FORTH PORTS

Port of Dundee Maintenance Dredge Disposal: Marine Licence Application 2023

Best Practicable Environmental Option Report

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1. INTRODUCTION

1.1 Background

This report has been prepared by Environmental Resources Management Ltd (ERM) on behalf of Forth Ports Ltd (Forth Ports) in support of a Marine Licence application for disposal of dredged material at sea from maintenance dredging from the Port of Dundee.

Under the *Marine (Scotland) Act 2010, Section 21(1),* a Marine Licence issued by Marine Scotland is required for the dredging and the deposit of substances or objects within waters adjacent to Scotland. Under *Part 4, Section 27(2),* Marine Scotland has an obligation to consider the availability of practical alternatives when considering applications involving disposal of material at sea. Applications for a Marine Licence to dispose of dredged spoil at sea require a Best Practical Environmental Option (BPEO) (1) assessment, demonstrating that alternatives to sea disposal have been investigated and that sea disposal does not pose an unacceptable risk to the marine environment and other legitimate users.

This report compares various options for the disposal of maintenance dredge material from the Port of Dundee and identifies the BPEO.

Marine Licences for maintenance dredging activities are currently valid in Scotland for up to three years (2). Forth Ports currently has a maintenance disposal licence (MS-00008912) to maintain a safe navigable depth which covers the period 03 December 2020 to 02 December 2023. This current application is to cover the period from 03 December 2023 to 02 December 2026.

1.2 The Need for Dredging and Spoil Disposal

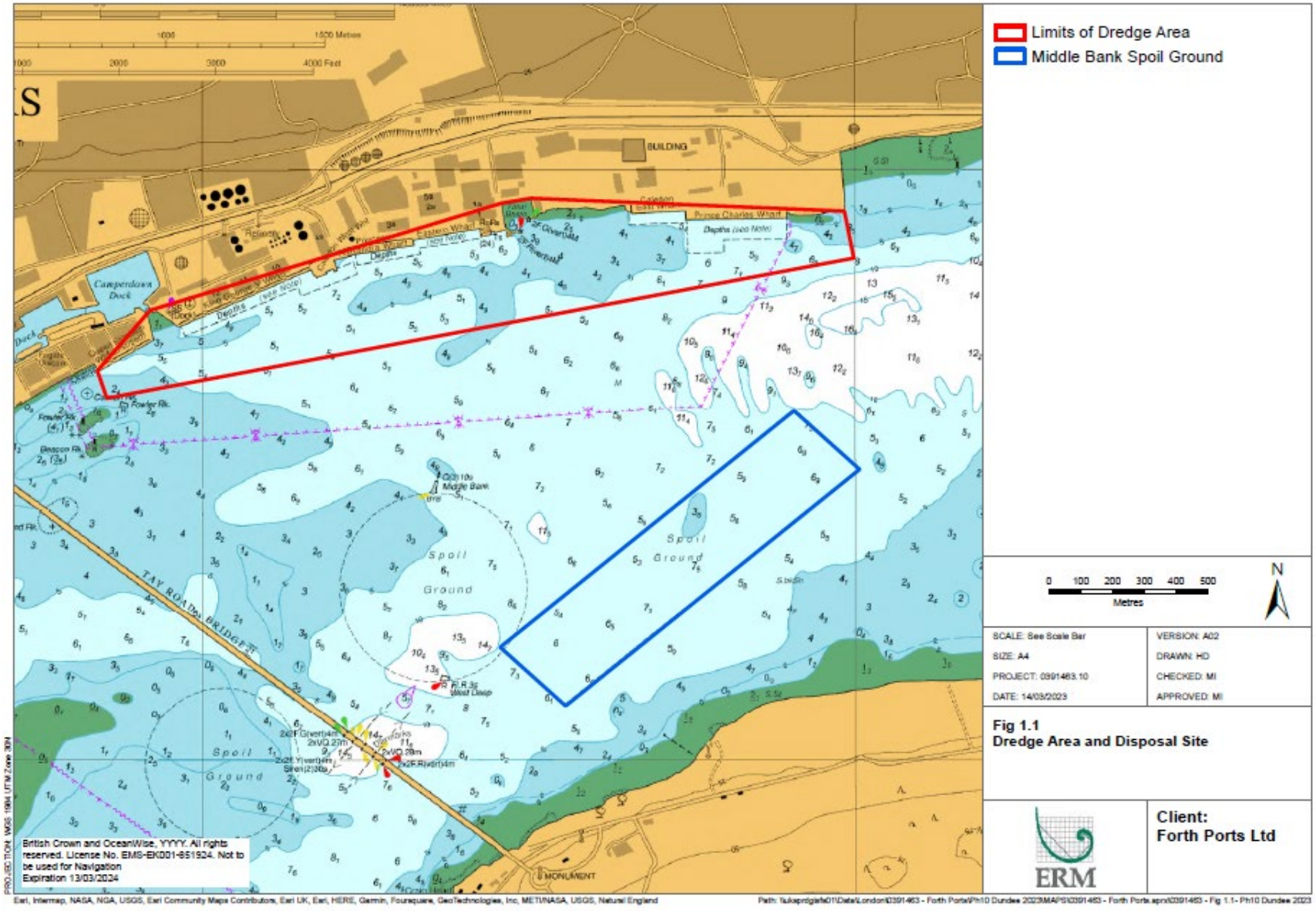
The Port of Dundee is located on the north bank of the Firth of Tay, immediately adjacent to Dundee, and has been owned by Forth Ports since 1995. The port comprises a number of vessel berths, wharves and jetties running east from the Tay Road Bridge for approximately 2.8 km. As confirmed by Forth Ports in February 2023, between 2019 and 2022 there were between 564 and 618 vessel movements each year.

In line with Section 13 of Scotland's *National Marine Plan (Marine Planning Policy Transport 4),* the planned dredging operations will continue to maintain and support the sustainable development of the Port of Dundee. It is proposed that the dredged material resulting from the maintenance dredging will be disposed of at sea at the licenced marine disposal site at Middle Bank. *Figure 1.1* shows the planned dredge area and proposed disposal site.

As the port naturally silts up, without maintenance dredging a safe navigable depth would not be maintained. The port services a range of vessel types including commercial cargo, pilot boats, support to offshore renewable energy developments, laid up drilling rigs and pleasure craft. Dredging is required to maintain the required depths of the working berths appropriate for the size of vessels visiting the port. Should Forth Ports consider the 'Do Nothing' approach, and not undertake the maintenance dredging operations, the Port of Dundee would not be able to continue to service current vessels and potential future vessels associated with the offshore wind and oil and gas decommissioning industries.

(1) The term BPEO was derived by the Royal Commission on Environmental Pollution who described it as a procedure which "establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at an acceptable cost, in the long term as well as in the short-term.
(2) Marine (Scotland) Act 2010, Part 4 Marine Licencing. General Guidance for Applicants. Available online http://www.scotland.gov.uk/Resource/0043/00435338.pdf

Figure 1.1 Proposed Disposal Site



1.3 Previous Maintenance Dredge Spoil Disposal Activities

In the early 1980s, spoil from maintenance dredging was deposited immediately upstream of the Tay Road Bridge. From 1994, maintenance dredging and sea disposal was conducted by the *Abbotsgrange,* a trailer suction dredger owned by Forth Ports. This vessel could not pass under the Tay Bridge and therefore a new disposal site at Middle Bank, located approximately 0.5 km downstream of the bridge was used (shown in *Figure 1.1*). The schedule of ongoing maintenance dredging activities was modified to a number of short dredging campaigns each year (typically three to six days) rather than dredging and depositing regular, smaller volumes throughout the year.

Since January 2001, Forth Ports has contracted United Kingdom Dredging (UKD) for the majority of operations within the Firth of Tay and Firth of Forth. The *UKD Marlin* (shown in Figure 1.2) a trailing suction dredger with a hopper capacity of 3,000 m^3, which is double that of the *Abbotsgrange,* has been used for previous dredging operations. It is likely that this or a similar vessel will be used for future dredging operations, subject to relevant contracting arrangements, currently subject to a tendering process. In addition, the smaller Wyre Sand or Cherry Sand or similar will be used for the shallower areas such as the Fish Dock where the larger dredging vessels cannot work (shown in Figure 1.3.

