et al*., 2024). Seagrass beds are known to be sensitive to changes in water clarity due to impacts on the ability of plants to photosynthesise; however, seagrass beds in the Tay Estuary are all intertidal and therefore only temporarily exposed to suspended sediment therefore they are considered to be of high sensitivity. Additionally, although peaks in SSC are high during the dredging and disposal activities, those peaks are short-lived, with levels quickly returning to ambient levels, and are very localised to the dredging and disposal activities. As such, the magnitude of impact for seagrass beds is considered to be negligible. The overall significance of effect of increased SSC therefore **minor adverse**, which is **not significant in EIA terms**.

Seagrass beds are assessed as having medium sensitivity to light sedimentation (<5cm), with some ability to adapt, except in the case of complete burial (Cabaço & Santos, 2007 (cited on MarLIN)). Sediment deposition is highly localised to the dredge areas and disposal site and would therefore have **no impact** on intertidal habitats.

Blue mussel beds in and around the dredge areas and disposal site may experience some limited sedimentation; however, given how localised deposition is predicted to be to the dredge areas and disposal site (**Figure 7-29**), the magnitude of any sedimentation is considered to be low.

The sensitivity of benthic habitats, including blue mussel beds is assessed as medium for sediment deposition (smothering); therefore, sediment deposition is considered to represent a **minor adverse effect** which is **not significant in EIA terms**.

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is minor adverse significance, which is not significant in EIA terms.

9.6.1.2 Release of sediment bound contaminants as a result of the proposed dredging and disposal

Sediment disturbance during dredging could lead to the mobilisation of contaminants contained within the sediments. Sediment quality and the potential for release of sediment bound contaminants are discussed in **Chapter 8**. On average, the levels of contaminants within the sediment to be dredged are mostly below AL1 and are considered suitable for disposal at sea.

One sample from the Port of Dundee dredge area (station DP06, sample depth 1.2m) showed values above AL1 for Nickel and Zinc as well as several PAHs. Values for metals were below AL2 and while there is no

AL2 for PAHs, comparison against Canadian Interim Sediment Quality Guidelines (ISQG) indicate that the PAH levels reported are below the level at which adverse effects may be expected for a wide range of species (see **Chapter 8**).

Further, the sediment from the dredge area is to be disposed to an active disposal site, designated for the disposal of dredged material. The sediment deposition modelling shows that the sediment is likely to remain within the bounds of the dredge area and disposal site (see **Chapter 7**).

The sensitivity of benthic habitats, including blue mussel beds is assessed as medium. Given the low contaminant levels and the localised nature of sediment deposition, the magnitude of the impact is assessed as negligible. As such, the release of sediment bound contaminants is considered to represent a **minor adverse effect** which is **not significant in EIA terms**.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is minor adverse significance, which is not significant in EIA terms.

9.6.1.3 Underwater noise during piling

Underwater noise produced by activities such as piling is known to result in physiological and behavioural changes in a variety of marine organisms. While mobile species are capable of avoiding the impacted area, species with limited mobility, such as blue mussels are not able to do so. The majority of studies on the impacts of underwater noise have been focuses on fish and marine mammals; however, there is limited evidence of impacts on invertebrates. Studies of the effects of vessel noise on blue mussels have shown DNA changes, reduced feeding rate, reduced oxygen consumption, increased valve gape (Wale *et al.*, 2019) and increased settlement of larvae (Jolivet *et al.*, 2016); however, these studies are based on laboratory conditions using playback of continuous low frequency sound and one of the researchers stated “Given the wide distribution of mussels in areas where they may be exposed to noise, the impact of noise does not appear to be fatal or immediately dangerous for mussels” (Edinburgh Napier University, 2019).

A field study of the impact of pile driving within 15m of blue mussels in a dock environment reported an increased rate filtration in blue mussels during piling activity compared to those in ambient conditions (Spiga *et al.*, 2016). The field study went on to conclude that, in a situation where food resources are limited this may have a detrimental effect (Spiga *et al.*, 2016); however, the Firth of Tay is not likely to be resource limited for blue mussels. As such, while there is some evidence that underwater noise may affect blue mussels, experts have indicated that this does not appear to be having significant effects on blue mussel populations.

Benthic habitats are therefore considered to have low sensitivity to underwater noise and although the nature conservation value of blue mussel beds is high, the magnitude of impact is low. The significance of underwater noise on benthic habitats is therefore considered to be **negligible**, which is **not significant in EIA terms**.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

9.6.2 Potential impacts during operation

Changes to estuarine processes as result of the Proposed Scheme are predicted to be negligible. Given this and that there would be no change in maintenance dredging requirement at the Port nor maintenance

dredging of the Lady Shoal approach channel, no impacts to benthic habitats would occur during the operational phase.

9.6.3 Summary of Potential Effects to Benthic Habitats

Table 9-5 summarises the potential impacts to benthic habitats. Negligible and minor adverse effect are not significant in EIA terms.

Table 9-6 Summary of potential impacts to benthic habitats as a result of the Proposed Scheme

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Habitat loss	Benthic habitats	Medium	Low	Minor adverse	None required	Minor adverse
Increased SSC	Blue mussel beds	Negligible	Low	Negligible	None required	Negligible
	Seagrass beds	High	Negligible	Minor adverse	None required	Minor adverse
	Other benthic habitats	Negligible	Low	Negligible	None required	Negligible
Sediment deposition	Blue mussel beds	Medium	Low	Minor adverse	None required	Minor adverse
	Seagrass beds	Medium	None	No impact	None required	No impact
	Other benthic habitats	Medium	Low	Minor adverse	None required	Minor adverse
Release of sediment bound contaminants	Benthic habitats	Medium	Negligible	Minor adverse	None required	Minor adverse
Underwater noise	Benthic species	Low	Low	Negligible	None required	Negligible

9.7 Potential Impacts on Otter

9.7.1 Potential Effects During Construction

Potential impacts to otter include disturbance to resting places, or holts, due to dredging and pilling activities. Piling, in particular, can generate airborne noise and vibration, which may disturb otters using nearby areas, especially if undertaken close to potential resting or foraging habitat. These effects may reduce habitat connectivity and increase competition among otters for limited resources, potentially reducing their overall fitness.

Given the existing level of usage of the area surrounding the recorded holts, it can be assumed that otters using the area are habituated to the existing operations of the Port. In addition, the recorded holts are approximately 250m (RS3) and 230m (RS4) from the proposed piling works.

Given the above, the sensitivity of the receptor is considered to be medium and the magnitude of the impact is considered to be low. The significance of disturbance to otters during construction is therefore considered to be **minor adverse**, which is **not significant in EIA terms**.

Mitigation measures and residual impact

To minimise disturbance from the construction activities a lighting strategy will be put in place, which includes:

- Avoid artificial lighting on or near the water, especially white or blue-spectrum lights;
- Use directional lighting (using fittings such as hoods, cowls or shields) to direct light downwards wherever possible and avoid unnecessary light spill;
- LED luminaires should be used where possible due to their sharp cut-off, lower intensity, good colour rendition and dimming capability;
- Adopt a warm white spectrum (ideally <2700 Kelvin, max 4000 Kelvin) to reduce the blue light component;
- Position lighting to avoid illumination of suitable foraging and commuting habitat within and adjacent to the Site; and
- Restrict lighting times where practicable (e.g. switch off between 23.00 and 05.00) to maintain dark periods.

With adherence to the above mitigation, the magnitude of impact would remain low and the residual impact is minor adverse, which is not significant in EIA terms.

9.7.2 Summary of Potential Effects to Otter

Table 9-6 summarises the potential impacts to otter. Negligible and minor adverse effects are not significant in EIA terms.

Table 9-7 Summary of potential impacts to otter as a result of the Proposed Scheme

Potential effect	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Disturbance during construction phase	Medium	Low	Minor	Sensitive lighting strategy	Minor

10 Fish and Shellfish Ecology

10.1 Introduction

This chapter considers the potential impacts of the Proposed Scheme on fish and shellfish populations in the Firth of Tay. 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 effects are presented together with the likely residual impacts after these measures have been adopted. Blue mussel beds have been assessed in **Chapter 9**. Whilst features of European and Ramsar sites are assessed in this chapter, the assessment on these sites is presented in the accompanying shadow HRA.

This chapter is informed by the following chapters and appendix:

- **Chapter 7**: Estuarine Processes
- **Chapter 8**: Marine Water and Sediment Quality
- **Chapter 9**: Marine and Coastal Ecology
- **Appendix 10-1**: Underwater Noise Modelling Report

10.2 Legislation, Policy and Guidance

10.2.1 Legislation

The following legislation is relevant to fish and shellfish ecology:

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

10.2.2 Policy and plans

10.2.2.1 Scotland's National Marine Plan

Within Scotland's NMP are a set of GES indicators that must be met. Within these, of relevance to fish and shellfish ecology in the context of 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).
- Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (GES 11)".

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 SACs (and SPA, 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 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.

10.3 Consultation

Advice received during the EIA Screening process (**Section 5.3**) and from consultation with NatureScot (**Chapter 6**) have been taken into account in undertaking the assessment presented in this chapter.

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 (**Chapter 7**) and the extent to which underwater noise from piling and 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 twoFigure 7-22.

10.4.2 Data Sources

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

- River Tay Special Area of Conservation Advice Package (NatureScot, 2020);
- Sediment dispersion modelling, as described in **Chapter 7**;
- Sediment sample analysis of dredged material, as described in **Chapter 8**;
- Underwater noise modelling, as presented in **Appendix 10-1**;
- Scottish Natural Heritage's (SNH) (now NatureScot) HRA on the Firth of Forth: A Guide for developers and regulators (SNH, 2016); 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 5.5**.

10.5 Baseline Environment

10.5.1 Migratory fish associated with River Tay SAC

10.5.1.1 Atlantic salmon

Atlantic salmon within the Firth of Tay have a complex life cycle, which begins and ends in freshwater spawning grounds in the Tay's main tributary rivers Tummel, Dochart, Lyon, Lochay, Earn, Isla & Almond (Monteith, n.d.). 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 (NatureScot, 2020). Peak spawning occurs between November and December, but can extend from October to late February (SNH, 2016).

10.5.1.2 Sea lamprey

The Tay is likely to support one of the most important sea lamprey populations in Scotland. Mature sea lamprey migrate to the River Tay SAC and freshwater reaches of the Tay every year to spawn. Spawning 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 Tay in spring. 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).

10.5.1.3 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 Tay and other coastal or estuarine areas where they will spend up to two years feeding and reaching maturation.

10.5.2 Other migratory fish

European smelt or sparling *Osmerus eperlanus*, are only found in three Scottish rivers: the Tay, the Forth and the Cree (NatureScot, 2023). They migrate upstream using the high spring tides from February to April to spawn, spawning is linked to the lunar cycle (Maitland and Lyle, 1996; NatureScot, 2023). Spawning on gravel, cobbles, boulders and vegetation. The events happen quickly and can be difficult to detect (NatureScot, 2023). Eggs require good quality that is well-oxygenated to hatch successfully, usually within two weeks (Forth Rivers Trust, n.d.). After hatching the juveniles move to the estuary to feed and grow, returning to the rivers as adults to spawn (NatureScot, 2023). Adults do return to the estuary after spawning, but mortality rates can be high (Forth Rivers Trust, n.d.).

Other migratory fish travel through the Firth of Tay, including European eel *Anguilla Anguilla*, which migrate downstream throughout the year with peak counts in Scotland between August and October (Malcolm *et al.*, 2010). As well as sea trout Salmo trutta, which migrate upstream as juveniles to overwinter and as adults to spawn (Malcolm *et al.*, 2010; O'Reilly *et al.*, 2021a).

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 Tay but are not regular and are not features of any Scottish SAC (Forth Rivers Trust, 2020; Honkanen *et al.*, 2024).

10.5.3 Resident estuarine fish and shellfish

Surveys conducted by O'Reilly *et al.* (2021b) state the Tay Estuary is insufficient to characterise the fish communities in these water bodies, though it is noteworthy that sampling in the Tay Estuary highlighted the presence of smelt, as well as a few sea trout, salmon, and river lamprey.

10.5.4 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 are presented in **Table 10-1**.

Table 10-1 Fish and shellfish PMFs that are likely to be present in the study area

Common Name	Scientific Name
Atlantic Salmon	*Salmo salar*
River lamprey	*Lampetra fluviatilis*
Saithe	*Pollachius virens*
Sandeels	*Ammodytes marinus & Ammodytes tobianus*
Sea Trout	*Salmo trutta*
European Eel	*Anguilla anguilla*
Smelt / Sparling	*Osmerus eperlanus*

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 Tay (see **Sections 10.5.1** and **10.5.2**), namely Atlantic salmon, sea lamprey and river lamprey, 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. lavate* and spurdog *Squalus acanthias*. During the summer of 2023, there were two sightings of basking sharks *Cetorhinus maximus* were in the Firth of Tay[5]; however, there are currently no recent (within the last decade) abundance information to calculate densities (Marine Scotland, 2025).

[5] Hebridean Whale & Dolphin Trust

10.6 Prediction of Potential Effects During the Construction Phase

Potential impacts to fish and shellfish ecology during construction phase of the Proposed Scheme include:

- Underwater noise from piling operations and dredging activity;
- Changes in water quality; and
- Changes in habitat quality.

10.6.1 Underwater noise from piling operations and dredging activities

Fish have a wide range of auditory capabilities depending on the species, mostly in the frequency range of 30Hz to 1kHz, and detect sound through mechanosensory organs including the otolithic organs and (for detecting nearby sounds) a lateral line system. As such, underwater sound arising from the piling and dredging is expected to fall within the hearing ranges of fish species present in the River Tay (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 (Popper and Hastings, 2009). The impacts can be summarised into four broad categories (Popper *et al.*, 2014):

1. **Mortality and mortal injury** – immediate or delayed death.
2. **Recoverable injury** – injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.
3. **TTS** – short or long term changes in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6dB or greater that persists. This level is selected since levels less than 6 dB are generally difficult to differentiate. It is also the view of Popper et al., (2014)that anything less than 6dB will not result in a significant effect from the standpoint of hearing.
4. **Masking / behavioural effects** – impairment of hearing sensitivity by greater than 6dB, including all components of the auditory scene, in the presence of noise. Behavioural effects include a substantial change in behaviour for the animals exposed to a sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements.

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 piling and dredging works coinciding with migratory periods, the underwater noise assessment specifically focuses on the following migratory species that are known to be present in the Firth of Tay:

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

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).

The swim bladder of Atlantic salmon does not aid in hearing and the species can be regarded as a hearing generalist (Popper *et al.*, 2014). Studies by Hawkins and Johnstone (1978) found salmon show low sensitivity to noise. Their ability to respond to noise is regarded as poor with a narrow frequency span and a limited ability to discriminate between different noises. Nedwell et al (2006), concluded for salmon and brown trout, no obvious signs of trauma could be attributed to sound exposure from vibro and impact piling associated with these fish species which were caged between 30m – 400m from the source of noise.

Sea lamprey and river lamprey are fish without a swim bladder and are considered to have a low sensitivity to noise (Popper *et al.*, 2014).

Overall, sea and river lamprey; and Atlantic salmon are considered to be members of Hearing Group One and Two respectively, as defined by Popper *et al.* (2014), and therefore have low sensitivity to noise (Popper *et al.*, 2014).

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. Of particular relevance for transitional 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.

An underwater noise assessment has been undertaken for fish within the River Tay and Firth of Tay based on noise modelling of both impulsive (impact piling) and continuous (vibro-piling and dredging) noise sources, using recognised noise threshold criteria set by Popper *et al.* (2014). The noise modelling methodology report can be seen in **Appendix 10-1**. Given that river lamprey and sea lamprey are both members of hearing group one (as set out by Popper *et al.*, 2014), with low sensitivity to noise, they are considered together in this underwater noise assessment.

As set out in **Appendix 10-1**, for fish, the largest recoverable injury ranges (203dB SEL_{cum} threshold) are predicted out to a maximum of 10m when considering a stationary animal, which reduces to less than 10m for fleeing animal calculations. Maximum TTS impact ranges (186dB SEL_{cum} threshold) are predicted out to 80m for stationary animals, and these ranges also reduce to less than 10m when considering fleeing animals.

Salmon and / or lamprey species within 10m of the piling source would be exposed to injurious noise levels from a single strike of an impact pile. For cumulative exposure to repeated strikes over a working day (i.e. up to six hours), lamprey species (which lack a swim bladder) would not be at risk of injury (mortal or recoverable) if stationary next to the piling source throughout that period. Atlantic salmon (which have a swim bladder not involved in hearing) would be at risk of injury if stationary within 10m of the piling source. It is considered highly unlikely that Atlantic salmon individuals would remain stationary within 10m of a pile for the duration of the piling schedule, and would move away from the undesirable noise source. There is a potential for TTS in all species at a distance of up to 80m from the piling source, again assuming a stationary animal for the entire four hours of piling. Since only mobile adults / pre-adults are likely to be present within the marine estuary, with an ability to move away from the worst case impact range of 80m around a pile (for TTS), there is little to no risk of mortality, recoverable injury or TTS onset.

In terms of the potential effects of underwater noise on migration activity, the key migratory route is considered to be in and out of the mouth of the Tay estuary. At the location where the piling would take place (Figures 4-1 and 4-2 in **Appendix 10-1**), the estuary is approximately 1.5km wide, which is greater than the maximum impact range predicted in the modelling. In terms of behavioural effects, Popper *et al.* (2014) provides a qualitative description of relative sensitivity of fish and indicates that far-field behavioural responses (i.e. more than 1km from the source) would be of low magnitude for Atlantic salmon and lamprey species. As such, based on the modelled maximum impact range, it can be concluded that the respective ranges for potential injury, TTS and significant behavioural modification would not sufficiently extend into the migratory route to interfere with migration; therefore, there is no potential for a 'barrier' effect from noise produced by the Proposed Scheme and migration is expected to continue unimpeded. Any individuals that may move along the southern edge of the Firth of Tay (and hence may encounter noise levels capable of preventing onwards movement (bearing in mind that there remains a lack of evidence for the potential of piling noise to cause a barrier to movement for these species) would be able to simply move further out into the river channel to circumnavigate through unaffected waters.

The duration of the piling works is expected to be up to 35 days. There is potential for Atlantic salmon's migration to overlap with piling activity. NatureScot have highlighted that Atlantic salmon migration is of greater sensitivity between November and May and have advised a piling restriction during those months (see Appendix 4-1 of the accompanying HRA); however, based on the results of the underwater noise modelling (**Appendix 10-1**), noise generated from piling would not interfere with Atlantic salmon migration. It therefore considered that a seasonal restriction on piling activity is not necessary for the Proposed Scheme.

Underwater noise modelling was also undertaken for dredging and vibro-piling, which indicated that transitional fish would not be impacted either by recoverable injury or TTS. The impacted zone is hence considerably smaller than that predicted from piling activity and again would have no significant effect on the capability of lamprey and salmon to navigate along the estuary during migration. Based on the above, the magnitude of the impact is assessed to be negligible.

As such, the overall significance of the effect on migrating fish is **minor adverse** for species with a swim bladder (salmonids, European smelt and European eel) and **negligible** for species that lack a swim bladder (lamprey), both of which are **not significant in EIA terms**.

Mitigation measures and residual impact

Soft start procedures as per the JNCC protocol (JNCC, 2010) would be adhered to, to remove the risk of injury to any fish within close proximity to the piling activities. The residual impact is minor adverse/negligible, which is not significant in EIA terms.

10.6.2 Changes in water quality

Dredging and disposal 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.

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. For all other fish species and shellfish, the sensitivity is considered to be medium.

The Firth of Tay and Eden Estuary is characterised by powerful tidal currents which generate high suspended sediment load (Bates *et al.*, 2004). Turbidity has been measured near to the Port of Dundee and Lady Shoal approach channel. At both locations, the minimum suspended sediment concentration measured was 5mg/l, with most values within the time series between 10mg/l and 100mg/l. The highest observed SSCs were 551mg/l near the Port and 339mg/l near the Lady Shoal approach channel (see **Chapter 7**).

The extent of the sediment plume predicted from the proposed dredging and subsequent disposal is described in detail in **Chapter 7**Figure 7-20. Following each disposal event, SSC is predicted to disperse to baseline levels within 30 minutes. 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 extent of the sediment plume predicted near to the sea bed is shown on **Figure 7-22**, which shows that significant increase in SSC during dredging and disposal would be localised to the immediate vicinity of the dredge footprint and disposal site. At a distance of 500m to the west and 1.3km to the east from the disposal site, maximum SSC increases are predicted to be less than 300mg/l, which is within the natural variations for the Tay. SSC increases at the disposal site are predicted to last up to 30 minutes before returning to ambient.

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 modelled plume extent would not be present at any single time. The Firth of Tay at the location of the Proposed Scheme is approximately 1.5km wide, hence there would be no significant obstruction or 'barrier effect' to migrating lamprey, salmonids, European smelt or European eels. As such, the magnitude of effect is considered to be negligible.

Any trace contaminants disturbed during dredging would be bound to fine sediment particles due to their larger surface area, so would only be present within the sediment plume. Chemical analysis of the source dredge material has been undertaken and is reported in detail in **Chapter 8**. The analyses show that contaminant levels within the sediment are sufficiently low that disposal of the material is considered appropriate and therefore would not pose a significant risk to fish and shellfish.

As such, the significance of the effect on migratory fish and is **minor adverse**, which is **not significant in EIA terms** and **negligible** for all other fish and shellfish, which is also not **significant in EIA terms**.

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is minor adverse/negligible, which is not significant in EIA terms.

10.6.3 Changes in habitat quality

In terms of physical loss of habitat used by fish, this would constitute the approaches to DunEco Quay and PCW, and at the Lady Shoal approach channel dredge area. In addition, the suspension and deposition of sediment as a result of the dredge / disposal activities may lead to 'loss' or change in the composition of supporting habitat for fish species.

As these areas are within the Firth of Tay, migratory fish use the area to transit to and from their spawning and nursery grounds. As such, the Proposed Scheme would have no effect on the spawning and nursery habitat of migratory fish. The assessment of the Proposed Scheme on benthic habitats can be seen in **Chapter 9**, and which concluded minor to negligible impacts on benthic habitats, which are not significant, and which would recover following the dredging. As such, the magnitude of the impact is negligible and the sensitivity of receptor is considered to be low.

As such, the overall significance of the effect on fish and shellfish is **negligible**, which is **not significant in EIA terms**.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

10.7 Prediction of Potential Effects During the Operation Phase

Changes to estuarine processes as result of the Proposed Scheme are predicted to be negligible. Given this and that there would be no change in maintenance dredging requirement at the Port nor maintenance dredging of the Lady Shoal approach channel, no impacts to fish and shellfish ecology would occur during the operational phase.

10.8 Summary

Table 10-2**Table 10-2** summaries the potential effects to fish and shellfish ecology assessed in this chapter. Negligible adverse and minor adverse effects are not significant in EIA terms.

Table 10-2 Summary of potential effects to fish and shellfish ecology

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Underwater noise from piling and dredging	Migratory fish (salmon, trout, European eel)	Medium	Low	Minor adverse	JNCC soft start procedures	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Low	Low	Negligible		Negligible
Water quality	All migratory fish	High	Negligible	Minor adverse	None required	Minor adverse
	All other fish species and shellfish	Medium	Negligible	Negligible	None required	Negligible
Habitat quality	All fish and shellfish	Low	Negligible	Negligible	None required	Negligible

11 Ornithology

11.1 Introduction

This chapter considers the potential impacts of the Proposed Scheme on estuarine bird populations in the Firth of Tay. 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 effects are presented together with the likely residual impacts after these measures have been adopted. Whilst features of European and Ramsar sites are assessed in this chapter, the assessment on these sites is presented in the accompanying shadow HRA.

This chapter is informed by the following chapters and appendices:

- **Chapter 7**: Estuarine Processes
- **Chapter 8**: Marine Water and Sediment Quality
- **Chapter 10**: Fish and Shellfish Ecology
- **Appendix 11-1**: Port of Dundee Overwintering Bird Survey Report 2023/24; and
- **Appendix 11-2**: Port of Dundee Overwintering Bird Survey 2024/25: distribution and abundance maps.

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.

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 Priority Marine Features in marine planning (though this does not include wild birds species).

11.2.3 Best Practice and Guidance

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

11.3 Consultation

Advice received during the EIA screening process (**Section 5.3**) and from consultation with NatureScot (**Chapter 6**) have been taken into account in undertaking the assessment presented in this chapter.

11.4 Assessment Methodology

11.4.1 Study Area

For the purpose of assessment on ornithology, the study area comprises 5km from the Proposed Scheme (including both the Port of Dundee and the Lady Shoal approach channel) for the purposes of identification of designated sites.

11.4.2 Data Sources

Project-specific baseline bird surveys and desk-based study of existing data sources have been used to describe the baseline ornithological environment within the ornithological study area, and to inform the subsequent assessment on ornithological receptors. These include:

- Site-specific estuarine bird counts between April 2023 and March 2024 (**Appendix 11-1**);
- Site-specific bird counts between October 2024 and April 2025 (**Appendix 11-2**);
- SPA citations for Firth of Tay and Eden Estuary SPA (SNH 2018) and Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA (SNH 2020);
- Ramsar Site Information Sheet for Firth of Tay and Eden Estuary Ramsar Site (JNCC, 2005);
- British Trust for Ornithology (BTO) Wetland Bird Survey[6] (WeBS) annual peak counts data for Tay Estuary for WeBS years 2019/20 to 2023/24 (Calbrade *et al.*, 2025); and
- eBird data from 2015 – 2025 from the eBird Hotspots Broughty Ferry Mudflats and Tayport Promenade.

In addition to the above, other scientific papers have been used as appropriate for certain species to provide evidence to support the conclusions of the ornithological assessments.

11.4.3 Assessment methodology

11.4.3.1 Sensitivity of ornithological receptors

For ornithological receptors, sensitivity is dependent on the factors as set out in **Section 5.5** (i.e. it based on the tolerance, adaptability and recoverability of the receptor), which defines sensitivity levels for a generic receptor, 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.

[6] *Wetland Bird Survey (WeBS) | BTO*

11.4.3.2 Assigning nature conservation value to ornithological receptors

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 nature conservation value of ornithology receptors is defined as per the criteria set out in **Table 11-1**. 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.

Table 11-1 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: o Annex I of the Birds Directive; and o 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.

11.4.3.3 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 Tay are considered to be appropriate receptor populations.

For waterbird species, regional reference populations are the latest WeBS five-year mean peak counts (2019/20 to 2023/24) (Calbrade *et al.,* 2025) from the 'Tay Estuary' site (which covers the entire tidal reach of the Tay from Newburgh to the St Andrews Bay at Tentsmuir Point). Population data for estuarine birds is collected on an on-going basis by the BTO WeBS. The WeBS scheme monitors the numbers and distribution of non-breeding waterbirds (ducks, swans, geese, grebes, divers, waders, herons, rails, cormorants, gulls and terns) in the UK. Peak counts data in the online WeBS Report is considered to provide more comprehensive estimates of populations than the published report document, as they account for results of supplementary counts such as those undertaken for the Icelandic-breeding Goose Census, and under the WeBS Low Tide Count Survey and WeBS Core Count Survey. WeBS Five-year average data (the mean of the validated annual peak counts of each species in the five 'WeBS years' (July to following June) 2019/20 to 2023/24) was used. 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 reference 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 11-2**. In some instances, mitigating circumstances (such as the documented distribution or habitats of a given species within the Firth of Tay) have been used in concluding the spatial magnitude of an effect.

Table 11-2 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).

11.4.3.4 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.

11.4.3.5 Impact significance

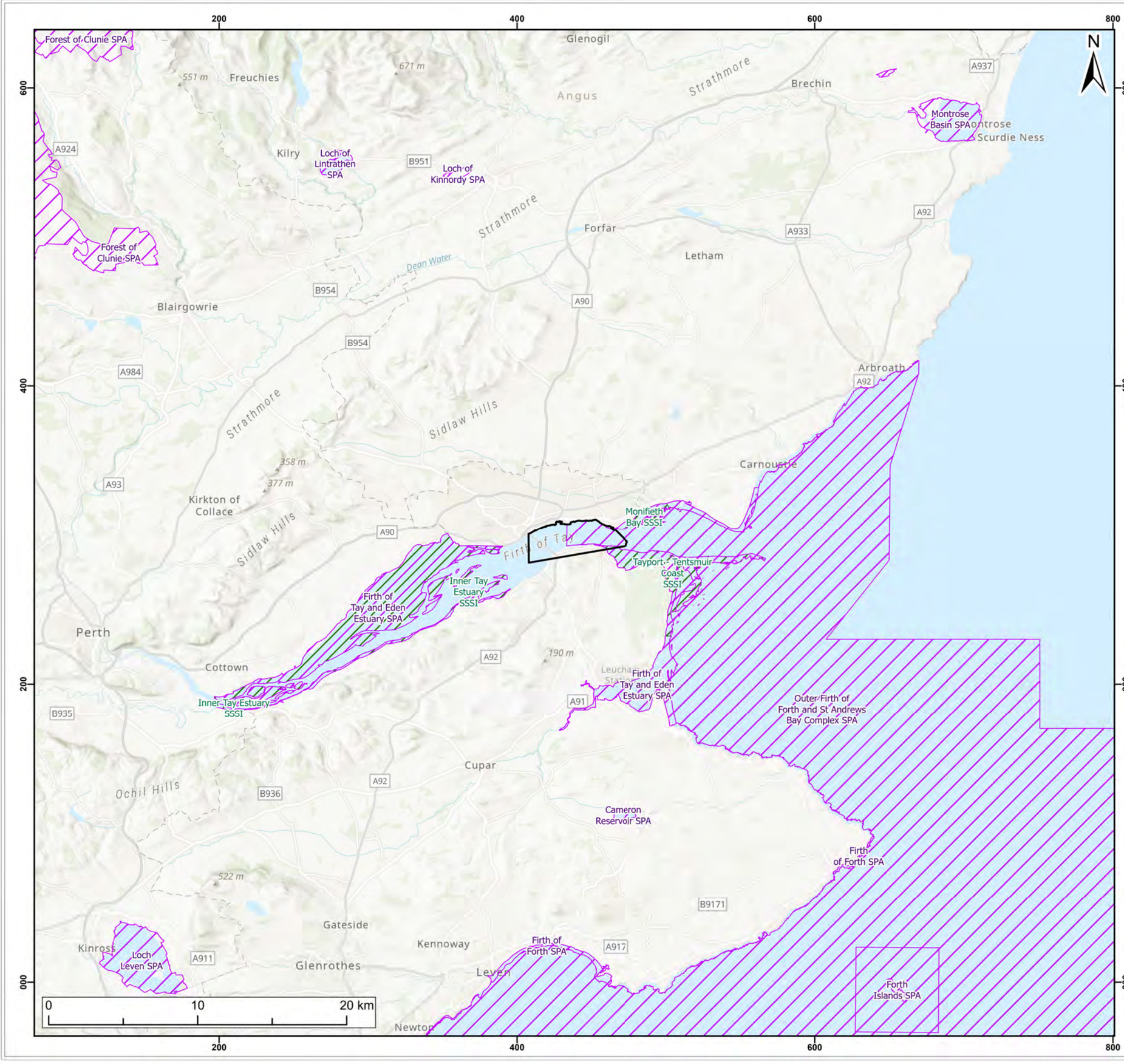
Following determination of receptor sensitivity / value and the magnitude of a given effect, the significance of the impact (and residual impact if mitigation measures are to be implemented) has been determined as outlined in **Section 5.5.3**.