Figure 1.2 Dredge Vessel - UKD Marlin

Figure 1.3 Dredge Vessel – Wyre Sands and Cherry Sand

http://www.wyremarineservices.co.uk/fleet-and-equipment.html
https://www.ukdredging.co.uk/UKD_Fleet/Cherry_Sand/

1.4 Proposed Dredging and Disposal Operations

Forth Ports wishes to apply for a licence from Marine Scotland for the disposal of dredge spoil to a maximum of 150,000 m^3 each year (up to 210,000 wet tonnes based on density of 1.4). This is required to ensure compliance with safe vessel berthing and to allow for any fluctuation in sediment deposition or contingencies.

Dredging operations would normally be undertaken for between 72 and 144 hrs (three to six days) in a number of short campaigns, depending on siltation levels. The boundary co-ordinates of the proposed dredge area shown in Figure *1.1* are presented in *Table 1.1.*

Table 1.1 Co-ordinates of Planned Dredge Area at Port of Dundee

Node	Latitude	Longitude
A	56°27.614'N	2°57.291'W
B	56°27.850'N	2°55.006'W
C	56°27.930'N	2°55.035'W
D	56°27.952'N	2°55.993'W
E	56°27.944'N	2°56.084'W
F	56°27.763'N	2°57.159'W
G	56°27.661'N	2°57.320'W

Coordinates in WGS84, UTM Zone 30N, degrees decimal minutes

For the continuing dredging operations at the Port of Dundee, Forth Ports proposes to use the Middle Bank disposal site located approximately 0.6 nautical miles (nm) from Dundee. This is the site that has been used for disposal of dredge spoil from the Port of Dundee since 1994, is not used by any other parties and is the site closest to the port which minimises the travel distance for the dredging vessel to and from the disposal site. The water depth at the site is 6 to 9 m below Chart Datum (CD) and sampling undertaken for the Port of Dundee expansion EIA scoping report (2013) indicated that sediment at Middle Bank comprise sand [(1)]. The boundary co-ordinates of the disposal site are presented in Table 1.2 and illustrated in *Figure 1.2.*

Table 1.2 Coordinates of Middle Bank Disposal Site

Node	Latitude	Longitude
1	56° 27.593’ N	002° 55.187’ W
2	56° 27.491’ N	002° 54.989’ W
3	56° 27.095’ N	002° 55.889’ W
4	56° 27.191’N	002° 56 087’ W

All coordinates in WGS84, UTM 30N, degrees decimal minutes

The volume of dredged material deposited at the Middle Bank disposal site from the Port of Dundee from 1994 to 2022 ranged from zero in 2019 and 2020 to 190,730 m^3 in 2000. Annual spoil disposal volumes are presented in *Table 1.3.*

(1) Haskoning UK Ltd, 2013. Port of Dundee Expansion and Marine Aggregate Extraction EIA Scoping Report and HRA Screening Report. Report for Scottish Enterprise.

Table 1.3 Dredge Spoil Disposal at Middle Bank Disposal site from Dundee (1994 to 2022)

Year	Quantity (m^3)
1994	38,739
1995	22,910
1996	112,778
1997	105,160
1998	31,370
1999	98,490
2000	190,730
2001	38,310
2002	75,934
2003	76,806
2004	38,278
2005	45,581
2006	43,829
2007	35,338
2008	50,371
2009	47,134
2010	35,749
2011	22,628
2012	32,656
2013	46,269
2014	33,209
2015	30,082
2016	47,242
2017	29,909
2018	27,079
2019	0
2020	0
2021	90,312
2022	30,138

Data source: Forth Ports February 2023

1.5 Description of Sediment to be Dredged and Disposed

In line with Marine Scotland guidelines on pre-dredge sampling (1), a survey programme was undertaken by Forth Ports between 18th January and 3rd February 2023.

Surface sediment samples were collected at eight stations using a van-Veen grab. For each of the samples the following physical and chemical analysis was undertaken by Socotec UK Ltd.

- Sediment water content and density.
- Sediment particle distribution.
- Total organic carbon.
- A suite of metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc).
- Tributyl tin.

(1) Guidance for the sampling and analysis of sediment and dredged material to be submitted in support of applications for sea disposal of dredged material. Available online http://www.scotland.gov.uk/Resource/0044/00443832.pdf

- Poly chlorinated biphenyls.
- Polycyclic aromatic hydrocarbons.
- Total hydrocarbon content.
- Presence of asbestos.

The location of the sample stations and the results of the physico-chemical analysis are presented in *Appendix A.*

The sediment comprises of sandy muds with two samples having small gravel fractions. There are elevated concentrations of some metals (Cr and Ni) and some PAHs within the material to be dredged above Marine Scotland Action Level 1(1), consistent with historic industrial discharges to the Firth of Tay. No samples recorded concentrations of contaminants above Marine Scotland Action Level 2.

Historic sediment analysis data from the Port of Dundee and the Firth of Tay Middle Bank disposal site are presented in *Appendix A.*

1.6 Scope of the Study

This report provides an appraisal of available disposal options and short-lists those that are considered to be practicable. Options are reviewed according to the Waste Hierarchy, as outlined in the European Waste Framework Directive (2008/98/EC) (2). The options on the short-list are then reviewed against strategic, health and safety, environmental and cost considerations. The options are then compared and the BPEO identified.

The remainder of this report is structured as follows.

- *Section 2* describes the BPEO assessment method.
- *Section 3* describes each of the available disposal options and summarises their respective advantages and disadvantages.
- *Section 4* compares the disposal options.
- *Section 5* identifies the BPEO.

Further supporting information is provided in the three Appendixes.

- *Appendix A:* Sediment Sample Chemical Analysis Results.
- *Appendix B:* Environmental Impacts of Disposal Operations.
- *Appendix C:* Consultee Responses.

(1) Action Levels for metals, PCBs, TBT and PAHs are used by Marine Scotland to assess the suitability for disposal of sediments at sea.

(2) Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098

2. BPEO ASSESSMENT METHOD

2.1 Introduction

The BPEO study was undertaken using the following method.

- Identification of potential disposal options.
- Preliminary appraisal and short-listing of options based on practicability.
- Assessment of the short-listed options based on:
  - strategic considerations;
  - worker and general public health and safety considerations;
  - environmental considerations *i.e.* what the environmental impacts would be; and
  - cost, in terms of capital and maintenance/operating costs.
- Comparison of the relative merits and performance of the options and identification of the BPEO.

Information was obtained through literature review and the following consultees were requested to provide any relevant information they hold and any comment on the proposed sediment disposal operations.

- Dundee City Council (DCC).
- Maritime and Coastguard Agency (MCA).
- Northern Lighthouse Board (NLB).
- Scottish Environment Protection Agency (SEPA).
- Nature Scot (NS).
- Tay District Salmon Fisheries Board (TDSFB).
- The Crown Estate Scotland (CES).

2.2 Identification of Options

The following seven potential treatment/disposal options for the dredged material were identified:

- beach nourishment;
- coastal reclamation and construction fill;
- spreading on agricultural land;
- sacrificial landfill;
- incineration;
- other disposal options and reuse; and
- sea disposal.

2.3 Preliminary Appraisal

A preliminary appraisal of each of the options identified above was undertaken, based on an assessment of the practicability of each option with regard to availability of disposal sites. Following the preliminary appraisal those options that were considered to be practicable were short-listed for further consideration.

2.4 Assessment of Options

The short-listed options were then subject to a more detailed assessment. The parameters which were used to assess the performance of the short-listed options are described below.

2.4.1 Strategic Considerations

Strategic considerations included the following.

- **Practicability.** Whether the option is technically and operationally practicable.
- **Availability of sites/facilities**. Whether there are any sites or facilities which can take the dredge spoil.
- **Security of option**. Whether Forth Ports will have control over all stages of the disposal.
- **Established practice**. Whether technologies and techniques proposed are established and therefore whether the performance and potential difficulties of the technologies and techniques can be anticipated.
- **General public acceptability**. Whether the public are likely to object to or support the proposals.
- **Likely agency acceptability**. Whether public agencies are likely to have any major concerns when consulted on the Marine Licence application.
- **Legislative implications.** Compliance with relevant legislation and the potential management control required.

2.4.2 Health, Safety and Environmental Considerations

The health, safety and environmental performance considerations are summarised below.

- **Public health**. Whether there would be any risk of a detrimental effect on public health, based on predicted pathways and receptors.
- **Safety.** Considering potential sources of hazard and probability that there would be any risk to the general public or workers.
- **Contamination/pollution.** Whether there is potential for pollution or contamination that could result in failure to meet Water Framework Directive (WFD) objectives and associated Environmental Quality Standards (EQSs: the amount or concentration of a substance that should not be exceeded in an environmental system). Contamination is defined as the presence of an unwanted constituent in the natural environment whilst pollution is the introduction of contaminants into the natural environment that causes adverse change.
- **Ecological impact.** Assessing the significance of any potential impact on important habitats or species, including designed sites.
- **Interference with other legitimate activities**. Whether there are likely to be impacts on other activities, such as other users of the port, firth or roads.
- **Amenity/aesthetic**. Assessing whether there is likely impact on local amenity *e.g.* visual, olfactory or noise impact resulting from the disposal activities.

2.4.3 Cost Considerations

Cost of disposing of dredged material was considered in terms of the capital costs (construction of facilities and equipment hire /purchase costs) and operational costs (transport costs and disposal costs, including site operation).

2.4.4 Comparison of Options

The performance of each option was evaluated on a scale from Low to High according to definitions presented in *Table 2.1*. Intermediate grades (Low to Medium and Medium to High) were also used where the assessment was marginal between Low, Medium or High. The results of the assessment process are presented in *Section 3* and *Section 4.*

Table 2.1 Definitions of Performance

Consideration	High	Medium	Low
Strategic Considerations			
Technical and Operational Practicality	Few practical difficulties, easy to undertake and process is proven to be straightforward and robust. Low number of stages and each stage easy to control.	Some practical difficulties. Moderate number of stages with some difficulties.	Major practical difficulties. Large number of steps with some major difficulties.
Availability of Sites/Facilities	Suitable site/facility available within 1 km of the docks by road and 10 km by sea.	Suitable site/facility available within 10 km of the docks by road and 20 km by sea.	No suitable sites/facilities within the vicinity (over 10 km by road and 20 km by sea).
Security of option	In complete operational control of Forth Ports.	Is mainly in control of Forth Ports with some outside involvement for which there are alternative sources of supply.	Has elements that are out of Forth Ports control for which there are no practical alternative sources of supply.
Established Practice	Technology and techniques are established and used for dredge spoil disposal.	Technology and techniques have been tested but not applied to dredge material.	Technologies and techniques are untested and unforeseen problems are likely.
General Public Acceptability	Likely to be generally acceptable to the public based on reaction to similar operations.	Unlikely to provoke a strong negative or positive reaction based on reaction to similar operations.	Likely to provoke a strong negative reaction based on reaction to similar operations.
Likely Agency Acceptability	Likely to be generally acceptable to statutory bodies after consultation.	Statutory bodies may have some concerns that may be overcome through further consultation and option development.	Statutory bodies may have major concerns that may not be overcome through consultation and option development.
Legislative Implications	Would comply with legislation with a low level of management control and intervention.	Requires some management control and intervention to achieve compliance.	Requires a high level of management control and intervention to achieve compliance.
Health, Safety and Environmental Considerations			
Public Health	Will not cause workers or public to be exposed to substances or activities potentially hazardous to health.	May cause some low-level intermittent exposure to substances or activities potentially hazardous to health.	Risk of exposing workers and general public to substances or activities potentially hazardous to health.
Safety	No significant safety risk to workers and the general public with no specific controls required.	Low safety risk to workers and the general public which is easily controlled.	Moderate to high safety risk to workers and general public and difficult to control.

Consideration	High	Medium	Low
Contamination/ Pollution	Compliant with emission standards and water/sediment/ground quality objectives. Low risk of harm from substances released to environment.	Environmental quality standards may be approached or breached occasionally. Some risk of harm to environment.	Environmental quality standards may be breached regularly and there is a moderate or high risk of harm to environment.
Ecological Impact	Priority species and habitats under the UK Biodiversity Framework (1) and qualifying features and species under the *Habitats Regulations, 2019* (2) will not be affected.	Priority species and habitats under the UK Biodiversity Framework and qualifying features and species under the *Habitats Regulations, 2019* may be slightly affected.	Priority species and habitats under the UK Biodiversity Framework and qualifying features and species under the *Habitats Regulations 2019*, are likely to be significantly affected.
Interference with other Legitimate Activities	Little potential for interference with other activities.	Some potential for interference with other activities.	High potential for interference with other activities.
Amenity/Aesthetic	No significant impact on local amenity or aesthetic qualities.	Potential for impacts of moderate significance on local amenity or aesthetic qualities.	Potential for impacts of high significance on local amenity or aesthetic qualities.
Cost			
Capital and maintenance	£1 m or less.	Between £1 m and £5 m.	More than £5 m.

(1). JNCC and Defra (on behalf of the Four Countries' Biodiversity Group). 2012. UK Post-2010 Biodiversity Framework. July 2012. Available from: http://jncc.defra.gov.uk/page-6189.

(2) The *Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations, 2019* apply to European sites (formerly Special Protection Areas and Special Areas of Conservation).

3. PRELIMINARY ASSESSMENT OF AVAILABLE DISPOSAL OPTIONS

3.1 Introduction

This section describes the identified disposal options and makes a preliminary assessment of each based on overall practicality. There are a number of steps that are common to some of the land-based options and these are described in *Section 3.2* to avoid repetition. The section concludes by identifying those options that are short-listed for further consideration in the BPEO process.

The seven identified disposal options are:

1. beach nourishment;
2. coastal reclamation;
3. spreading on agricultural land;
4. sacrificial landfill;
5. incineration;
6. other disposal options and reuse; and
7. disposal at sea.

3.2 Common Steps to Land-Based Disposal Options

The disposal options that have land-based components include:

- beach nourishment (if material transported by road);
- coastal reclamation and construction fill (if material transported by road);
- spreading on agricultural land;
- sacrificial landfill;
- incineration; and
- other disposal options and reuse (such as brick making/concrete aggregate/topsoil production).

The steps that are common to the land-based disposal options are:

- landing the dredged material;
- storage of dredged material;
- dewatering the dredged material;
- loading and transport for disposal; and.
- disposal/treatment.

These steps are described below along with a discussion of the practicalities of undertaking these steps at the Port of Dundee.

3.3 Landing the Dredged Material

All of the land-based options require transport to onshore facilities. This could be via a pumped discharge, conveyor or grab. As Forth Ports does not have suitable facilities at the Port of Dundee or elsewhere within the Firth of Tay area for landing dredged material, a new coastal landing facility would be required to enable the material to be landed.

3.3.1 Storage of Dredged Material

Once the dredged material has been landed, it will require storage prior to onward transport for final disposal. A storage facility may therefore require construction at the landing site, capable of retaining the dredged material and associated run-off and dust.

3.3.2 Dewatering the Dredged Material

The land disposal options require dewatering of the dredged material either to make transport more feasible or to create a material which is suitable for disposal to land or incineration *i.e.* disposal of a more solid sludge. Based on tests on previous dredged loads undertaken by Forth Ports the contents of the dredger are assumed to have an average 20% solids (by volume) and range from 30% to 10% solids *i.e*, solids to liquid ratio will decrease as dredging operations progress and only isolated pockets of sediments remain resulting in an increased uptake of water.

There are three approaches that could be used for drying marine sediments: construction of settling lagoons, use of a mobile centrifuge unit and filter press, as described below.

Settling Lagoons

Settling lagoons are large, ring-dammed structures into which the dredged material would be pumped. These could be built within the intertidal area or on land. The material would be piled up in the lagoon which would have a drainage system to collect the water and watery sludge from the dredged material for further treatment (*e.g* by hydrocyclone, as described below) or to be transported offsite for disposal. The lagoons would need to be of sufficient size to contain the dredged material prior to transport. They would also need to be accessible by road and have facilities to load the dredged material into tankers or sealed heavy goods vehicles (HGVs) for movement to the disposal/treatment centre. To minimise the distance the wet dredged material would have to be transported from the dredger, the lagoon would need to be located near the landing site.

Setting up settling lagoons would require assessment to ensure that any leachate from them would not contaminate groundwater and a licence would be required from SEPA under the *Water Environment (Controlled Activities) Regulations (2011)*. Forth Ports advise that the potential to be able to find appropriate space to create lagoons close to the Port of Dundee is considered to be low. Furthermore, as the material contains metals, PAHs and TBT (see *Appendix A* for sample analysis data) it might be additionally necessary to construct the lagoons with special liners to retain the contaminants and consider treatment of the drainage water out of the lagoons.