11.5 Baseline Environment

The Proposed Scheme overlaps with, or is in close proximity to, a number of nature conservation designations of ornithological interest, as shown in **Figure 11-1**.

11.5.1 Firth of Tay and Eden Estuary SPA (UK9004121) and Ramsar site (UK13018)

The Firth of Tay and Eden Estuary SPA is a complex of estuarine and coastal habitats, covering an area of 69.47km² from the mouth of the River Earn in the inner Firth of Tay east to St Andrews on the Fife coast. There are extensive intertidal flats on the north side, west of Dundee. To the east, the substrate becomes sandier. The south shore consists of shelving mud and shingle. The Inner Tay Estuary is noted for continuous dense beds of common reed along its north shore. A summary of the qualifying features of the SPA is presented in **Table 11-3**. Of the qualifying features of the SPA four were found to be favourable declining (bar-tailed godwit *Limosa lapponica*, dunlin *Calidris alpina alpina*, goldeneye *Bucephala clangula*, redshank *Tringa totanus*), nine favourable maintained (marsh harrier *Circus aeruginosus*, cormorant, goosander, grey plover *Pluvialis squatarola*, black-tailed godwit *Limosa limosa islandica*, oystercatcher, sanderling *Calidris alba*, waterfowl, pink-footed goose), six unfavourable declining (greylag goose, common scoter, long-tailed duck, red-breasted merganser, shelduck *Tadorna tadorna*, velvet scoter *Melanitta fusca*), and one unfavourable no change (little tern *Sternula albifrons*).



Legend:

- Survey Area
- Special Protection Areas (SPA)
- Sites of Special Scientific Interest (SSSI)
- Vantage Point

Client: Port of Dundee Limited	Project: Port of Dundee Capital Dredge and Quay Improvement Works

Title: Designated Sites with Ornithological Features

Figure: 11-1 | Drawing No: PC6550-RHD-XX-XX-D-EV-0062

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	07/07/2025	JH	RG	A3	1:250,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

Table 11-3 Summary of Firth of Tay and Eden Estuary SPA qualifying features

Description	Features
The Firth of Tay and Eden Estuary SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex I species:	Non-breeding • Bar-tailed godwit Breeding • Little tern • Marsh harrier
The Firth of Tay and Eden Estuary SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species:	Non-breeding • Redshank • Greylag goose • Pink-footed goose
The Firth of Tay and Eden Estuary SPA also qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual waterfowl, including the above qualifying features and nationally important populations of the following species:	Non-breeding • Velvet scoter • Cormorant • Shelduck • Eider • Common scoter (*Melanitta nigra*) • Black-tailed godwit • Goldeneye • Red-breasted merganser • Goosander • Oystercatcher • Grey plover • Sanderling • Dunlin • Long-tailed duck (*Clangula hyemalis*).

The Firth of Tay and Eden Estuary Ramsar site is a complex of estuarine and coastal habitats in eastern Scotland covering an area of 10.2km². The site includes extensive invertebrate-rich intertidal flats and areas of reedbed, saltmarsh and sand dune. A summary of the qualifying features of the Ramsar site is presented in **Table 11-4**.

Table 11-4 Summary of the Firth of Tay and Eden Estuary Ramsar site qualifying features

Description	Features
The Firth of Tay and Eden Estuary Ramsar site qualifies under Ramsar Criterion 2 by supporting:	**Breeding** Marsh harrier (1992 to 1996, an average of 4 females, 3% of the GB population), and Little tern (1993 to 1997, an average of 25 pairs, 1% of the GB population).
Firth of Tay and Eden Estuary Ramsar site further qualifies under Ramsar Criterion 5 by regularly supporting:	Waterbirds in numbers of 20,000 individuals or more. In the period 1990/91 to 1994/95, a winter peak mean of 48,000 individual waterbirds was recorded, comprising 28,000 wildfowl (ducks/geese/swans) and 20,000 waders [1].
The Firth of Tay and Eden Estuary Ramsar site also qualifies under Ramsar Criterion 4 by supporting the following.	Waterbird species at a critical stage in their life cycles[1].
Firth of Tay and Eden Estuary Ramsar site also qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds (1990/91 to 1994/95):	**Non-breeding** Bar-tailed godwit (a winter peak mean of 2,400 individuals, 2% of the Western European biogeographic population). Redshank (a winter peak mean of 1,800 individuals, 1% of the Eastern Atlantic biogeographic population).

Description	Features
	Greylag goose (a winter peak mean of 1,200 individuals, 1% of the Iceland/UK/Ireland biogeographic population). Pink-footed goose (a winter peak mean of 2,800 individuals, 1% of the Eastern Greenland/Iceland / UK biogeographic population).
[1] Component species: Velvet scoter (730 individuals, 24% of the GB population), Cormorant (230 individuals, 2% of the GB population), Shelduck (1,200 individuals, 2% of the GB population), Eider (13,800 individuals, 18% of the GB population), Common scoter (3,100 individuals, 9% of the GB population), Black-tailed godwit (150 individuals, 2% of the GB population), Goldeneye (230 individuals, 1% of the GB population), Red-breasted merganser (470 individuals, 5% of the GB population), Goosander (220 individuals, 2% of the GB population), Oystercatcher (5,100 individuals, 1% of the GB population) Grey plover (920 individuals, 2% of the GB population) Sanderling (220 individuals, 1% of the GB population) Dunlin (5,200 individuals, 1% of the GB population), and Long-tailed duck (560 individuals, 2% of the GB population). Bar-tailed godwit, redshank, greylag goose and pink-footed goose, are also components of the waterbird assemblage.	

The Conservation Objectives of the Firth of Tay and Eden Estuary SPA are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within the site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

11.5.2 Outer Firth of Forth and St Andrews Bay Complex SPA (UK9020316)

The OFFSABC SPA is a marine designation that covers an extensive area off the east coast of Scotland, totalling 2,721km^2, including the Firth of Forth. The SPA protects foraging and resting areas of wintering and breeding waterbirds and seabirds and has one of the largest and most diverse marine bird concentrations in Scotland. A summary of the qualifying features of the SPA is presented in **Table 11-5**Table 11-5. All features of the SPA assessed as in favourable maintained condition with one feature, the breeding seabird assemblage, not assessed.

Table 11-5 Summary of OFFSABC SPA qualifying features

Description	Features
Qualification under Article 4.1 (of the EU Birds Directive) by regularly supporting Annex I populations of national / international importance.	Non-breeding: • Red-throated diver • Slavonian grebe *Podiceps auritus* • Little gull *Hydrocoloeus minutus* Breeding: • Common tern *Sterna hirundo* • Arctic tern *Sterna paradisaea*,
Qualification under Article 4.2 by regularly supporting migratory populations of European importance.	Non-breeding: • Eider Breeding: • Shag; and • Gannet *Morus bassanus*.

Description	Features
Qualification under Article 4.2 by regular supporting in excess of 20,000 individual birds in a single season.	Non-breeding: • Waterfowl assemblage[1] • Seabird assemblage[2] Breeding: • Seabird assemblage[3]
[1]Component species: long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser. [2]Component species: black-headed gull *Chroicocephalus ridibundus*, common gull, herring gull, guillemot, shag, kittiwake *Rissa tridactyla*, razorbill *Alca torda*. [3]Component species: puffin *Fratercula arctica*, kittiwake, Manx shearwater *Puffinus puffinus*, guillemot, herring gull.	

Draft Conservation Objectives of the OFFSABC SPA are (NatureScot 2024):

- To ensure that the qualifying features of the OFFSABC SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.
- To ensure that the integrity of the OFFSABC SPA is restored in the context of environmental changes by meeting the following objectives for each qualifying feature:
    - The populations of qualifying features are viable components of the site.
    - The distributions of the qualifying features throughout the site are maintained by avoiding significant disturbance of the species.
    - The supporting habitats and processes relevant to the qualifying features and their prey / food resources are maintained, or where appropriate restored, at the OFFSABC SPA.

11.5.3 Monifieth Bay SSSI

Monifieth Bay is situated on the north shore of the outer Firth of Tay, 5km east of Dundee covering an area of 199.23ha. It consists primarily of intertidal sand and mud, extending for 4km along the coast and up to 1km seawards. The site is important as the extensive mud flats with its rich invertebrate population provide a feeding ground for wintering waders specifically important numbers of sanderling. Designated for the following species:

- Sanderling (non-breeding)

11.5.4 Tayport – Tentsmuir Coast SSSI

Tayport - Tentsmuir Coast SSSI is situated in the extreme north-east corner of Fife, and comprises a coastal strip extending from Tayport to Kinshaldy. The SSSI covers an area of 1261.29ha and is designated for the following species:

- Bar-tailed godwit (non-breeding)
- Common scoter (non-breeding)
- Cormorant (non-breeding)
- Dunlin (non-breeding)
- Eider (non-breeding)
- Goldeneye (non-breeding)
- Goosander (non-breeding)
- Grey plover (non-breeding)
- Greylag goose (non-breeding)
- Icelandic Black-tailed godwit (non-breeding)
- Little tern (breeding)

- Long-tailed duck (non-breeding)
- Marsh harrier (breeding)
- Oystercatcher (non-breeding)
- Pink-footed goose (non-breeding)
- Red-breasted merganser (non-breeding)
- Redshank (non-breeding)
- Sanderling (non-breeding)
- Shelduck (non-breeding)
- Velvet scoter (non-breeding)
- Waterfowl assemblage (non-breeding)

11.5.5 Inner Tay Estuary SSSI

The Inner Tay Estuary SSSI covers an area of 4115.38ha, the site consists primarily of intertidal sand and mud flats that extend seawards out to the main channel, the majority of which lie on the northern side of the estuary. The site is important for its wintering populations of roosting grey geese, its breeding birds, including several nationally important populations, its saltmarsh habitats, and habitats demonstrating the transition from saltmarsh to freshwater fens and dry land and is designated for the following species:

- Bearded tit (breeding)
- Marsh harrier (breeding)
- Water rail (breeding)
- Bird assemblage (breeding)
- Greylag goose (non-breeding)
- Pink-footed goose (non-breeding)
- Cormorant (non-breeding)
- Goldeneye (non-breeding)

11.5.6 Baseline Estuarine Bird Surveys

11.5.6.1 Ornithology Survey (2023/24)

A bird survey was carried out at the Port of Dundee between April 2023 and March 2024 (**Appendix 11-1**) (see **Figure 11-2**).

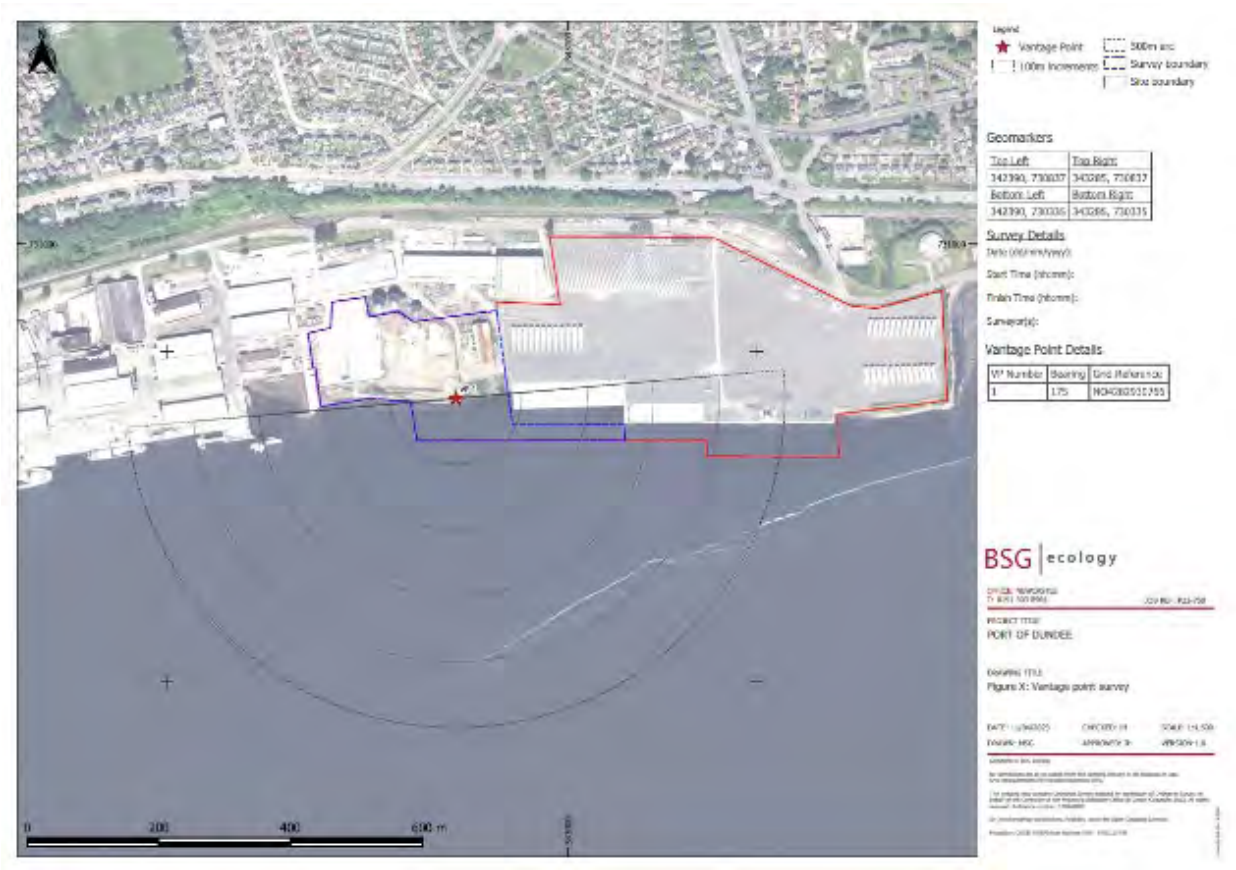


Figure 11-2 Port of Dundee Bird Survey Area 2023 / 2024

During these surveys, 13 species of relevance to SPAs and Ramsar site within 5km of the Port of Dundee were recorded:

- Black-headed gull *Chroicocephalus ridibundus* - recorded generally in flight traversing the coastline;
- Common gull *Larus canus* - only observed in flight;
- Cormorant *Phalacrocorax carbo* - present throughout the year and typically in low numbers (peak count 15 and all other surveys numbering seven or fewer individuals), recorded flying up and down the estuary or foraging (infrequently within 50m of the vantage point);
- Eider *Somateria mollissima* - recorded in small numbers (<5 individuals) resting on the water (as near as 50m from the vantage point);
- Goosander *Mergus merganser* - recorded at a peak of 43 individuals at rest in the estuary (i.e. Within 500m of the vantage point) in January;
- Greylag goose *Anser anser* - only recorded flying high over the vantage point;
- Guillemot *Uria aalge* - recorded resting on the water in small numbers (six or fewer individuals) (within 50m of the vantage point on multiple occasions);
- Herring gull *Larus argentatus* - present throughout the year and largely occurred in flight, close in, in both directions along the foreshore, but only rarely making use of rocky foreshore within the development area;
- Oystercatcher *Haematopus ostralegus* – on occasion using the rocky shore habitat on the foreshore for foraging and resting with typically only two or three individuals using the area at any one time;

- Pink-footed goose *Anser brachyrhynchus* - only recorded flying high over the vantage point;
- Red-throated diver *Gavia stellata* - Two were recorded in one survey visit (January) foraging within 50m of the vantage point before moving further into the estuary;
- Red-breasted merganser *Mergus serrator* - approximately 55 individuals observed in a mixed flock with goosander at rest within the estuary during one survey visit (January), as near as 100m from the vantage point; and
- Shag *Gulosus aristotelis* - one individual was observed foraging within 50m of the vantage point in October.