Centrifuge or Hydrocyclone System

The use of a centrifuge or hydrocyclone system to dewater the material to a level suitable for disposal to landfill (approximately 10% water content) may be required, depending on the final water content of the recovered material. One mobile unit system was reported as being capable of treating up to 150 m^3hr^{-1} depending on unit size and material solids content. Other systems may be available that can process material at different rates, however, for the purposes of this assessment a rate of 150 $m^3\ hr^{-1}$ has been used. If material can be dried at a rate of 150 $m^3\ hr^{-1}$, to dewater a total volume of approximately 150,000 m^3 would require approximately 1,000 hours. Other units with lower throughputs could take longer.

Filter Press

Filter presses are used to separate solids and liquids using pressure. The press is filled with the spoil, building up pressure before the spoil is strained through filter cloths by force. The remaining dried spoil can then be removed from the filter press and taken away for disposal. This drying process achieves the best level of dryness of the three options, however, is considerably more expensive than either of the other two options.

3.3.3 Loading and Transport for Disposal

A loading facility would be required adjacent to the storage or dewatering area to load the material into covered HGVs for transport to treatment/disposal sites. The required infrastructure would include hard standing area to allow a fleet of HGVs to be loaded by mechanical excavators. Although hard standing is available at the Port of Dundee, there are no storage or dewatering sites adjacent to the possible loading area.

Assuming the materials can be dried to a water content of 10% (by volume) at the Port of Dundee, the estimated 132,000 m^3 (1) of dried materials would require transport for disposal, either to an incinerator, to agricultural land, to landfill or to a reclamation project. The length of journey required would depend on the location of the treatment/disposal sites.

A volume of 132,000 m^3 of dried (to 10% water content) material equates to approximately 184,800 tonnes (2). Assuming 20 tonne capacity sealed HGVs are used, this would equate to 9,240 return trips or 18,480 vehicle movements.

The significance of the number of movements will be dependent upon the distance to the disposal/treatment site and the existing volume of HGVs on the haulage routes. The access road to the Port of Dundee exits onto the trunk road network where the HGV count is estimated as 202,940 each year (averaged 2021 data (3)). The additional HGV movements as a result of the dredging operations would increase this current level by approximately 9.1% each year. There may also be an issue with regard to increase in HGV traffic flows if minor roads are used to reach disposal/treatment sites.

3.3.4 Disposal/Treatment

Neither method of the drying process (*e.g.* lagoons or centrifuge) is likely to reduce the concentration of metals, PAHs and salt present within the dredged material. This may restrict disposal and reuse options and pre-treatment may be required to reduce contaminant concentrations prior to disposal on land.

Where an option involves disposal on land there is an issue of classification of the dredged material. Once the material has been removed from the harbour for disposal on land it will be classed as waste. The waste then requires disposal at a licensed waste management facility and to be transported by a registered waste carrier. In the waste hierarchy set out in the *Waste Management Licensing (Scotland) Regulations, 2011*, dredged spoil is coded as 17 05 05 (Mirror Hazardous) or 17 05 06 (Mirror Non-hazardous), depending on the concentrations of particular contaminants. If landfill is identified as the disposal route for this waste, then further analysis may be required to ensure that the material meets the Waste Acceptance Criteria for hazardous landfill.

The saline nature of the sediment also restricts its application on land, as without going through a washing process it will not be able to support any form of terrestrial flora growth.

3.4 Beach Nourishment

3.4.1 Process Description

Beach nourishment involves the disposal of the dredged material on a beach directly from the dredging vessel or, if dewatering was required, the spoil would be brought ashore and dewatered prior to transport or placement on the beach using earth moving plant.

(1) 150,000 m^3 total spoil at 80% solids content equals 120,000 m^3 plus 12,000 m^3 (10% water content) equals 132,000 m^3.

(2) Based on a density of 1.4 tonnes per m^3 of dredge spoil

(3) Traffic counts Scotland. Data for the A92 outside the Port of Dundee. https://roadtraffic.dft.gov.uk/manualcountpoints/40858 Accessed 17/03/2023

3.4.2 Suitable Sites for Beach Nourishment

Beach nourishment requires materials of a similar composition to the existing beach materials and usually involves clean sand or gravel. The sediment from within the proposed dredge zone generally comprises fine material with small quantities of gravel present in two of the samples (sandy mud and gravelly mud). The sediment from the Port of Dundee is not suitable for beach recharge due to the particle size distribution and the presence of contaminants such as metals and organics (PAHs). NatureScot has previously confirmed that it would only be appropriate to use material on a beach of similar sediment particle size distribution, and provided contaminant levels were not of concern.

3.5 Coastal Reclamation and Construction Fill

3.5.1 Process Description

This section considers the use of the dredged material in coastal reclamation projects or as fill material inland. Depending on the potential site, reclamation or fill could involve landing, storage, dewatering, possibly desalination and transport. Coastal use directly from the dredging vessel would be preferable as this would involve pumping or spraying the material directly from the dredger or barge to the site where it was needed and would avoid handling and transporting the material on land.

3.5.2 Suitable Sites for Coastal Reclamation

Forth Ports, Marine Scotland and Dundee City Council are the most likely bodies to be responsible for or aware of reclamation projects in the Tay. No sites for coastal reclamation have been identified through the consultation process as requiring any of the dredged material. In addition, the dredged material would not be suitable for many reclamation sites due to the low compressive strength properties of muddy sediments. The spoil could be pumped into bunded lagoons at the edge of the Firth of Tay to create land that could be used for development, agricultural or similar purposes. This is unlikely to be acceptable to NatureScot due to the potential impact on designated areas in the Firth of Tay and Eden Estuary.

3.5.3 Construction Fill Material

Use of dredged material as construction fill in inland construction projects would not be appropriate because of low compressive strength properties of mud and the need for landing, drying and transport of the dredged material. If landing, drying and transport were feasible then it may be that the material could be used for quarry/landfill capping. However, the presence of contaminants in the dredged material and its high salt content make this option unattractive.

3.6 Spreading on Agricultural Land

3.6.1 Process Description

SEPA has previously confirmed that the disposal or recycling of marine dredged material on agricultural land does not fall within the exemptions under Paragraph 7 of Schedule 1 of the *Waste Management Licensing (Scotland) Regulations, 2011*, and the activity would therefore require to be licensed. Planning permission may also be required from the local authority. In support of the application to dispose of the dredged material to agricultural land, evidence that the material would not cause pollution of the environment or harm to human health would need to be provided.

The disposal of marine dredged material to agricultural land would involve landing, dewatering, storage, desalination and transport for disposal. Dewatering the dredged material in lagoons, centrifugal drier or filter press would remove some of the salt; however it is likely that the desalination would still be required. Desalination could be achieved by placing the spoil in lagoons, layering it with sharp sand, spraying water over the material and allowing leaching of the salt back into the Firth of Tay.

Approximately 200,000 tonnes of sludge are recycled to agricultural land each year across Scotland. Forth Ports are seeking to dispose of approximately 150,000 m^3 of dredged material (approximately 210,000 wet tonnes at 1.4 tonnes m^{-3}) of dried material, equating to approximately 105% of the current volume of annually recycled sludge in Scotland.

As the material from Dundee has a low organic carbon content (an average of approximately 2.5% from the sediment sample analysis) spreading dredged material from Dundee on agricultural land is not considered a practicable option.

In addition, the material sampled at Dundee has contamination from some metals and PAHs above Action Level 1 so the spoil cannot be applied to land without confirmation from SEPA that levels of these contaminants are acceptable.

3.7 Sacrificial Landfill

3.7.1 Process Description

The type of landfill site which can take the spoil is dependent upon the classification of the waste. As discussed above it is understood that the waste would be classified as non-hazardous and therefore a suitably licensed landfill site with sufficient capacity is required.

3.7.2 Available Landfill Sites

Subsequent to implementation of the *Landfill Allowance Scheme (Scotland) Regulations 2005* and re-evaluation of landfill licences, there is currently one site within an hour's drive from the Port of Dundee with the facilities to accept the material. Fife Council landfill site in Cupar, approximately 15 miles south of Dundee, can accept non-hazardous material. In 2021, it received 311,595 tonnes of wastes, including 118,722 tonnes of soil/stones. To receive dredge material from the Port of Dundee the volume of similar waste material to the landfill site would double if the full annual volume of material was dredged each year) (1).

3.7.3 Taxes and Royalties

The material will be exempt from landfill tax under the terms of the Landfill Tax (Scotland) Act 2014 issued by the Scottish Government that specifies that dredged material from any inland waters, including harbours and their approaches, are not subject to landfill tax.

3.8 Incineration

3.8.1 Process Description

Incineration would involve landing the dredged material, dewatering, possibly storing it and transporting it to either an existing incinerator or a newly constructed incinerator. The residual incineration ash would then require disposal. Options for disposal of ash include landfill, reclamation and spreading on agricultural land.

The average total organic content of the material to be dredged is 2.51%, based on the eight surface samples collected in 2023, and therefore there is only a small combustible component within the material. It is anticipated that incineration would result in a reduction in volume of the dried spoil by only 12.5% *i.e.,* 2.5% organics plus 10% water content. Incinerator operators generally require material to have an organic content above 20% to ensure efficient combustion and would most likely reject material with an organic content below this threshold (2).

(1). PPC/E/0020085. Lower Melville Wood. LF, Cupar. 60. 50. 130.

PPC/E/0020001.https://consultation.sepa.org.uk/permits/lower_melville_wood_landfill_ppc_variation_app/

(2) Baldovie Waste to Energy Plant, pers comm, January 2014

A further consideration is that the material to be dredged contains some metals and some PAHs above Action Level 1. In a typical thermal desorption incineration process it is likely that some of the contaminants would be removed and the leaching potential of metals would be reduced , however, the ash is likely to still be contaminated. Pre-treatment may be required for the removal of metals. Emissions to atmosphere from the incineration processes would also require to be controlled by SEPA/EA under the *Environmental Protection Act 1990.*

3.8.2 Available Incinerator Sites

There are no appropriate waste incinerators in Scotland that could accept the dredged material. The nearest incinerator is at Ellesmere Port, Merseyside (approximately 310 miles south) and transport would be costly and is unlikely to be practicable.

3.9 Other Disposal Options and Reuse

The other disposal options are re-injection into the tidal flats via a pipeline and reuse in brick making, concrete aggregate or topsoil production processes.

3.9.1 Re-injection

This would involve the construction of a pipeline to take the dredged material to a high tide point on the Tentsmuir sandflats (the closest to the Port of Dundee) and injecting it at velocity back into the sandflats. The advantage of this is that it effectively keeps the sediment within the sediment cell. The disadvantage is that the re-injection at velocity would be likely to have an adverse impact on the protected sandflat habitat through disturbance and erosion and may affect the haul out behaviour of seals using the sandflats.

3.9.2 Brick Making/Concrete Aggregate/Topsoil Production

There are processes by which marine sediments can be made into bricks or can be used to form concrete aggregate. The advantage is that the materials can be beneficially used and metals are sealed into the bricks or aggregate. Previous consultations between Forth Ports and a brick making factory confirmed that the mineralogy of the material would not be appropriate for brick making and the contamination by salt would be unacceptable for any construction material.

Almost no agricultural species can grow in salty soils and very few in brackish soils. The salinity of the dredged sediment would require to be reduced naturally by rainwater or by a washing and dewatering process before consideration for use as topsoil. The best topsoil is a mixture of sand, silt, clay and organic matter and must be clean for use in the production of food crops [(1)]. This option would not be feasible at the Port of Dundee due to lack of necessary handling facilities and the potential contamination levels in the dredged spoil. In addition, there is no known demand for this material to be used in topsoil production.

3.10 Disposal to Sea

3.10.1 Process Description

Disposal at sea involves the dredge material being transported to a licensed disposal site in a dredging vessel. It involves the dredger sailing to a licenced disposal site and releasing the materials, usually by lowering the excavator head into the water or through bottom doors. A differential global positioning system (dGPS) is used to position the vessel in the disposal area to record the spoil discharge locations. This approach takes place at sea and does not require the landing of any materials. Forth Ports have used the *UKD Marlin* since 2001 to dredge the dock areas.

(1) Permanent International Association of Navigation Congresses. Permanent Technical Committee II. Working Group 19. 1992. Beneficial Uses of Dredged Material, Issue 19.

3.10.2 Available Sites

There is currently only one licenced marine disposal site in the Firth of Tay; Middle Bank. Six further spoil sites have been licenced in the past (Horseshoe Buoy, Firth of Tay B, Firth of Tay E, Tay Bridge, Invergowrie A and Invergowie B) but are not currently used or licenced. For the dredging operations at the Port of Dundee, Forth Ports would propose to use the Middle Bank disposal site approximately 0.6 nm from the Port of Dundee. This is the closest site to the harbour thus minimising the distance for vessel transport. The time required for one cycle (dredging - travelling - discharging - travelling) is approximately one hour.

3.11 Conclusion

The description of the available options allows options that are evidently impracticable to be ruled out. This is summarised in *Table 3.3.* The assessment of the short-listed options taken forward for further consideration is presented in *Section 4.*

Table 3.1 Short-listing of Options

Option	Assessment	Result
Beach Nourishment	This option does not appear to be practicable. The material is not suited to beach nourishment in the Firth of Tay and there are no beaches identified by Forth Ports, consultees or in the NCCA (2017) (1) within the Firth of Tay that require nourishment with this grade of material.	Discard
Coastal Reclamation and Construction Fill	This option may be practical. The salt content, poor load bearing properties and the potential concentration of contaminants limits the available options for reuse of the dredged material.	Short-list
Spreading on Agricultural Land	This option does not appear to be practicable. The material is not desirable for disposal on agricultural land due to potentially containing concentrations of contaminants and having a low organic content. Furthermore, desalination, storage, dewatering and transport of this material are impractical. Disposal on agricultural land would require a Waste Management Licence and evidence that there would be no harm to human health.	Discard
Sacrificial Landfill	This option may be practicable and there is one local site within one hour's drive. There is a large number of steps involved in storage, dewatering and transport. Landfill site operators may be unwilling to accept the material due to the sediment composition and the volumes.	Shortlist
Incineration	This option does not appear to be practicable. The material is not suited to incineration due to low organic content and large volume of spoil involved. If incinerated, volume would only slightly reduce and there are no available incinerators in Scotland that could take this amount of material.	Discard
Other Uses	This option may be practicable in the form of brick making, concrete aggregate and topsoil production.	Short-list
Disposal at Sea	This option is practicable and has been the BPEO for previous dredging campaigns at the Port of Dundee.	Short-list

(1) Fitton JM, Rennie AF and Hansom JD (2017). Dynamic Coast - National Coastal Change Assessment: Cell 2- Fife Ness to Cairnbulg Point. CRW1014/2.

4. ASSESSMENT OF SHORT-LISTED DISPOSAL OPTIONS

4.1 INTRODUCTION

This section presents an assessment of each option against the assessment definitions of performance listed in Table 2.1. A classification of likely performance is provided for each of the criteria and the assessment is then summarised in *Section 5*.

The environmental effects of disposal at sea are addressed in *Appendix B.*

4.2 COASTAL RECLAMATION AND CONSTRUCTION FILL

4.2.1 Strategic Considerations

Technical and Operational Feasibility

The reuse of the dredged material for reclamation will involve either direct pumping from the dredger into the disposal site or landing, drying, desalinating, storing and transporting the material disposal on land. This option would be achievable if disposal sites were available adjacent to the Firth of Tay.

Classification: Medium

Availability of Sites

No coastal sites requiring this grade of material for reclamation or construction fill have been identified by Forth Ports, consultees or in the latest Dynamic Coast – National Coastal Change Assessment (2017) [(1)].

Classification: Low

Security of Option

No sites have been identified as belonging to Forth Ports, so disposal to reclamation sites is out with their control and could present practical problems, such as scheduling in sediment delivery with proposed dredging programme.

Classification: Low to Medium

Established Practice

The use of suitable dredged materials in coastal reclamation and construction fill is common practice and the technologies and techniques are well established, however, this is for dredged primary aggregate materials such as sands and gravels.

Classification: Low to Medium

General Public Acceptability

Use of the materials for reclamation is likely to be viewed as an acceptable option by the general public. Depending on the method of transporting the dredged material to the site requiring it will affect acceptability by the general public. Transport by sea is likely to be viewed as more favourable than transport by land, which may be viewed as unacceptable by local residents and road users.

Classification: Medium to High

Likely Agency Acceptability

Use of the dredged material for reclamation or construction fill is likely to be acceptable to public agencies. There may be some concerns regarding the proposed volume of material to be transported by HGVs for reasons relating to air quality and proximity to residential areas.