Of the species observed, the pink-footed goose and herring gull were the most abundant, with peak counts of 238 and 66, respectively; the pink-footed goose was only observed in December and only in flight high over the vantage point.

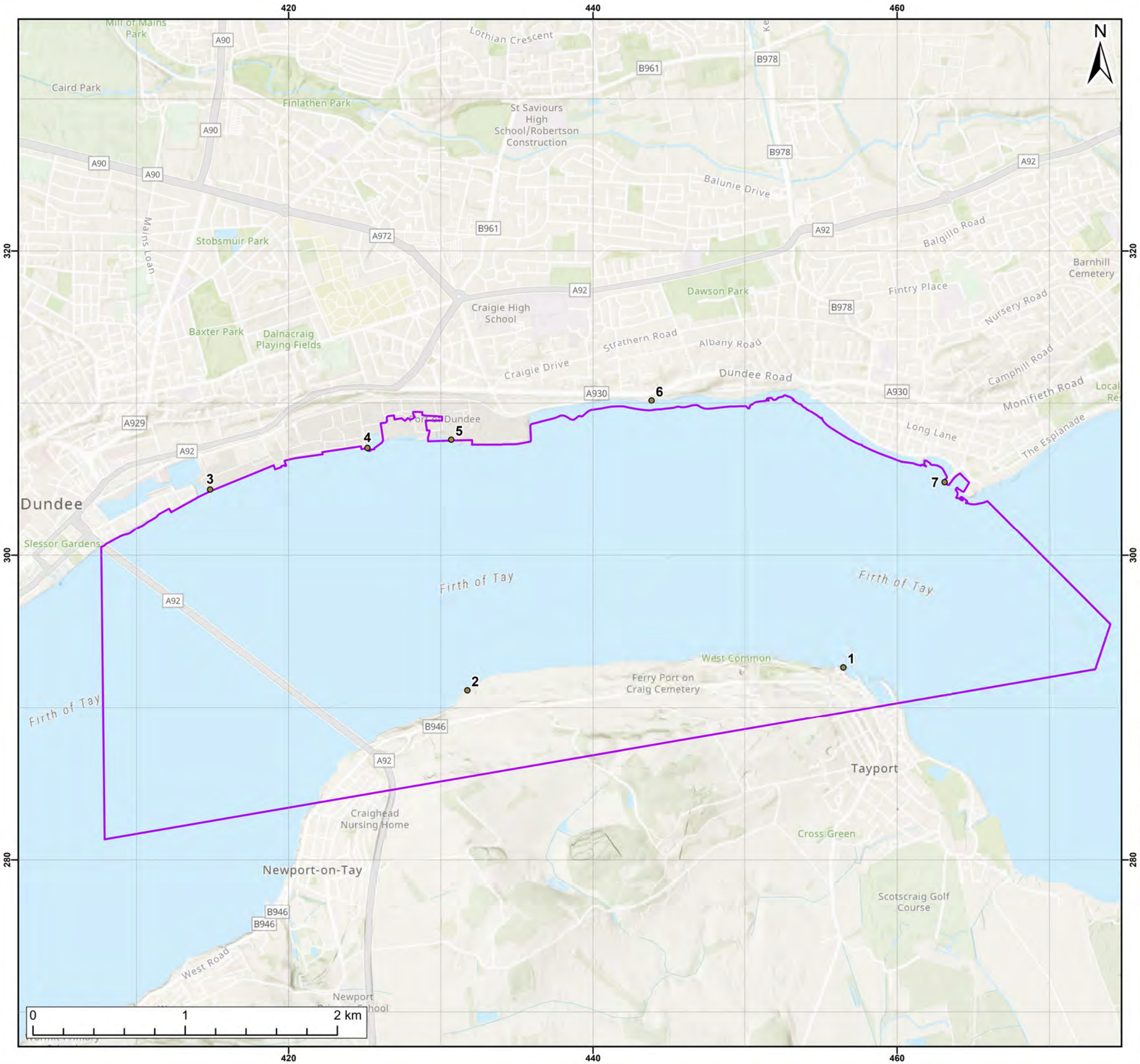
11.5.6.2 Ornithology Survey (2024/25)

Following engagement with NatureScot undertaken in September 2024, it was confirmed that an overwintering bird survey was required that included the estuarine area in front of the port. The bird survey was carried out between October 2024 and April 2025, inclusive, with the survey area shown in **Figure 11-3**.

The survey area included the Port area, DunEco Quay, PCW and an approximate 2km buffer into the Firth of Tay. The area was defined using points on both banks of the Tay, ensuring consistent boundaries for recording bird activity. The eastward extent was marked from Craighead to Discovery Point, and the westward extent from Broughty Ferry piers to Pile lighthouse.

The survey was conducted once per month and covered the entire survey area, including a 2km buffer. The count was timed to coincide with low tide at dawn or dusk to maximize the likelihood of observing geese roosting, as this timing was chosen because geese are most likely to use the site for roosting when there is exposed sand or mud.

Two 3-hour watches per month were conducted from two vantage points, scheduled on the same day with a half-hour break in between. These watches were timed to start at dawn and end at dusk, aligning with low tide to observe geese roosting behaviour. A total of 42 hours of survey from October to April. Geese present throughout the survey were recorded as points, allowing data to be recorded on tablets rather than on paper. During the survey visits, 11 species of relevance to surrounding SPAs and Ramsar site were recorded (**Table 11-6**). Of these species, black-headed gull and herring gull were the most abundant, with peak counts of 70 and 25, respectively; both were observed flying, roosting and loafing in the survey area.



Legend:

- Survey Area
- Vantage Point

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Survey Area for Overwintering Birds 2024/2025

Figure:	Drawing No:
11-3	PC6550-RHD-XX-XX-D-EV-0059

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/07/2025	JH	RG	A3	1:25,000

Co-ordinate system: British National Grid

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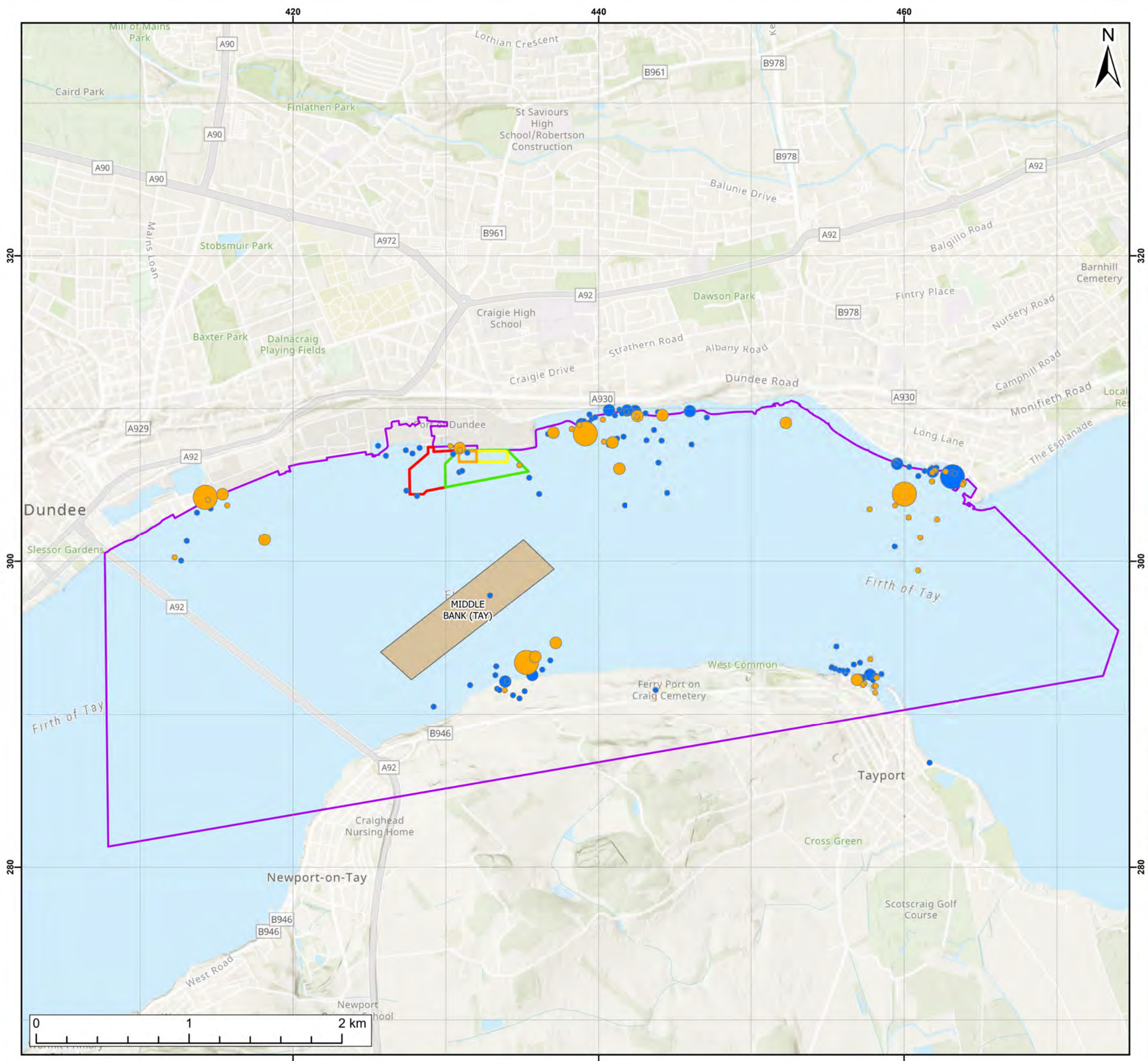
Table 11-6 Summary of Port of Dundee 2024 / 2025 bird survey results

Species	Location	Activity	Peak Number Observed
Black-headed gull	1km east of the Proposed Scheme	Flying, foraging	70
Cormorant	Survey area, shoreline to the boundary of the Proposed Scheme, 1km east	Roosting, foraging	4
Herring gull	Survey area, shoreline to the west of PCW	Flying, roosting, loafing	25
Common gull	East and southeast of the Proposed Scheme, estuary between Tayport and Broughty Ferry Salt Dog Marine	Roosting, in flight	5
Eider	1km east of the Proposed Scheme, Tayport, Broughty Ferry	Roosting, foraging	7
Great black-backed gull	Broughty Ferry Salt Dog Marine	Roosting	3
Guillemot	East of the Proposed Scheme, estuary between Tayport and Broughty Ferry Salt Dog Marine	Foraging	7
Oystercatcher	1km west and east of the Proposed Scheme	Roosting, foraging	20
Redshank	Proposed Scheme, Tayport	Roosting	3
Red-breasted merganser	Shoreline 1km east of the Proposed Scheme	Foraging	3

The distribution of all birds recorded during the survey can be seen in **Figure 11-4**, species specific distribution maps can be found in **Appendix 11-2**.



Legend:

- Survey Area
- Quay Improvement Works
- DunEco Quay Approach Channel Dredge Area
- Prince Charles Wharf Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Disposal Site

Loafing Bird
- 1-5
- 6-20
- 21-70

Foraging Bird
- 1-5
- 6-20
- 21-70

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Distribution map of all birds recorded during overwintering bird survey, October 2024 - April 2025

Figure:	Drawing No:
11-4	PC6550-RHD-XX-XX-D-EV-0060

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/07/2025	JH	RG	A3	1:25,000

Co-ordinate system: British National Grid

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11.5.6.3 Desk based study for Lady Shoal area

Given the location of the Lady Shoal Approach channel area, a desk-based assessment of the location has been undertaken using publicly available datasets, as per NatureScot's advice (see **Chapter 6**).

The desk study covered all waterbird and seabird species potentially supported by the water column or bottom substrate of the Lady Shoal approach channel dredge area; these being a) qualifying features or named assemblage components of designated sites; and b) non-named species but contributing significant numbers to the waterbird assemblage according to the Tay Estuary WeBS data (**Figure 11-5**), or c) having specific behavioural habits of significant disturbance and displacement by vessels in open water (e.g. divers, grebes, Fliessbach *et al.* 2019).

Figure 11-5 WeBS Tay Estuary Site

eBird is a biodiversity science project in which bird sightings are contributed by users while birding recreationally worldwide. eBird is managed by the Cornell Lab of Ornithology. eBird data documents bird distribution, abundance, habitat use, and trends through checklist data collected within a simple, scientific framework[7]. eBird data from 2015 – June 2025 from the eBird 'Hotspots' Broughty Ferry Mudflats and Tayport Promenade combined, were used to inform the desk study. These locations are the nearest eBird locations to the Lady Shoal approach channel dredge area. Whilst they are land-based sites, largely overlooking the nearshore marine waters and tidal flats, they provide an indication of the birds that would be present. Occurrence and count data from all types of checklist visit methodology (Complete Checklist (reporting all species identified), Incomplete List (select subset of species according to notability, etc.), Historical, Incidental) were considered.

[7] *eBird (Cornell Lab of Ornithology, Ithaca NY, USA) <https://ebird.org>*

The data, as presented in eBird's Bar Charts feature, illustrated each species' reporting rate as a percentage of Complete Checklists submitted for each of 48 approximate 'weeks' (quarter-months) in the calendar year, here aggregated for period 2015 to June 2025. The mean number of Complete Checklists underlying the data for each of the 48 weeks was 3.0, with only four weeks with zero Complete Checklists, and a maximum weekly sample size of 9. The Line Graphs feature was used to access the weekly High Count data throughout the calendar year for each species. This illustrated further occurrences of the species (e.g. as captured in Incidental observations) and seasonal variation in their abundance.

Population data for estuarine birds is collected on an on-going basis by the WeBS[8]. The WeBS scheme monitors the numbers and distribution of non-breeding waterbirds (ducks, swans, geese, grebes, divers, waders, herons, rails, cormorants, gulls and terns) in the UK. Reference populations have been developed based on the citation SPA population of each species (qualifying feature or named assemblage component). WeBS five-year average data (the mean of the validated annual peak counts of each species in the five 'WeBS years' (July to following June) 2019/20 to 2023/24) for the Tay Estuary (which covers Newburgh to the opening of the Firth into St Andrews Bay (**Figure 11-5**)) from the WeBS Online Report was used as the reference population for non-named SPA waterbird assemblage species where there is no SPA citation population given.

For Arctic tern and common tern, there is no cited populations however is considered to support foraging individuals from the Forth Islands SPA breeding population, therefore, this SPA population has been used a reference population for these species.

The desk-based baseline marine ornithology assessment for the area surrounding the Lady Shoal approach channel is summarised in **Table 11-7**.

Table 11-7 Desk-based study results for baseline marine ornithology adjacent to the Lady Shoal approach channel area

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Firth of Tay and Eden Estuary SPA (UK9004121) and Ramsar site (UK13018)			
Bar-tailed godwit	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Little tern	The species was not recorded.	-	-
Marsh harrier	The species was not recorded.	-	-
Redshank	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Greylag goose	Three eBird records in past ten years in August to December, with a high count of two.	1,200 individuals	<1
Pink-footed goose	This species largely uses terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Velvet scoter	Two eBird records in past ten years, in July and December with a high count of 30.	730 individuals	4

[8] *Waterbirds in the UK 2023/24: The Wetland Bird Survey and Goose & Swan Monitoring Programme. BTO/RSPB/JNCC/NatureScot. Thetford. app.bto.org/webs-reporting/ Contains Wetland Bird Survey (WeBS) data from Waterbirds in the UK 2023/24 © copyright and database right 2025. WeBS is a partnership jointly funded by the BTO, RSPB and JNCC, with fieldwork conducted by volunteers.*

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Cormorant	Recorded all year round (weekly high counts typically 5 to 30 individuals).	230 individuals	12
Shelduck	Recorded all year round, with highest counts (10-30 individuals) mainly from February to June.	1,200 individuals	3
Eider	Recorded all year round, up to 2,000 individuals recorded (especially between November and April but also in June and August possibly due to migratory passage).	13,800 individuals	10
Common scoter	The species was not recorded.	-	-
Black-tailed godwit	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Goldeneye	Recorded in small numbers (fewer than 15 individuals) November to March.	230 individuals	7
Red-breasted merganser	Recorded from July to March (weekly high counts of 10 to 100 individuals).	470 individuals	25
Goosander	Recorded March to December (with peak in abundance in June to August – 40 to 200 individuals).	220 individuals	90
Oystercatcher	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Grey plover	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Sanderling	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Dunlin	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Long-tailed duck	Scarce, one eBird record in past ten years, in December.	560 individuals	<1
Red-necked grebe[1]	Scarce, one eBird record in past ten years, in September.	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 0	n/a
Great crested grebe[1]	Recorded infrequently from January to March (1 to 2 individuals).	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 1	n/a
Black-throated diver[1]	Scarce, four eBird records in past ten years, in November to March.	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 0	n/a
Great northern diver[1]	Scarce, one eBird record in past ten years, in March.	BTO WeBS Tay Estuary mean peak count	n/a

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
		2019/20 to 2023/24: 0	
Outer Firth of Forth and St Andrews Bay Complex SPA (UK9020316)			
Red-throated diver	Scarce, two eBird records in past ten years, in October and December.	851 individuals	<1
Slavonian grebe	The species was not recorded.	-	-
Little gull	Recorded infrequently or sporadically from January to August (1 to 10 individuals).	126 individuals	8
Common tern	Recorded infrequently June to September in small numbers (3 to 5 individuals).	334 pairs (based on Forth Islands SPA breeding population)	<1
Arctic tern	Three eBird records in past ten years, in May to August with a high count of three.	540 pairs (based on Forth Islands SPA breeding population)	<1
Eider	Recorded all year round, with up to 2,000 individuals recorded (especially between November and April but also in June and August possibly due to migratory passage).	21,546 individuals	10
Shag	Recorded infrequently in small numbers (typically fewer than 10 individuals) from August to April.	2,426 individuals	<1
Gannet	Four eBird records in past ten years, from July to October with a high count of four.	10,945 individuals	<1
Long-tailed duck	One eBird record in past ten years, in December, with a high count of four.	1,948 individuals	<1
Common scoter	The species was not recorded.	-	-
Velvet scoter	Two eBird records in past ten years, in July and December with a high count of 30.	775 individuals	3
Goldeneye	Recorded in small numbers (fewer than 15 individuals) November to March.	589 individuals	3
Red-breasted merganser	Recorded from July to March (weekly high counts of 10 to 100 individuals).	431 individuals	25
Black-headed gull	Recorded all year round, with peak abundance (100 to 1,000 individuals) from July to February.	26,835 individuals	4
Common gull	Recorded all year round (typically 10 to 100 individuals).	14,647 individuals	<1
Herring gull	Recorded all year round (weekly high counts typically 100 to 400 individuals).	3,044 individuals (breeding) 12,313 (non-breeding)	4
Guillemot	Recorded from July to March in small numbers (typically fewer than 10 individuals).	28,123 individuals	<1

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Kittiwake	One eBird record in past ten years, in July with a high count of one.	12,020 individuals (breeding 3,191 (non-breeding)	<1
Razorbill	Recorded infrequently from August to March in small numbers (typically fewer than five individuals).	5,481 individuals	<1
Puffin	The species was not recorded.	-	-
Manx shearwater	The species was not recorded.	-	-
Notes – 1. Species is not a named assemblage component but is a species vulnerable to disturbance and displacement by vessel traffic			

11.6 Prediction of Potential Effects During the Construction Phase

Potential impacts on ornithology during the construction phase of the Proposed Scheme include:

- Noise and visual disturbance from vessels and piling works;
- Changes in prey availability due to changes in water quality; and
- Displacement of prey species due to underwater noise.

11.6.1 Noise and visual disturbance

The construction phase has the potential to cause acoustic and visual disturbance to bird populations in close proximity to the Proposed Scheme. Estuarine birds can respond to disturbance, both visual and acoustic, in a number of ways. Disturbance may cause birds to move away from an area to another site, in which case the consequence is essentially the same as habitat loss. Disturbance may also cause birds to temporarily interrupt their normal activity, leading to, for example, reduced feeding rates or productivity, or increased energy expenditure through movement away from sources of disturbance. In these ways and others, disturbance effects have the potential to reduce individuals' fitness and could ultimately lead to an increase in mortality.

Some bird species habituate to disturbance. Given that the Port of Dundee a busy working port environment and the Lady Shoal approach channel forms the main navigable channel into the Tay, it is considered that many of the birds using the area of the Proposed Scheme and adjacent habitats would already be habituated to anthropogenic activity, and this has been taken into account in the assessment. Given this, it is considered that the sensitivity of the assemblage present in the vicinity to the Proposed Scheme to be medium.

Birds that are typically found in areas relatively unexposed to day-to-day port activity (e.g. more distant locations such as the shoreline at Broughty ferry and Tayport and the habitat located 1km east of the Proposed Scheme, and offshore areas) would not be exposed to the visual disturbances associated with the construction phase of the Proposed Scheme, since these would be confined to the Port. Even individuals that regularly use 'less exposed' environments within the study area are likely to have some degree of resilience and habituation to anthropogenic activity, given the level of activity that is regular present across the wider study area (e.g. from walkers, dogs, anglers, boats, etc.).

In terms of noise disturbance, the most likely cause of disturbance to birds using the study area during the construction phase would arise as impulsive noise from impact pile driving, although this would be persistent during operational hours and would be classed as a 'regular' (as opposed to periodic or 'irregular') noise source. The assessment of disturbance-related effects on ornithological receptor populations, presented below, focuses specifically on the potential impacts that may arise from noise disturbance during piling activity.

The estuarine habitat in proximity to the Proposed Scheme would be exposed to noise levels within a range that would be expected to result, at worst, in minor disturbance responses such as elevated alertness and / or localised redistribution (Wright *et al.*, 2010; Cutts *et al.*, 2009 and 2013). Individuals that use habitat in close proximity to the piling activity (e.g. on the foreshore adjacent to the works), where disturbance levels are predicted to be high to moderate, would be able to easily relocate to those preferred habitats as an alternative for foraging and / or resting. It should be noted that the temporal magnitude of piling-associated noise disturbance would be short-term (a period of up to 35 days). Birds that are locally displaced would be able to return to all areas following completion of the piling works, as well as at times of the day when piling is not being undertaken. The 2023/2024 and 2024/2025 survey indicates that the potential displacement from the Proposed Scheme represents a very small number and proportion of birds.

Given the reversibility of the impact, the magnitude of impact is assessed to be low; therefore, the significance of the effect on ornithology is **minor adverse**, which is **not significant in EIA terms**.

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

11.6.2 Change in prey availability due to changes in water quality

Dredging and disposal of fine material during the construction phase of the Proposed Scheme would result in a temporary increase in SSC. An increase in SSC within the water column may lead to adverse impacts on prey resources, such as fish, within the water column, which could lead to behavioural responses such as temporary displacement of those species from the affected range. This, in turn, has the potential to affect piscivorous bird species that feed on such resources. Furthermore, high turbidity as a result of increased SSC limits visibility through the water, which may adversely affect the ability of aerial predators to detect prey items in the affected range (Cook and Burton, 2010).

The extent of the sediment plume predicted from the proposed dredging and disposal is described in detail in **Chapter 7**. Increases in SSC would be short term, returning to baseline levels within 30 minutes to 1.5 hours at the disposal site and port, respectively, and up to 5 hours at the Lady Shoal approach channel.

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 dredge material has been undertaken and is reported in **Chapter 8**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal and therefore would not pose a significant risk to prey resources.

As detailed in **Chapter 9**, the increased SSC would not have a significant effect on benthic species; therefore, consequent effects on waterbirds feeding on such prey are unlikely. Sensitivity of non- piscivorous species, such as waders and wildfowl that feed on invertebrates or algae, is negligible.

For piscivorous (or partly piscivorous) waterbird and seabird species, namely tern species, lesser black-backed and herring gull, cormorant species, diving ducks and red-throated diver, the distribution of species recorded in the 2024/2025 survey (**Appendix 11-2**) do not indicate a foraging reliance on areas within the

extent of the predicted sediment plume. Instead, foraging activity is generally located to the east of the Proposed Scheme, indicating that it would be possible for those species to forage in alternative areas unaffected by increases in SSC and potential displacement of prey resources. Piscivorous species are found in low numbers around the Port and are not limited in their ability to forage further afield. Given this adaptability and lack of reliance on specific foraging areas, plus the fact that prey resources are likely to return to affected areas quickly following completion of the dredging and disposal activities, the sensitivity of piscivorous species to this effect is considered to be low.

Given the overall magnitude of impact is considered to be low, the significance of the effect is deemed to be **negligible**, which is **not significant in EIA terms**.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

11.6.3 Displacement of prey species due to underwater noise

Underwater noise from piling and dredging activities during construction may injure, disturb, and displace fish prey species of piscivorous (or partly piscivorous) species, namely tern species, lesser black-backed and herring gull, cormorant species, diving ducks and red-throated diver. If the abundance and / or availability of prey is reduced through displacement or mortality arising from underwater noise, which could adversely affect those species.

Impact piling activities, creating impulsive underwater noise, are considered to pose the greatest risk to prey fish species, with very limited risk posed by other underwater noise sources such as dredging (see **Chapter 10**). Impact piling would be undertaken over an anticipated period of up to 35 days; hence, the indirect effect on piscivorous birds would be short-term.

The effects of underwater noise from the proposed piling on fish is presented in **Chapter 10**, and would not be significant. Additionally, the distribution maps presented in **Appendix 11-2** indicate that there is no particular propensity for concentrated foraging activity within the affected range by any piscivorous species; instead, foraging activity was either spread across the marine area or focused on the west and east of the study area and outside the affected range. Furthermore, the importance of the study area in a regional context is low to moderate, and therefore the sensitivity of the receptor is considered to be medium. For such species, the spatial magnitude of the impact on the receptor population would be low. Given the short-term temporal magnitude, the overall magnitude of impact on most piscivorous waterbird and seabird species screened in for assessment would be low.

Given the above, the significance of the effect is deemed to be **minor adverse**, which is **not significant in EIA terms,** for piscivorous seabirds and waterbirds that may feed on fish resources within the study area.

Invertebrate and algal feeding birds, including non-breeding ringed plover and other waterbirds present along the shoreline, would be unaffected by the indirect effects of underwater noise on prey resources.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

11.7 Prediction of Potential Effects During the Operation Phase

The Proposed Scheme will not change the number or type of vessel berthing at the Port of Dundee and there would be no change in maintenance dredging requirement at the Port nor maintenance dredging of the Lady Shoal approach channel; therefore, there would be no impacts to ornithology during the operational phase.

11.8 Summary

Table 11-8 summarises the potential effects to ornithology assessed in this chapter. Negligible and minor adverse effects are not significant in EIA terms.

Table 11-8 Summary of potential impacts to ornithology as a result of the Proposed Scheme

Potential effect	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Noise and visual disturbance	Medium	Low	Minor adverse	None required	Minor adverse
Change in prey availability due to changes in water quality	Low	Low	Negligible	None required	Negligible
Displacement of prey species due to underwater noise	Medium	Low	Minor adverse	None required	Minor adverse

12 Marine Mammals

12.1 Introduction

This chapter considers the potential impacts of the Proposed Scheme with respect to marine mammals. 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 effects are presented together with the likely residual impacts after these measures have been adopted. Whilst features of European and Ramsar sites are assessed in this chapter, the assessment on these sites is presented in the accompanying shadow HRA.

This chapter is informed by the following chapters and appendices:

- **Chapter 7**: Estuarine Processes
- **Chapter 8**: Marine Water and Sediment Quality
- **Chapter 10**: Fish and Shellfish Ecology
- **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	International	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	International	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 EC Habitats and Birds Directives and measures under the Berne Convention and the Bonn Convention.
Convention on Biological Diversity 1993	International	All cetacean 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 the Baltic, North East Atlantic, Irish	International	All cetacean species	ASCOBANS entered into force in 1994 under the auspices of the Convention on Migratory Species (CMS or Bonn Convention), with additional areas (the north-east Atlantic and Irish Sea) included into the convention in 2008. The aim of the convention is to promote cooperation between parties

Legislation	Level of protection	Species included	Details
and North Seas, 2008 (ASCOBANS)			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	International	All cetacean species	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 (CITES) 1973.	International	All cetacean species	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 reenacted, 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	National	All cetacean species	'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 12 nautical miles (nm).
Nature Conservation (Scotland) Act 2004	National	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.	National	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)	National	All cetacean species	Schedule 5: all cetaceans are fully protected within UK territorial waters. This includes disturbance or harassment of a wild animal (either intentionally or recklessly). Under The Wildlife and Countryside Act (as amended) in Scotland, basking shark are a protected species of fish, and there is a requirement to apply for a basking shark licence for the disturbance or harassment, killing or injury of basking shark (either intentionally or recklessly).
The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014	National	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).
- Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (GES 11)".

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 SACs (and SPA, 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 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.

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, as well as basking shark.

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 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 12 nm) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Regulation 39(1) of these Regulations make it an offence to:

a) Deliberately or recklessly capture, injure or kill a wild animal of an EPS;
b) Deliberately or recklessly:
i. Harass a wild animal or group of wild animals of an EPS;
ii. Disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
iii. Disturb such an animal while it is rearing or otherwise caring for its young;
iv. 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;
v. 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;
vi. 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
vii. 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

Advice received during the EIA screening process (**Section 5.3**) and in the HRA process (see **Section 6**) has been taken into account in undertaking the assessment presented in this chapter.

12.4 Assessment Methodology

12.4.1 Study Area

The study area for marine mammals includes mobile species that have the potential to be present within the Proposed Scheme area. In this case, the study area was set by the Moray Firth bottlenose dolphin population, located approximately 140km from the Proposed Scheme.

12.4.2 Data Sources

The following project specific information on was used to inform the baseline review and assessment of effects:

- Underwater noise modelling (**Appendix 10-1**);
- Sediment dispersion modelling, as described in **Chapter 7**;
- Sediment sample analysis of dredged material, as described in **Chapter 8**; and
- Assessment of potential impacts to benthic habitats, and fish and shellfish (**Chapters 9** and **10**, respectively)

Additionally, a number of data sets have been used to inform the baseline as listed in **Table 12-2**Table 12-2.