(1) Fitton, J.M., Rennie, A.F., and Hansom, J.D. (2017) Dynamic Coast - National Coastal Change Assessment: Cell 2 - Fife Ness to Cairnbulg Point, CRW2014/2

Classification: Medium to High

Legislative Implications

The disposal of dredged material from Dundee directly from the dredger to a reclamation site requires a Marine Licence from Marine Scotland under *Section 20(1) of the Marine (Scotland) Act 2010*.

Once landed, the dredged material would be classed as waste under the *Waste Management Licensing (Scotland) Regulations, 2011* and the disposal will therefore require a waste management licence and an exemption for reclamation works.

As well as a Marine Licence for the construction works, consent will be required from the planning authority and a levy paid to the Crown Estate Scotland.

Classification: Medium to High

4.2.2 Health, Safety and Environmental Considerations

Public Health

No risks to public health are anticipated due to the short-term increase in HGV traffic.

Classification: Medium to High

Safety

Transferring the dredged material ashore has risks associated with operational activities, all of which have mitigation measures in place. Should the dredged material be transported by HGV, there may be an increase in safety risks associated with the movement of materials for disposal, particularly if tankers/sealed HGVs travel through populated areas and along minor roads.

Classification: Medium

Contamination/Pollution

The dredged material may be classified as hazardous or non-hazardous (*i.e*. not inert) due to the concentration of contaminants with respect to land based disposal, however, further analysis would be required to confirm this and run-off and leaching would need to be controlled. There may be localised and temporary deterioration in air quality as a result of HGV movements.

Classification: Medium

Ecological Impacts

There are unlikely to be any ecological risks resulting from the use of dredged materials for reclamation, assuming any contaminants are contained within the site and there would be no significant impact on national or local priority species or habitats. If the site was to be used for terrestrial habitat creation, then the salt levels would limit plant growth.

Classification: Medium to High

Interference with Other Legitimate Activities

The disposal of dredged material is unlikely to interfere with other activities unless the reclamation site is in the port area, in which case the dredger may interfere with other port users. If HGVs are used to transport the dredged material, they may affect other road users.

Classification: Medium to High

Amenity/Aesthetic

If the dredged material is disposed of directly from the dredger there is low risk to amenities/aesthetics. If disposed of by HGV, landing, storage and transport may result in an impact to both amenities and aesthetics of the area.

Classification: Medium to High

4.2.3 Cost Considerations

If the dredged material was pumped directly ashore there would be no further capital costs. The estimated operational costs below would apply:

- operational costs for the operation of the dredger - £0.5 million per annum;
- Pumping material to site – approximately £1.5 million pumping costs (£10 per m^3 (1) for 150,000 m^3).

Total: £2 m.

Classification: Medium

If the dredged material was pumped directly ashore there would be no further capital costs. If the dredged material was transported by road, the estimated costs below would apply.

- operational costs for the operation of the dredger: £0.5 m per annum;
- a discharge berth for the dredger with a storage facility: £3.5 m;
- lagoons to settle dredged material and possibly desalinate: £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 150,000 m^3 of silt per annum: £10 m;
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/hour(2): £1.1m.

Total £7.6 m to £15.1 m

Classification: Low

4.3 Sacrificial Landfill

4.3.1 Strategic Considerations

Operational Feasibility

Disposal to landfill would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 132,000 tonnes of dried material would require transport. This option has practical difficulties relating to drying the dredged material and transport of material to a landfill site.

Classification: Low to Medium

Availability of Sites / Facilities

There is one site is located at Cupar Landfill approximately 15 miles from the Port of Dundee. Receiving this type of material from Dundee would double the volume of soils/stones that the site currently received annually. Under the *Landfill (Scotland) Regulations, 2003* the presence of contaminants will classify the material as *non-hazardous* rather than *inert* and consequently reduces the number of available landfill sites capable of accepting this material.

Classification: Low to Medium

Security of Option

Whilst Forth Ports have control over the dredging operations, it would have no control over the continued availability of landfill space for the material or the disposal route.

Classification: Low to Medium

(1) Based on previous consultation with contractors.

(2) Estimated cost based on consultation with HGV operator at £50/hour for two hours per load.

Established Practice

Dredged material is sometimes disposed of to landfill for small one-off dredging operations, however it is not established practice to routinely dispose of large quantities of dredged material in this way. Landfill sites require the dredged material to be dried to 10% water content before acceptance. It is unlikely that this is a practice that would be acceptable if there are other viable alternatives.

Classification: Low to Medium

General Public Acceptability

Disposal of the material to landfill is likely to be acceptable to the general public. However, the transport of the dredged material from the Port of Dundee to potential landfill sites may be unacceptable to residents and other road users.

Classification: Medium to High

Likely Agency Acceptability

Scotland's Zero Waste Plan (2010) establishes the direction of the Scottish Executive's policies for sustainable waste management. One such policy is to reduce landfilling of waste to 5% of all wastes by 2025 and as such there may be objection to dredged material routinely requiring space in landfill. Disposal to nearby landfill sites is likely to be acceptable to SEPA provided the materials are regarded as suitable for landfill, however, the acceptability would depend on the quantities to be disposed of and further assessment and classification of hazardous substances.

Classification: Medium to High

Legislative Implications

The material would be controlled waste material for the purposes of transport, storage and disposal. As such, Section 34(7) of *The Environmental Protection Act 1990* and Regulation 6 of the *Pollution Prevention and Control (Scotland) Regulations 2012* will apply, and compliance is likely to be possible. The disposal of the material will also require a waste management licence under *Waste Management Licensing (Scotland) Regulations 2011.*

Classification: Medium

4.3.2 Health, Safety and Environmental Consideration

Public Health

There may be a slight risk to public health due to the significant increase in HGV traffic may arise.

Classification: Medium

Safety

There may be an increase in safety risks associated with the movement of materials for disposal, particularly if tankers/sealed HGVs travel through populated areas and along minor roads.

Classification: Medium

Pollution/Contamination

There may be a small risk of leaching of contaminants being disposed of in landfill, however, these should be contained on site.

Classification: Medium to High

Ecological Impacts

Although there is a small risk of contaminants leaching out from the dredged material, this would be at very low concentrations and is unlikely to cause significant harm to the local ecology. The salt content in the material may prevent plant growth unless covered in a topsoil.

Classification: Medium to High

Interference with Other Legitimate Activities

The increase in HGV movements may interfere with other road users. Baseline traffic data for the A92 in the vicinity of the Port of Dundee that in 2021 HGVs made up an average of 2.7% of all traffic of road traffic in the vicinity of the port (556 HGV movement per day out of 20,653 vehicles). As a result of the proposed disposal to landfill, the total HGV movements would increase in the vicinity of the Port of Dundee during the periods that the dredged material was being transported. Depending on the landing and storage arrangements there may be potential for interference with other harbour users.

Classification: Medium

Amenity/Aesthetic

The movement of HGVs through the area will have an impact on local amenity through noise, vibration, visual impacts and road congestion. This risk also applies to the disposal site.

Classification: Medium

4.3.3 Cost Considerations

The estimated costs below would apply:

- operational costs for the operation of the dredger - £0.5 million per annum;
- a discharge berth for the dredger with a storage facility: £3.5 m;
- lagoons to settle dredged material and possibly desalinate: £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 150,000 m^3 of silt per annum: £10 m;
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/hour(1): £1.1m.
- a Waste Management Licence.

Total £7.6 m to £15.1 m

Classification: Low

4.4 OTHER DISPOSAL OPTIONS AND REUSE

4.4.1 Strategic Considerations

Operational Feasibility

Reuse for brick making, concrete aggregate or topsoil production would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 132,000 tonnes of dried material would require transport. There are practical difficulties relating to handling the dredged material at the Port of Dundee. The availability of suitable factories/facilities to process the dredged material and markets for the final products are also considerations.

Classification: Low to Medium

Availability of Sites/Facilities

There are no known sites or facilities to receive the dredged material for other uses such as topsoil production, aggregates or brick making.

Classification: Low

(1) Estimated cost based on consultation with HGV operator at £50/hour for two hours per load.

Security of Option

Although Forth Ports would have control over the dredging and landing, they would not have control over the continued acceptance of the materials for aggregates or making bricks.

Classification: Low to Medium

Established Practice

Use of marine aggregates such as clean sands and gravels are used as a source of primary construction aggregates, but fine sediments are not used for this purpose. Whilst topsoil has been made from dredged material in the past it is not common practice.