Table 12-2 Data sources used to inform marine mammal assessment

Data	Year	Coverage	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-IV) data (Gilles *et al.*, 2023)	Summer 2022	North Sea and European Atlantic waters	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2022, including the proposed offshore development area.
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al.*, 2019)	1980-2018	North-east Atlantic	Provides information on harbour porpoise in the North Sea area.
Management Units (MUs) for cetaceans in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG), 2023)	2023	UK waters	Provides information on cetacean MUs for the proposed offshore development area.
Abundance estimation and movements of bottlenose dolphin along the east coast of Scotland (Arso Civil *et al.*, 2021)	2009-2019	East coast, Scotland	Provides abundance estimates for bottlenose dolphin on the east coast.
Site Condition Monitoring of bottlenose dolphins within the Moray Firth SAC (Cheney *et al.*, 2024)	2017-2022	Moray Firth SAC	Provides information on the population abundance of Bottlenose Dolphins in the Moray First SAC between 2017-2022.

12.4.3 Impact Assessment Methodology

The approach to determining the significance of an impact 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 impact 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.

12.4.3.1 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.

12.4.3.2 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 Biodiversity Action Plan (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 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.

12.4.3.3 Magnitude

The significance of the potential impacts 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	Impact has an irreversible adverse effect on the population or the environment. These impacts threaten the long-term viability, health and functioning of the affected population or environment and typically difficult to mitigate. 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 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	Impacts are noticeable and measurable but do not exceed the limits in which a population can recover or threaten the overall integrity or functioning of the affected environment or population. Permanent assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to effect. OR Temporary assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to effect.
Low	Impacts are detectable, but do not cause significant adverse changes to a population or the habitat the receptors live in. The effects of these impacts are localised and short term in nature without long-term consequences. Permanent assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to effect. OR Intermittent and temporary effect assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Impacts are so minor that they do not cause any significant changes to the environment or population. These impacts are often undetectable of fall within the natural variability of the system. Permanent assessment indicates that less than 0.001% of the reference population anticipated to be exposed to effect. OR Intermittent and temporary assessment indicates that less than 1% of the reference population anticipated to be exposed to effect.

The thresholds defining each level of magnitude of effect for each 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 effect 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 Favourable Condition Status (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 and Department for Environmental Food and Rural Affairs (Defra) advice (Defra, 2003; 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 (Defra, 2003; ASCOBANS, 2015).

12.4.3.4 Effect significance

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

12.4.3.5 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 *Halichoerus grypus* and harbour seal *Phoca vitulina*. 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	Assessment for Range	Assessment for Population Level	Assessment for Supporting Habitats
Harbour porpoise *Phocoena phocoena*	Favourable	Unknown	Unknown
Bottlenose dolphin *Tursiops truncates*	Favourable	Unknown	Unknown
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable	Unknown	Unknown
Minke whale *Balaenoptera acutorostrata*	Favourable	Unknown	Unknown
Grey seal	Favourable	Favourable	Favourable
Harbour seal	Favourable	Unfavourable - inadequate	Unknown

12.4.3.6 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 will be 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 will be 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 impacts on the designated marine mammal populations has been undertaken and presented in the accompanying shadow HRA.

12.5 Baseline Environment

A number of marine mammal species are found off the east coast of Scotland, with the most common being harbour porpoise, bottlenose dolphin, grey seal and harbour seal (Paxton *et al.*, 2016; Evans and Waggitt 2020; Carter *et al.*, 2025). Other species include minke whale *Balaenoptera acutorostrata*, with increased presence in the summer periods (DECC, 2016; Paxton *et al.*, 2016; Waggitt *et al.*, 2019). Aerial survey sightings have been made of bottlenose dolphin south of the Moray Firth (Gilles *et al.*, 2023). Less common marine mammal species in this area include common dolphin *Delphinus delphis*; humpback whale *Megaptera novaeangliae*, killer whale *Orcinus orca*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus* and long-finned pilot whales *Globicephala melas* (Waggitt *et al.*, 2019).

Reported sightings of marine mammal species to the Seawatch Foundation in 2024 and 2025 near to the Port of Dundee, include mainly bottlenose dolphin, with lower numbers of sightings of minke whale, common dolphin, white-beaked dolphin, and harbour porpoise.

There are a number of marine mammal protected areas along the east coast of Scotland, including:

- Firth of Tay and Eden Estuary SAC, designated for harbour seal - approximately 0km from the Proposed Scheme;
- Isle of May SAC, designated for grey seal - approximately 39.5km from the Proposed Scheme;

- Berwickshire and North Northumberland Coast SAC, designated for grey seal – approximately 64km from the Proposed Scheme;
- Southern Trench Marine Protected Area, designated for minke whale - approximately 140km from the Proposed Scheme; and
  Moray Firth SAC, designated for bottlenose dolphin - approximately 138km from the Proposed Scheme.

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; Giles *et al.,* 2023), indicates harbour porpoise to be the most common cetacean species present in the relevant survey block NS-D (**Figure 12-1**Figure 12-1). Other cetacean species recorded in survey blocks NS-D included, white-beaked dolphin, and minke whale. Bottlenose dolphin was recorded in the survey block in the SCANS-III survey in summer 2016 (Hammond *et al.,* 2021), referred to as survey block R.

The marine mammal species most likely to be present within potential impact ranges of the Proposed Scheme are harbour porpoise, bottlenose dolphin, grey seal, and harbour seal. Other species that may be present, although in lower numbers, are minke whale and white-beaked dolphin. All have been included into the assessment.

12.5.1 Harbour Porpoise

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**Figure 12-2) and the estimated abundance of harbour porpoise in this survey block is 38,577 harbour porpoise (95% Confidence Limit (CL) = 18,017- 76,61); with a density estimate of 0.5985 harbour porpoise/km^2 (Coefficient of variation (CV) = 0.367 (Giles *et al.,* 2023).

For harbour porpoise, the Waggitt *et al.* (2019) distribution maps (**Figure 12-2**) 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 0.386 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% Confidence Interval (CI) = 289,498 – 419,967); The UK portion is estimated to be an abundance of 159,632 (IAMMWG, 2023).

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; Santos *et al.,* 2004).

Figure 12-1 Area covered by SCANS-IV and adjacent surveys. SCANS-IV: pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green were surveyed by the Irish ObSERVE project. (Giles et al., 2023).

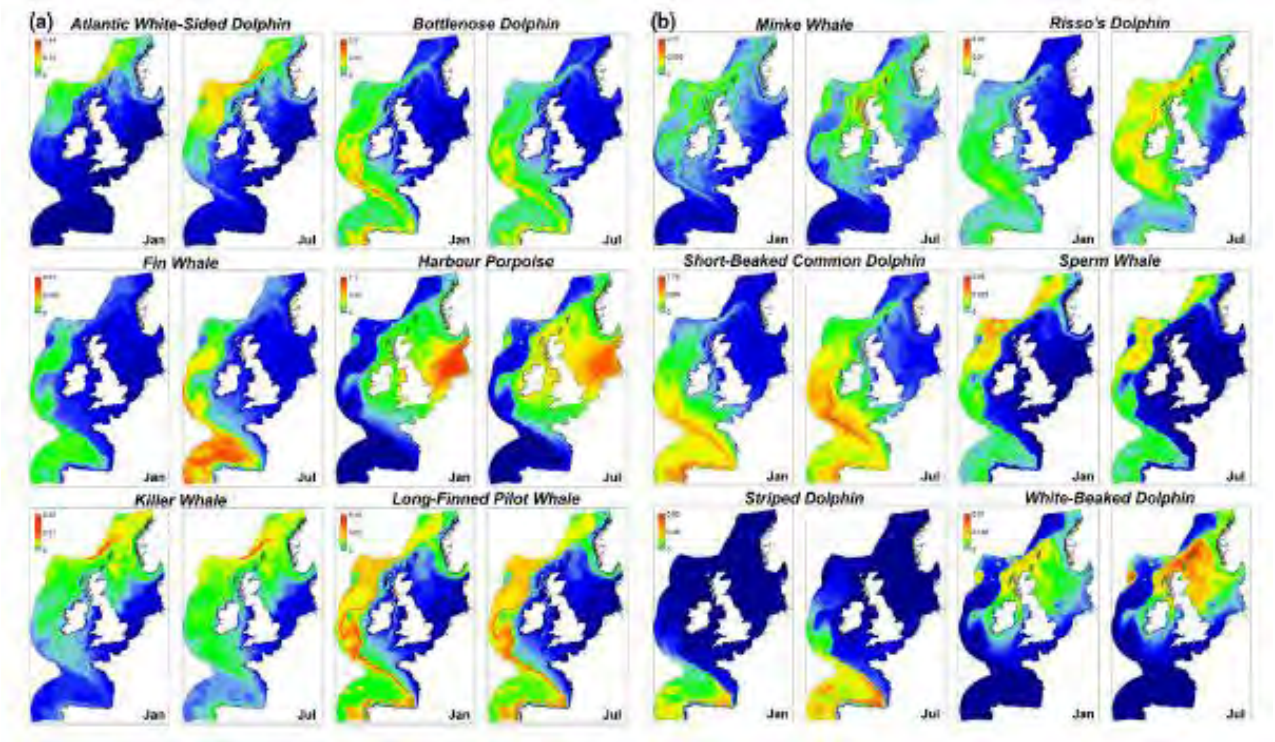

Figure 12-2 Spatial variation in predicted densities (animals per km^2) of cetacean species in January and July in the North- East Atlantic (taken from Waggitt et al., 2019)

12.5.2 Bottlenose Dolphin

Although the closest designated site for bottlenose dolphins is the Moray Firth SAC, bottlenose dolphins are known to be common along the east coast of Scotland. In recent years, the population of bottlenose dolphin has been extending its range south (Cheney *et al.*, 2024). The bottlenose dolphin occurrence is common close to the Firth of Tay, particularly as at the mouth of the river Tay near to Broughty Ferry beach it is a popular place for the public to see bottlenose dolphin sightings (Dundee City Council, 2024).

No bottlenose dolphin was recorded in the SCANS-IV survey; however, for the SCANS-III survey area in survey block R (where the Proposed Scheme is), bottlenose dolphin abundance in the summer of 2016 was estimated to be 19,201, with an overall estimated density of 0.0159/km^2 (CV = 0.242; 95% CL = 11,404 - 29,670; Hammond *et al.*, 2021). The SCANS-III survey block R has 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 by Waggitt *et al.*, (2019) (**Figure 12-2**) 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 0.0001 individuals per km^2; however, 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 226 (95% CL = 155 – 216); (Cheney *et al.*, 2024).

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.*, 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

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 (JCP) 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 SCANS-IV survey, white-beaked dolphin abundance in the summer of 2022 was estimated to be 5,149 in survey block NS-D with an overall estimated density of 0.0799 white-beaked dolphin/km^2 (CV = 0.481; CL = 961 -10,586; Giles *et al.*, 2023).

The distribution maps (**Figure 12-2**) by Waggitt *et al.*, *(*2019) for white-beaked dolphins 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 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); The UK portion is estimated to be an abundance of 34,025 (IAMMWG, 2023).

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). White-beaked dolphin have also been observed to associate with herring *Clupea harengus* and mackeral *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

Minke whale 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. JCP data; Paxton *et al.*, 2016).

While minke whale are not regularly a common species near to the Port of Dundee, as seen in the latest SCANS survey density estimate of 0.0419 minke whale per km^2 in the NS-D block, abundance 2,702 (CL of 5477-7,357) (Gilles *et al.*, 2023); however, there are reports of higher densities closer to the Southern Trench area, with adjusted densities of up to 10 per km^2 observed within the Southern Trench MPA area (SNH, 2014). Due to the distance between the MPA and the Proposed Scheme, there is no potential for direct impacts.

For minke whale, the distribution maps (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 0.0046 minke whale per km^2.

There is one 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). The UK portion is estimated to be an abundance of 10,288 (IAMMWG, 2023).

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.

A study into the diet of minke whale in the north-eastern Atlantic sampled a total of 210 minke whale for stomach contents from 2000 to 2004, with a total of 37 minke whale samples analysed within the northern North Sea. Within this area, minke whale were found to prey upon a number of different species at the population level, however, 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea.

12.5.5 Grey Seal

On the east coast of Scotland, a relatively high number of grey seals breed with numbers continuously increasing each year. The main breeding colonies seen along this coast start from the Firth of Forth and extend south towards Fast Castle, with the total pup production in Firth of Forth being 7,400 in 2021 (SCOS, 2024). There are no main grey seal breeding colonies were reported within the Firth of Tay (SCOS, 2024) but there is a known haul-out sandbanks in the Tayport - Tentsmuir Coast SSSI. The outer sandflats provide a haul-out for grey seals in the area as a summer, but not for breeding or moulting (NatureScot, 2010). Within the Firth of Tay, the closest designated seal haul-out site is Craigleith, for grey seal, approximately 55.2km from the Proposed Scheme. As such, designated seal haul-out sites would not be affected by the Proposed Scheme.

Grey seal 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, 2024). Compared with other times of the year, grey seal 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, 2020).

Grey seal forage in the open sea and they may range widely to forage and frequently travel over 100km between haul-out sites (SCOS, 2024). 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 they can feed up to several hundred kilometres offshore (SCOS, 2024).

Carter *et al.*, (2025) provides habitat-based predictions of at-sea distribution for grey and harbour seals in the Scottish waters. The habitat preference approach predicted distribution maps provide estimates per species, on a 5km x 5km grid, of absolute and relative at-sea density for seals in Scottish waters. The grey seal absolute density estimates for the Proposed Scheme are calculated from the 5km x 5km grid cells that overlap with the Proposed Scheme. The absolute at-sea density estimates from this data has been used in the assessment, as the worst-case, with a grey seal density estimate of 0.774 grey seal/km^2 (Carter *et al.*, 2025).

The most recent counts of grey seal in the August surveys 2016-2019, estimated that the minimum count of grey seals in the UK was 39,902 (SCOS, 2024), using a 0.2515 correction factor to account for diving seals, the predicted population is 173,360 for the whole of the UK, 83,272 in Scotland. As grey seal 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 MU and East Scotland MU (IAMMWG, 2013; SCOS, 2024). Assessments have been made against the East Scotland MU (as is the one within which the Proposed Scheme lies) and against the Moray Firth and East Scotland MUs together. The reference population for these areas are as follows:

- East Scotland MU = 6,298 grey seal (SCOS, 2024)
- Moray Firth MU = 5,384 grey seal (SCOS, 2024)

Diet and Prey Species

Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2024; Hammond and Grellier 2006). Diet varies seasonally and from region to region (SCOS, 2024). 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, flounder, and dab *Limanda limanda* (Hammond and Grellier, 2006). Amongst these, sandeels are typically the predominant prey species.

12.5.6 Harbour seal

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 sand banks 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 seals normally feed within 50km around their haul out sites (SCOS, 2024). At the southeastern end of the Firth of Tay are the sandbanks in the Tayport - Tentsmuir Coast SSSI. The outer sandflats provide for a nationally important pupping and moulting haul-out for harbour seals (NatureScot, 2010). Sandbanks are usually mobile and are influenced by water movements therefore natural change in the extent and distribution of this feature is expected (NatureScot, 2024).

Tracking studies have shown that harbour seal typically travel between 50km and 100km offshore and can travel 200km between haul-out sites (Lowry *et al.*, 2001; Sharples *et al.*, 2012). The range of these trips varies depending on the location and surrounding marine habitat. 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 (Russell *et al.*, 2017; Carter *et al.*, 2020, SCOS, 2024).

The harbour seal absolute density estimates for the Proposed Scheme area has been calculated from the 5km x 5km cells (Carter *et al.*, 2025). The mean at-sea density estimate has been used in the assessment, as the worst-case, with a mean harbour seal density estimate of 0.08779 harbour seal per km^2.

Harbour seal are counted while they are on land during their August moult, giving a minimum estimate of population size (SCOS, 2024). Combining the most recent counts (2016-2023) gives a total of 29,178, applying a correcting factor of 0.72 to account for diving seals, the total UK count is 40,525, with 34,475 in Scotland (SCOS, 2024). As for grey seal, the reference population extent for harbour seal will incorporate the East Scotland MU and Moray Firth MU (IAMMWG, 2013; SCOS, 2024).

The reference population for harbour seal is therefore currently based on the following most recent estimates for the:

- East Scotland MU = 383 harbour seal (SCOS, 2024)
- Moray Firth MU = 1,365 harbour seal (SCOS, 2024)

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 30km-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 and do not travel 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 12-7**. For the Proposed Scheme, the assessment will be carried out suing the densities and the UK portion of the reference population, with the larger/wider abundance used for the cumulative assessment (see **Section 13.1**).

Table 12-7 Marine mammal densities and reference populations of relevance to the Proposed Scheme

Marine mammal	Density (/km^2)	Source	Reference population	Source
Harbour porpoise	0.5985	SCANS-IV block NS-D (Giles *et al.*, 2023)	346601 (NS MU) 159,632 (NS MU UK portion)	IAMMWG (2023)
Bottlenose dolphin	0.0298	SCANS-III block R (Hammond *et al.*, 2021)	226 (CES MU)	Cheney et al (2024)
White-beaked dolphin	0.0799	SCANS-IV block NS-D (Giles *et al.*, 2023)	43,951 (CGNS MU) 34,025 (CGNS MU UK portion)	IAMMWG (2023)

Marine mammal	Density (/km^2)	Source	Reference population	Source
Minke whale	0.0419	SCANS-IV block NS-D (Giles *et al.*, 2023)	20,118 (CGNS MU) 10,288 (CGNS MU UK portion)	IAMMWG (2023)
Grey seal	0.744	(Carter *et al.*, 2025)	6, 298 (ES MU) & 11,682 (ES & MF MU)	SCOS, 2024
Harbour seal	0.0877		383 (ES MU) & 1,749 (ES & MF MU	SCOS, 2024

12.6 Prediction of Effects During the Construction Phase

Potential impacts on marine mammals during the construction phase of the Proposed Scheme include:

- Auditory injury and disturbance from underwater noise from piling operations;
- Auditory injury and disturbance from underwater noise from dredging and the presence of vessels;
- Increased collision risk with vessels during construction; and
- Indirect effects due to changes in water quality and prey availability.

Piling impacts would be temporary and for a short period only. If required, underwater noise impacts would be managed using standard mitigation measures in line with the Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010). This would ensure that the potential effect ranges for instantaneous permanent auditory injury are mitigated for, therefore no significant effects are anticipated.

Vessel good practice measures would reduce the potential for increased disturbance and collision risk. The measures include ensuring that vessel movements, where practicable, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, as well as reduced vessel speeds wherever practicable.

12.6.1 Potential of effects from underwater noise during piling

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 to impact marine mammals and therefore has been assessed as the worst-case, as shown by the underwater noise modelling report (**Appendix 10-1**).

Impact piling has long been established as a source of high level underwater noise (Nedwell *et al.*, 2007; Thomsen *et al.*, 2006). If a marine mammal is located very close to the piling sound source, the high peak sound pressure levels (SPL) 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, or PTS (Permanent Threshold Shift) or from a temporary loss in hearing sensitivity, or TTS (Temporary Threshold Shift). 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}).

Cetaceans (whales, dolphins and porpoises) 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, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are assessed as having medium sensitivity to TTS onset due to underwater noise.

12.6.1.1 Assessment of auditory injury due to piling

Southall *et al.* (2019) guidelines and weightings were used to predict the likely range at which the thresholds for impulsive and non-impulsive sounds would be exceeded by marine mammals (**Appendix 10-1**). Using the peak sound pressure level (SPL_{peak}) criteria applied to the predicted noise contours, it is unlikely that animals will exceed the PTS threshold for all marine mammal species at any range from the impact piling activities. Predicted impact ranges are also presented using SEL for a fleeing animal. These details, along with TTS impact ranges predicted across all groups, are presented in **Table 12-8**.

The predicted impact range for PTS in all marine mammals except for harbour porpoise is predicted to be not exceeded the given criteria based on the results of the modelling which means that noise levels from piling have minimal risk of auditory injury (PTS/TTS) to marine mammals.

Table 12-8 Estimated impact ranges for impact piling activities using the Southall et al. (2019) SPL_{peak}) marine mammal criteria for impulsive noise sources and SEL marine mammal criteria assuming a fleeing anima=l for impulsive noise sources.

Southall *et al.* (2019) criteria (Impulsive)		Estimated impact range (m) using SPL_{peak}	Estimated impact range (m) using SEL, for fleeing animal
Low Frequency (LF) cetaceans (minke whale)	PTS	No Exceedance	No Exceedance
	TTS	10	10
High Frequency (HF) cetaceans (dolphin species)	PTS	No Exceedance	No Exceedance
	TTS	No Exceedance	No Exceedance
Very High Frequency (VHF) cetaceans (harbour porpoise)	PTS	No Exceedance	<10
	TTS	10	80
Phocids in Water (PCW) (seals)	PTS	No Exceedance	No Exceedance
	TTS	No Exceedance	No Exceedance

For harbour porpoise using SEL, with a fleeing response, the predicted impact range for PTS is 10m, which equates to an impact area of 0.00031km^2. Although it is very unlikely for any marine mammal to remain within close proximity to a noisy activity, if that was the case, less than one individual (0.0002) would potentially be at risk of PTS, 0.0000001% of the NS MU (UK portion) could be affected. The predicted impact range for TTS is up to 80m (0.02km^2), resulting in less than two individuals (1.2) that could be impacted and 0.000008% of the NS MU (UK portion) population could be affected.

The predicted impact range for TTS for minke whale is 10m (0.00031km^2), less than one individual (0.001) could be impacted; 0.0000001% of the CGNS MU UK reference population could be impacted.

The significance effect for PTS in marine mammals is assessed as negligible resulting in a potential impact of **minor adverse** significance**,** which is **not significant in EIA terms.** For TTS, the magnitude is also assessed as negligible resulting in a potential impact of **negligible** significance, which is **not significant in EIA terms** (**Table 12-9**).

Table 12-9 Significance of effect of auditory injury from piling to marine mammals

	Potential impact	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
All Marine mammals	PTS	High	Negligible	Minor adverse	JNCC soft start procedure	Minor adverse
	TTS	Medium	Negligible	Negligible		Negligible

Mitigation measures and residual impact
JNCC soft start procedures will be adhered to. The residual impact is minor adverse/negligible, which is not significant in EIA terms.

12.6.1.2 Assessment of disturbance due to piling

For marine mammal species, there is currently no agreed threshold for disturbance from underwater noise. The US National Marine Fisheries Service (NMFS) guidance (NMFS, 2018) sets the Level B harassment threshold[9] for marine mammals at 160 dB re 1 µPa (root mean square (rms)) for impulsive noise and 120 dB re 1 µPa (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 as 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 240 dB re 1 µPa. 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.

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; therefore, with a low sensitivity, the significance effect for all marine mammals is assessed as **negligible**, which is **not significant in EIA terms** (**Table 12-10**).

[9] *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*

Table 12-10 Significance of effect of disturbance from piling to marine mammals

	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
All Marine mammals	Low	Low	Negligible	None required	Negligible

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

12.6.2 Potential Impacts from underwater noise during dredging works

12.6.2.1 Assessment of auditory Injury

The Southall *et al.* (2019) guidelines and weightings were used to predict the likely range at which the thresholds for impulsive and non-impulsive sounds would be exceeded by marine mammals (**Appendix 10-1**). When the SEL_{cum} criteria for non-impulsive noise is applied to the predicted noise contours, it is unlikely that animals will exceed the PTS threshold for all marine mammal species at any range from the dredging activities. This assumes that the dredging is taking place continuously for eight hours, and that the animals flee away from the noise source at a constant speed.

The predicted impact range for PTS in all marine mammals except for harbour porpoise and minke whale due to impact piling is predicted to be No Exceedance, indicating that no exceedance is expected for the given criteria based on the results of the modelling which means that noise levels from piling have minimal risk of permeant auditory injury to marine mammals. For TTS, the estimated impact ranges is <10m for minke whale and up to 30m for harbour porpoise (**Table 12-11**).

Table 12-11 Estimated impact ranges for non-impulsive sounds using the Southall et al. (2019) SEL_{cum} marine mammal criteria for non-impulsive noise sources assuming a fleeing animal.

Southall *et al.* (2019) criteria (Impulsive)		Estimated impact range (m) using SPL_{peak}	Estimated impact range (m) using SEL, for fleeing animal
LF cetaceans (minke whale)	PTS	No Exceedance	No Exceedance
	TTS	<10	<10
HF cetaceans (dolphin species)	PTS	No Exceedance	No Exceedance
	TTS	No Exceedance	No Exceedance
VHF cetaceans (harbour porpoise)	PTS	No Exceedance	No Exceedance
	TTS	20	30
Phocids in Water (PCW) (seals)	PTS	No Exceedance	No Exceedance
	TTS	No Exceedance	No Exceedance

Any risk of auditory injury to harbour porpoise or minke whale would be less that what was assessed in **Section 12.5.1.1** and therefore it is concluded that there would be no significance effect to any marine mammal, as any potential risk of PTS is assessed as **minor adverse** and TTS as **negligible,** both of which are **not significant in EIA terms** (**Table 12-12**).

Table 12-12 Significance of effect of auditory injury from dredging and vessel activity to marine mammals

	Potential impact	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
All Marine mammals	PTS	High	Negligible	Minor adverse	None required	Minor adverse
	TTS	Medium	Negligible	Negligible		Negligible

Mitigation measures and residual impact

No mitigation is required to reduce the impact significance. The residual impact is minor adverse/negligible, which is not significant in EIA terms.

12.6.2.2 Assessment of disturbance due to dredging activities

As noted for piling, the area surrounding the Port of Dundee is a busy marine area, and any marine mammals present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, that the dredging works will be small in scale and temporary, any potential for disturbance would be localised, and that it is unlikely to cause any significant disturbance to marine mammals in the area, it is unlikely that there would be any potential for any significant effect on marine mammals, as a result of dredging activity.

Sound sources include for dredging include the dragging of equipment on the seabed 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 dredgers are typically low frequencies, up to and including 1kHz (Robinson *et al*., 2011). Underwater noise from dredging is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011).

McQueen *et al.* (2020) found that habitat avoidance was not at a sufficient spatial scale to pose a risk to seals, in the context of activity in dredging areas (adjacent to navigation channels and port infrastructure areas). 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 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).

Without any know disturbance ranges of dredging to marine mammals, a 2km disturbance range and area of 12.57km^2 has been applied as previous studies by Brandt *et al.* (2018) and Benhemma-Le Gall *et al.* (2021) show that harbour porpoise could be disturbed up to 2km from construction vessels in renewables, therefore this disturbance range has been applied to all marine mammals. A 2km disturbance range is considered precautionary in this assessment as dredging is anticipated to be a low level noise, 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. **Table 12-13** presents the assessment for any potential disturbance from dredging activities using a 2km disturbance range.

Table 12-13 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of disturbance from dredging activities using a 2km disturbance range

Marine mammal species	Maximum number of individuals (% of reference population (UK portion)	Magnitude
Harbour porpoise	8 (0.005% NS MU)	Negligible
Bottlenose dolphin	<1 (0.4) (0.2% CES MU)	Negligible
White-beaked dolphin	1 (0.003% CGNS MU)	Negligible

Marine mammal species	Maximum number of individuals (% of reference population (UK portion)	Magnitude
Minke whale	<1 (0.5) (0.005% CGNS MU)	Negligible
Grey seal	<10 (0.1% ES MU & 0.08 ES & MF MU)	Negligible
Harbour seal	1 (0.3% ES MU & 0.06 ES & MF MU)	Negligible

Magnitude of wider MU's in brackets; ES = East Scotland; MF = Moray Firth

The significance of effect has been assessed as **negligible**, which is **not significant in EIA terms** (**Table 12-14**).

Table 12-14 Significance of effect of disturbance from dredging and vessel activity to marine mammals

Marine mammal species	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
Harbour porpoise	Low	Negligible	Negligible	None required	Negligible
Bottlenose dolphin		Negligible	Negligible		Negligible
White-beaked dolphin		Negligible	Negligible		Negligible
Minke whale		Negligible	Negligible		Negligible
Grey seal		Negligible (negligible)	Negligible		Negligible
Harbour seal		Negligible (negligible)	Negligible		Negligible

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

12.6.3 Potential Impacts from disturbance of seals at haul-out sites

Seals at haul-outs vary in their reaction to construction disturbance depending on disturbance type (vessel noise/presence, piling etc,) and proximity to the sites. The deepening of a section of the Lady Shoal approach channel is approximately 340m from the nearest seal haul-out located in the Tayport - Tentsmuir Coast SSSI.

The most common disturbance effects at haul out sites include increased vigilance and 'flushing' behaviour, which can be energetically taxing especially if pups are present or during moulting season when seals tend to spend more time on land (Machernis *et al.,* 2018). A study was carried out by SMRU (Paterson *et al.,* 2015) using a series of controlled disturbance tests at harbour seal haul-out sites, consisting of regular (every three days) disturbance through direct approaches by vessel and effectively 'chasing' the seals into the water. The seal behaviour was recorded via GPS tags and found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than would be considered normal (for example seals travelling between sites) and the seals were found to haul-out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

Further studies on the effects of vessel disturbance on harbour seals when they are hauled out, suggest that even with repeated disturbance events that are severe enough to cause individuals to flee into the water, the likelihood of harbour seals moving to a different haul-out site would not increase. Furthermore, this appeared to have little effect on their movements and foraging behaviour (Paterson *et al.* 2019). In areas

of high vessel traffic, there can be habituation effects and disturbance behaviours are generally reduced over time (Strong *et al.,* 2010).

It is expected that if there is any disturbance to seals at haul-out sites from dredging activities it is a short-term effect. For example, a 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% pre-disturbance levels four hours after a disturbance event (Paterson *et al.,* 2019).

A study of the reactions of harbour seal from cruise ships found that, if a cruise ship (which are larger and nosier than the dredging vessels and activities) was less than 100m from a harbour seal haul-out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul-out site (Jansen *et al.,* 2010). At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water (Jansen *et al.,* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

The sensitivity of grey seal to disturbance to seal haul-out sites is therefore low. During the breeding season and annual moult, the sensitivity of harbour seal to disturbance to seal haul-out sites is considered to be medium.

Taking into account the proximity of the shipping channel to and from existing ports, it is likely that seals hauled-out along this route would be habituated to the noise, movements and presence of vessels; therefore, the magnitude of impact of grey and harbour seals at haul-out sites to disturbance from dredging vessels and activities is negligible.

The significance of effect has therefore been assessed as **negligible**, which is **not significant in EIA terms** (**Table 12-15**).

Table 12-15 Significance of effect of disturbance at seal haul-out sites from dredging and vessel activity

Marine mammal species	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
Grey seal	Low	Negligible	Negligible	Scottish Marine Wildlife Watching Code	Negligible
Harbour seal	Medium	Negligible	Negligible		Negligible

Mitigation measures and residual impact

As best practice, vessels used during the construction phase of the Proposed Scheme will adhere to the Scottish Marine Wildlife Watching Code. Vessel movements would follow set routes located in areas to avoid disturbance at seal haul-out sites. All vessel movements would be kept to the minimum number that is required to undertake the works to reduce disturbance. Additionally, vessel operators would maintain a minimum of distances of 100m from seal haul-out sites when transiting outside of main shipping channels, particularly during sensitive periods for breeding and moulting. The residual impact remains negligible, which is not significant in EIA terms.