Classification: Low to Medium

General Public Acceptability

Making bricks, concrete or topsoil is likely to be publicly acceptable depending on the end use. However, the transport of the material over a large distance may not be acceptable to residents and other road users.

Classification: Medium to High

Likely Agency Acceptability

It is likely that brick making, concrete production and topsoil production would be acceptable to agencies and considered a positive activity. However, the contaminant levels in the samples would make using the material for topsoil unattractive.

Classification: Medium to High

Legislative Implications

SEPA would control emissions from brick making factories under the provisions of the *Environmental Protection Act 1990.* A waste management licence would also be required for their transport and storage under the *Waste Management Licensing (Scotland) Regulations 2011*.

Classification: Medium

4.4.2 Health, Safety and Environmental Considerations

Safety

There are unlikely to be any significant safety risks associated with making bricks, concrete or topsoil with the exception that there may be an increase in safety risks associated with the movement of materials, particularly if HGVs travel through settlements and along minor roads.

Classification: Medium

Public Health

Low risks to public health are anticipated due to the short-term increase in HGV traffic.

Classification: Medium

Pollution / Contamination

Pollution is not likely to be an issue provided emissions are controlled in accordance with licences.

Classification: Medium to High

Ecological Impacts

Making bricks or concrete should have no adverse ecological effects, provided the materials were decontaminated and desalinated before use.

Classification: High

Interference with Other Legitimate Activities

There is a slight risk that movement of the material would impact other road users.

Classification: Medium to High

Amenity/Aesthetic

The movement of HGVs through the area will have an impact on local amenity through noise, vibration, visual impacts and road congestion. This risk also applies to the disposal site.

Classification: Medium to High

4.4.3 Cost Considerations

The estimated costs below would apply:

- operational costs for the operation of the dredger - £0.5 million per annum;
- a discharge berth for the dredger with a storage facility: £3.5 m;
- lagoons to settle dredged material and possibly desalinate: £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 150,000 m^3 of silt per annum: £10 m;
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/hour(1): £1.1m.
- a Waste Management Licence.

Total £7.6 m to £15.1 m

Classification: Low

4.5 SEA DISPOSAL

4.5.1 Strategic Considerations

Operational Feasibility

Operationally disposal at the Middle Bank site is comparatively simple as it does not require the landing, storage and drying of the spoil and all the necessary procedures are understood. As this is the present discharge route for the ongoing maintenance dredge operations at the Port of Dundee, it has been proven as practicable and all the necessary procedures are understood and logistical arrangements in place.

Classification: High

Availability of Sites / Facilities

The sites/facilities which are required for the sea disposal option are those which are already used. Three of the eight disposal sites in the Firth of Tay are located west of the bridge, which is inaccessible to the dredger due to height restrictions. The next closest marine disposal site which would be available for the volume of dredged material is located approximately 1.5 km east of Middle Bank. Middle Bank is the only currently licenced spoil disposal site in the area. The alternative sites offers no apparent advantage and has the disadvantages of increasing the transit time and distance from the dredge site. The maximum volume of material to be dredged each year is 150,000 m^3 which equates to 210,000 wet tonnes of material based on a density of 1.4. The Middle Bank site had the capacity to accommodate these volumes.

Classification: High

(1) Estimated cost based on consultation with HGV operator at £50/hour for two hours per load.

Security of Option

Forth Ports will have full control over all stages in the dredging and disposal process assuming they receive a disposal licence.

Classification: Medium to High

Established Practice

Disposal at Middle Bank disposal site is the current practice for the disposal of the dredged spoil from Dundee. It is, therefore, established and proven as effective.

Classification: High

General Public Acceptability

Forth Ports has confirmed that recent similar disposal operations from the Port of Dundee have not attracted any comments. Dredging operations are unlikely to affect members of the general public, with the possible exception of some recreational users when the vessel is transiting to and from the disposal site.

Classification: High

Likely Agency Acceptability

Consultations with the regulatory bodies to date indicate that there is no objection to Sea Disposal at Middle Bank. Crown Estate Scotland and NatureScot did not raise an objection and have no knowledge of any sites that could make any beneficial use of the material, Dundee City Council and the Northern Lighthouse Board had no objections to spoil disposal at sea.

Classification: Medium to High

Legislative Implications

A Marine Licence will be required from Marine Scotland and provided that the BPEO is satisfactory, and the statutory consultees do not object, it is established practice that a Marine Licence will be issued. Compliance should not therefore demand significant management control. Permission will be required from Crown Estate Scotland for disposal of spoil to Crown Estate Scotland owned sea bed.

Classification: Medium to High

4.5.2 Health, Safety and Environmental Considerations

Safety

The operations are undertaken at sea, therefore members of the public are not likely to be exposed to risk from the disposal activities. The contractor appointed to undertake the dredging and disposal may be subject to a health, safety and environmental audit by Forth Ports.

Classification: High

Public Health

The risk of members of the general public being exposed to contamination from the dredged material is regarded as low. Commercial species of demersal fish are not taken from the area and no food chain links between sediment contamination or contamination liberated into the water column, and human consumers leading to impacts on public health are considered likely.

Classification: Medium to High

Pollution/Contamination

The effects on water quality of the disposal operations and the potential for impacts on sediment contamination may cause the occasional exceedance of Environmental Quality Standards and failure

to meet Water Framework Directive (WFD) objectives although based on current evidence this would be localised and short-term.

Classification: Medium

Ecological Impacts

The disposal operations may affect the benthic fauna in proximity to the disposal site due to suspended sediments depositing on the seabed outside the spoil ground. It is anticipated that there will not be any significant impact on the Tay marine ecosystem as a whole given the scale and duration of effects. There may be some short-term effects such as displacement on migrating fish due to increased turbidity caused by the discharge of dredged material into the water column but these impacts are not predicted to cause mortality or alter the viability of populations. Under the disposal proposed, cumulative impacts with other operations are not predicted to create a significant impact to the Firth of Tay and Eden Estuary SPA or marine ecosystem.

Classification: Medium to High.

Interference with Other Legitimate Activities

The disposal activities may cause some disruption to other users of the Firth of Tay, however as the operations will only be occurring for a limited period of time it is not anticipated that there will be any significant interference. In addition, Middle Bank is the current disposal location and historic operations in this area have not resulted in any considerable disruption to other Firth Tay users.

Classification: High

Amenity/Aesthetic

The disposal activities may cause some short-term disruption to other users of the Firth of Tay but the proposals will contribute to the normal functioning of the Port of Dundee and maintain its capacity to accommodate larger vessels.

Classification: Medium to High

4.5.3 Cost Considerations

There would be no capital required to purchase new equipment. Operational costs for the operation of the dredger to dredged up to 150,000 m^3 each year are approximately £500,000.

Classification: High

5. SUMMARY OF THE BPEO

5.1 INTRODUCTION

This section summarises the assessment of options against the criteria described in *Chapter 2*: *Table 2.1* and identifies the BPEO.

5.2 COMPARISON OF OPTIONS

Seven options were initially considered for the disposal of the dredged spoil from the Port of Dundee. These were reduced to a short-list of four options based on practicality. A summary of the key considerations with regard to each of the four short-listed options is provided below and illustrated in *Table 5.1.*

5.2.1 Coastal Reclamation and Construction Fill

Operationally coastal reclamation and construction fill would be possible; however it would likely be costly and involve a number of contractors to undertake the transition from vessel to bunded lagoons and drying and fixing of the material in the lagoons. The sediment is mixed, comprising primarily sandy mud, with gravelly mud. The sediment has low compressive strength properties, making it unsuitable for most types of construction. In addition, the presence of some heavy metals and PAHs classes it as non-hazardous rather than inert, which restricts its suitability for application on land.

Currently there are no significant areas of coastal reclamation planned in the Firth of Tay. The costs of this option would be high due to the requirement for construction of a landing and storage facility, a drying facility and transport costs.

5.2.2 Sacrificial Landfill

Operationally, disposal to landfill will be achievable but problematic. The dredged materials would require landing and drying in specially constructed facilities and would then require transport in sealed HGVs to an appropriate landfill site. There are limited sites available to take the material, and a full analysis of the contaminants in the material would be required by the operators before final acceptance.

Whilst small amounts of dredged sediment material are sometimes disposed of to landfill, it is not common practice and Forth Ports would not have the security of controlling the disposal route. The public and agencies are likely to find this disposal acceptable, but there may be concerns relating to transport and Scotland's Zero Waste Plan (2010) which favours a reduction in the volume of material disposed by landfill (to 5% of all wastes by 2025).