12.6.4 Potential for indirect effects as a result of changes to water quality and prey availability

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. Therefore, marine mammals are considered to have a negligible sensitivity to any direct impacts from suspended sediment during construction activities.

An increase in SSCs 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 7**).

The magnitude of the temporary effect of increase in SSCs for all species is low. The overall impact significance is negligible. 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 8.5**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal.

It is considered that magnitude of impact for all marine mammals would be negligible, resulting in a **negligible effect**, which is **not significant in EIA terms.**

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is negligible, which is not significant in EIA terms.

12.7 Prediction of Effects During the Operational Phase

The Proposed Scheme will not change the number or type of vessel berthing at the Port of Dundee and there would be no change in maintenance dredging requirement at the Port nor maintenance dredging of the Lady Shoal approach channel; therefore, there would be no impacts to marine mammals during the operational phase.

12.8 Summary

A summary of the potential effects on marine mammals are set out in **Table 12-16**.

Table 12-16 Summary of potential impacts to marine mammals as a result of the Proposed Scheme

Potential Impact	Sensitivity	Magnitude	Significance Effects	Mitigation measures	Residual effect
Auditory injury from piling activity	High	Negligible	Minor adverse	JNCC soft start procedure	Minor adverse
Disturbance from piling activity	Low	Negligible	Negligible	None required	Negligible
Disturbance from dredging	Low	Negligible	Negligible		Negligible
Disturbance of seals at haul-out sites	Medium - Low	Negligible	Negligible	Scottish Marine Wildlife Watching Code	Negligible
Indirect effects due to changes in water quality	Low	Negligible	Negligible	None required	Negligible

13 Cumulative Impact Assessment

In addition to the determination of the potential impacts from the Proposed Scheme 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 into account in the EIA process and can be excluded from the Cumulative Impact Assessment (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 consented 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 Scheme and, therefore, whether further assessment is required (**Table 13-1**).

Table 13-1 Long list of projects for consideration of cumulative effects

Project	Distance from the Proposed Scheme (approximate)	Date of Activity	Screened in for consideration
Port of Dundee proposed extension to laydown area and landside improvements to PCW	0km	August 2025 - June 2026	Yes – potential overlap of construction timeframes and cumulative effects on the same receptor populations of otter and birds. Given that the proposed extension to laydown area and landside improvements would have no effects on the marine environment, cumulative effects for marine receptors have been ruled out.
Seagreen OWF operation and maintenance (O&M)	6km	01/01/2024 - 31/12/2026	Yes – potential overlap in timeframes.
Neart na Goeithe OWF	28km	2024-2030	No – no known activities.

Project	Distance from the Proposed Scheme (approximate)	Date of Activity	Screened in for consideration
Inch Cape OWF - Landfall	57km	23/05/2024 - 31/12/2028	No - No EIA required, no effect on marine mammals.
Berwick Bank OWF geophysical survey	62km	01/01/2024 - 31/12/2027	Yes – potential overlap in construction timeframes.
Eastern Green Link Subsea cable construction	67km	20/05/2025 - 31/12/2031	Yes – potential overlap in construction timeframes.
North Sea Renewables Grid OWF geophysical surveys	112km	01/10/2024 – 01/10/2025	Yes – potential overlap in construction timeframes.
Moray West OWF O&M	248km	01/01/2023 – 31/12/2025	Yes – potential overlap in timeframes.
Beatrice O&G Decommissioning topside, jacket and subsea removals	269km	2025-2029	No – While this is within the study area for the dolphin population, the noise and disturbance levels were not considered to have a cumulative effect and were therefore screened out.

With the exception of the 'Port of Dundee proposed extension to laydown area and landside improvements to PCW' project, all other projects are further than 5km from the Proposed Scheme. As such, otter and ornithological features, for the reasons set out in **Table 13-1** and marine mammals, as highly mobile species with wide ranges, are at risk of cumulative impacts from the other projects. Due to the limited potential for any effect from either a change in water quality or a change in prey availability, this CIA focuses on the potential for cumulative underwater noise impacts only for marine mammals. In addition, as each project is required to provide mitigation for any potential for PTS onset, there is no potential for PTS onset at the Proposed Scheme cumulative with other projects; therefore, the following underwater noise assessment will include the potential for disturbance only.

13.1 Assessment of Cumulative Effects

Based on the screening assessment, the following projects have been screened into the CIA:

- Otter:
  - Port of Dundee proposed extension to laydown area and landside improvements to PCW
- Marine mammals:
  - Seagreen OWF O&M;
  - Berwick Bank OWF construction;
  - Eastern Green Link Subsea cable construction 1&2;
  - North Sea Renewables Grid OWF geophysical surveys; and
  - Moray West OWF O&M
- Ornithology:
  - Port of Dundee proposed extension to laydown area and landside improvements to PCW.

13.1.1 CIA – otter

The proposed improvements to the PCW as part of the Proposed Scheme has the potential to result in cumulative impacts with the proposed extension to laydown area and landside improvements to PCW at the Port of Dundee. Both projects have proposed mitigation measures to avoid and minimise potential impacts to otter, including the implementation of a sensitive lighting strategy. In addition, the landside improvements to PCW at the Port of Dundee will adhere to the following good practice measures:

- Cover / fence-off any excavations, or provide escape ramps at the end of the working day to avoid animals becoming trapped (if an animal does become trapped, advice would be sought immediately from NatureScot);
- Cap any temporarily exposed pipe systems out of work hours; and
- Avoid unnecessary disturbance to habitats by minimising the extent of ground clearance, as far as possible.

With the implementation of the mitigation measures proposed by the Proposed Scheme and the proposed 'Port of Dundee proposed extension to laydown area and landside improvements to PCW' project, cumulative impacts to otter are considered to be of **minor adverse** significance, which is **not significant in EIA terms**.

13.1.2 CIA – marine mammals

For cetaceans the density has been selected from the SCANs survey block of where the project is located and using the IAMMWG abundance for their full MU rather than the UK portion (**Table 12-7**). For grey and harbour seal, the density estimated from the Proposed Scheme has been used with the wider MU, ES and MF MU. For each marine mammal assessed in this EIA, an assessment of cumulative impacts has been undertaken with each project screened to determine the potential for significant effects. The results of these are set out in **Table 13-2** to **Table 13-7**.

The magnitude for harbour porpoise is negligible with less than 1% of the NS population being affected (**Table 13-2**).

Table 13-2 Cumulative effects for harbour porpoise

Project	Density (/km^2)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.5985	12.566	7.5
Seagreen O&M	0.5985	50.27	30.1
Eastern Green Link	0.2813	50.27	14.1
North Sea Renewables Grid geophysical surveys	0.5985	78.54	47.0
Berwick bank geophysical surveys	0.5985	78.54	47.0
Moray west O&M	0.2813	50.27	14.1
Total number			**190**

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Percentage of NS MU			**0.05%**
Magnitude of cumulative impact			**Negligible**

The magnitude for bottlenose dolphin is low with up to 3% of the CES population being affected (**Table 13-3**).

Table 13-3 Cumulative effects for bottlenose dolphin

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.0298	12.566	0.4
Seagreen O&M	0.0298	50.27	1.5
Eastern Green Link	0.0037	50.27	0.2
North Sea Renewables Grid geophysical surveys	0.0298	78.54	2.3
Berwick bank geophysical surveys	0.0298	78.54	2.3
Moray west O&M	0.0037	50.27	0.2
Total number of bottlenose dolphin			**9.0**
Percentage of CES MU			**3.7%**
Magnitude of cumulative impact			**Low**

The magnitude for white-beaked dolphin is assessed as negligible with less than 1% of the CGNS population being effected (**Table 13-4**).

Table 13-4 Cumulative effects for white-beaked dolphin

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.0799	12.566	1.0
Seagreen O&M	0.0799	50.27	4.0
Eastern Green Link	0.1352	50.27	6.8
North Sea Renewables Grid geophysical surveys	0.0799	78.54	6.3
Berwick bank geophysical surveys	0.0799	78.54	6.3
Moray west O&M	0.1352	50.27	6.8
Total number			**35.0**

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Percentage of CGNS MU			**0.08%**
Magnitude of cumulative impact			**Negligible**

The magnitude for minke whale is assessed as negligible with less than 1% of the CGNS population being potentially affected (**Table 13-5**).

Table 13-5 Cumulative effects for minke whale

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.0419	12.566	0.5
Seagreen O&M	0.0419	50.27	2.1
Eastern Green Link	0.0116	50.27	0.6
North Sea Renewables Grid geophysical surveys	0.0419	78.54	3.3
Berwick bank geophysical surveys	0.0419	78.54	3.3
Moray west O&M	0.0116	50.27	0.6
Total number			**13.0**
Percentage of CGNS MU			**0.06%**
Magnitude of cumulative impact			**Negligible**

The magnitude for grey seal is assessed as low with up to 2% of the East Scotland and Moray Firth population being potentially affected (**Table 13-6**).

Table 13-6 Cumulative effects for grey seal

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.744	12.566	9.3
Seagreen O&M	0.744	50.27	37.4
Eastern Green Link	0.744	50.27	37.4
North Sea Renewables Grid geophysical surveys	0.744	78.54	58.4
Berwick bank geophysical surveys	0.744	78.54	58.4
Moray west O&M	0.744	50.27	37.4
Total number			**276.0**
Percentage of East Scotland and Moray Firth MU			**2.4%**

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Magnitude of cumulative impact			**Low**

The magnitude for harbour seal is assessed as low with less than 2% of the East Scotland and Moray Firth population being potentially affected (**Table 13-7**).

Table 13-7 Cumulative effects harbour seal

Project	Density (/km²)	Effect area	Maximum number of individuals potentially disturbed
Proposed Scheme	0.08779	12.566	1.1
Seagreen O&M	0.08779	50.27	4.4
Eastern Green Link	0.08779	50.27	4.4
North Sea Renewables Grid geophysical surveys	0.08779	78.54	6.9
Berwick bank geophysical surveys	0.08779	78.54	6.9
Moray west O&M	0.08779	50.27	4.4
Total number			**33.0**
Percentage of East Scotland and Moray Firth MU			**1.8%**
Magnitude of cumulative impact			**Low**

The summary of cumulative effects with other projects is presented in **Table 13-8**.

Table 13-8 Summary of cumulative effects with other projects

Species	Sensitivity	Magnitude	Significance
Otter	High	Low	Minor
Harbour porpoise	Low	Negligible	Negligible
Bottlenose dolphin		Low	Negligible
White-beaked dolphin		Negligible	Negligible
Minke whale		Negligible	Negligible
Grey seal		Low	Negligible
Harbour seal		Low	Negligible

13.1.3 CIA – ornithology

The proposed improvement of the PCW as part of the Proposed Scheme has the potential to result in cumulative impacts with the proposed landside improvements to PCW, specifically with impact piling. The worst case scenario would be where piling works are carried out sequentially, resulting in a combined piling duration of up to 65 days.

The bird surveys carried out at the Port of Dundee have shown that the use of the Port and surrounding area by waterbirds and seabirds is low (see **Section 11.5.6.1** and **Section 11.5.6.2**). Given this and the availability of suitable habitats nearby that birds could move into, the sensitivity of the ornithology receptors is considered to be medium. The worst case piling scenario would be for a short duration, temporary and affect an area localised to the Port; therefore, the magnitude of the potential cumulative impact would be low. As such, the significance of the potential cumulative impact to ornithology would be of **minor adverse** significance, which is **not significant in EIA terms**.

14 Summary of Potential Effects and Mitigation Measures

Table 14-1 lists the potential effects that are predicted to arise as a result of the Proposed Scheme. The significance of each of the potential effects is stated, along with any mitigation measures that are recommended to avoid or reduce adverse impacts. The residual effect (i.e. the significance of the potential effect remaining following mitigation) is also stated. Negligible and minor adverse effects are not significant in EIA terms.

Table 14-1 Summary of potential environmental effects

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual Effect
Estuarine Processes				
Predicted changes to suspended sediment concentrations due to dredging and disposal	Marine water quality	Negligible	None Required	Negligible
Predicted changes to estuary bed level due to dredging and disposal	Seabed	Negligible (Near-field) No Impact (Far-field)	None Required	Negligible (Near-field) No Impact (Far-field)
Predicted changes to tidal current speeds and bed shear stresses due to changes in bathymetry	Seabed	Negligible (Near-field) No Impact (Far-field)	None required	Negligible (Near-field) No Impact (Far-field)
Marine Water and Sediment Quality				
Deterioration in water quality due to release of sediment-bound contaminants	Marine water quality	Minor adverse	None required	Minor adverse
Marine Ecology				
Habitat loss	Benthic habitats	Minor adverse	None required	Minor adverse
Increased SSC	Blue mussel beds	Negligible	None required	Negligible
	Seagrass beds	Minor adverse	None required	Minor adverse
	Other benthic habitats	Negligible	None required	Negligible
Sediment deposition	Blue mussel beds	Minor adverse	None required	Minor adverse
	Seagrass beds	No impact	None required	No impact
	Other benthic habitats	Minor adverse	None required	Minor adverse
Release of sediment bound contaminants	Other benthic habitats	Minor adverse	None required	Minor adverse
Underwater noise	Benthic species	Negligible	None required	Negligible
Disturbance / mortality during construction phase	Otter	Minor adverse	Sensitive lighting scheme	Minor adverse

Potential impact	Receptor	Effective significance	Mitigation proposed	Residual Effect
Fish and Shellfish Ecology				
Underwater noise from piling and dredging	Migratory fish (salmon, trout, European eel)	Minor adverse	SNH (2014) soft start procedures	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Negligible		Negligible
Water quality	All migratory fish	Minor adverse	None required	Minor adverse
	All fish and shellfish	Negligible	None required	Negligible
Habitat quality	All fish and shellfish	Negligible	None required	Negligible
Ornithology				
Noise and visual disturbance	Seabirds and waterbirds in the vicinity of the Proposed Scheme	Minor adverse	None required	Minor adverse
Water quality	Seabirds and waterbirds in the vicinity of the Proposed Scheme	Negligible	None required	Negligible
Displacement of prey species due to underwater noise	Seabirds and waterbirds in the vicinity of the Proposed Scheme	Minor adverse	None required	Minor adverse
Marine mammals				
Auditory injury from piling activity	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	JNCC soft start procedures	Minor adverse
Underwater noise from vessels and dredging		Negligible		Negligible
Disturbance		Negligible		Negligible
Indirect effects due to changes in water quality		Negligible		Negligible
Disturbance at seal haul-out sites	Grey seal Harbour seal	Negligible	Scottish Marine Wildlife Watching Code	Negligible

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Change is happening. And it's happening fast – from climate change to geopolitical tension and from the energy transition, digital transformation to changing customer demands. The speed and extent of these changes create complex challenges that cannot be addressed in isolation. We offer new perspectives to address the broader societal and technological picture and meet the needs of our ever-changing world.

Backed by the expertise of over 6,800 employees, we work from offices in more than 25 countries worldwide. We are helping clients to turn their challenges into opportunities and make the transition to smart and sustainable operations.

We act with integrity and transparency, holding ourselves to the highest standards of environmental and social governance. We are diverse and inclusive. We will not compromise the safety or well-being of our team or communities – no matter the circumstances.

We actively collaborate with clients from public and private sectors, partners and stakeholders in projects and initiatives. Our actions, big and small, are driving the positive change the world needs, and are enhancing society now and for the future.

Haskoning is a 'Royal' business as designated by the Royal House of the Netherlands in 1981.

Our head office is in the Netherlands, and we have offices across Europe, Asia, Africa, Australia and the Americas

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FORTH PORTS SCOTLAND

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