The requirement for transport will result in some safety and public health risks and interference with legitimate activities and there is low risk of ecological disturbance. There would be an increase in traffic volume due to HGV movements, along with elevated carbon dioxide emissions. The costs of this option outweigh the other short-listed options, due to the requirement for construction of a landing and storage facility, a drying facility and high transport costs.

5.2.3 Other Disposal Options and Reuse

Operationally this option would be achievable but there would be difficulties associated with the requirement to land, store, dry and transport the material. Forth Ports would have limited control over the option and it is not common practice to use marine dredged material for these purposes. It is likely to be viewed as an attractive option by the public and agencies and no legislative issues are anticipated. There would be potential for benefit through substitution of recycled material for primary minerals.

Environmental and public health and safety concerns associated with this option are linked to transport of the materials and are anticipated to be minimal. There will be no significant impact on

amenity and little interference with other legitimate users. As with Sacrificial Landfill, Coastal Reclamation and Construction Fill, capital costs would be high because of the need for landing, storage and drying facilities and transport costs.

The mineralogical composition, low organic content and salinity of the material limit its suitability for use for brick making, as concrete aggregate or in topsoil production as it would require treatment to desalinate and decontaminate the material.

5.2.4 Sea Disposal

Operationally few problems are anticipated with disposal at Middle Bank and this site is has been historically used for disposal of dredged materials from the Port of Dundee. It is anticipated that this option will be acceptable to both public and agencies. Forth Ports would have full control over the dredging process through the appointment of contractors and risks to safety and public health are anticipated to be low.

There will be some short-term effects on water quality during disposal, such as raised turbidity and suspended sediment levels, which may have short-term and localised ecological effects, but these are considered to be not significant. There is unlikely to be interference with other legitimate activities and there is not anticipated to be any impact on local amenity or navigation, which is managed by Forth and Tay Navigation Service.

5.3 IDENTIFICATION OF THE BPEO

The assessment of options highlights the major operational difficulties associated with the landfill and other use options that primarily relate to lack of available sites and facilities and the nature of the material. There are also major costs associated with the need to construct landing, storage and drying facilities at the Port of Dundee.

The proposed project supports the objectives set out in Scotland's National Marine Plan and will continue to maintain and support the sustainable development of the Port of Dundee and enable it to continue to service the offshore renewable and oil and gas industries and in turn, support the national economy.

Disposal at sea will keep the dredged material within the ecosystem, maintaining the sediment budget for the area. In line with guidance from Marine Scotland, the Best Practicable Environmental Option is identified as the disposal at a licensed sea disposal site. The preferred site for this is the Middle Bank disposal site.

Table 5.1 Summary of Assessment of Options

Consideration	Coastal Reclamation and Construction Fill	Sacrificial Landfill	Other Disposal Options and Reuse	Sea Disposal
Operational feasibility				
Availability of sites/facilities				
Security of option				
Established practice				
General public acceptability				
Likely agency acceptability				
Legislative implications				
Safety				
Public health				
Pollution / contamination				
Ecological impact				
Interference with other activities				
Amenity / aesthetic				
Capital and maintenance costs	#			

#: Medium if pumped to site

Key: Performance of Options	
Low	
Low to Medium	
Medium	
Medium to High	
High	

APPENDIX A SEDIMENT SAMPLE CHEMICAL ANALYSIS

A1 DUNDEE SEDIMENT SAMPLE DATA

A1.1 Introduction

Samples of the seabed sediments to be dredged were collected from the Port of Dundee by Forth Ports between 18th January and 3rd February 2023 and were analysed by Socotec UK Ltd.

The survey plan followed the Marine Scotland guidance and was submitted to Marine Scotland for review prior to commencement of the work. Based on the maximum dredge volumes and dredging depths applied for, grab samples from eight sample stations were required. Sample station locations are presented in Table A1.1 and *Figure A1.1*.

Table A1.1 Positions of the 2023 Sample Stations

Sample Station	Latitude	Longitude
D1-2023	56° 27.665' N	2 °57.202' W
D2-2023	56 °27.765' N	2 °56.840' W
D3-2023	56 °27.795' N	2 °56.607' W
D4-2023	56 °27.850' N	2 °56.283' W
D5-2023	56 °27.880' N	2 °56.245' W
D6-2023	56 °27.900' N	2 °56.048' W
D7-2023	56 °27.842' N	2 °55.491' W
D8-2023	56 °27.734' N	2 °56.304' W

Coordinates in WGS84, UTM Zone 30N, degrees decimal minutes

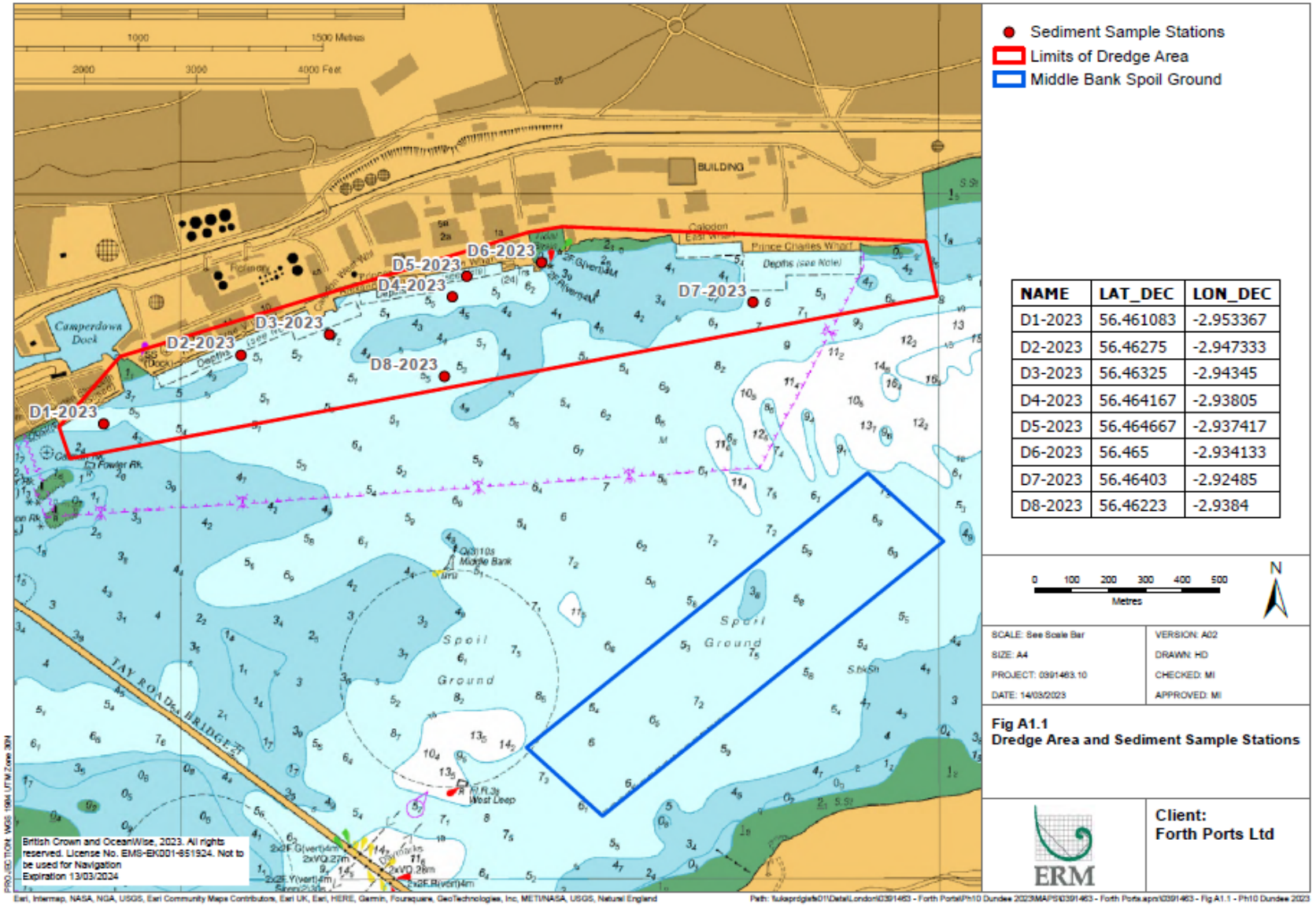
The grab samples retrieved from each survey station were photographed (shown in *Figure A1.20)* and subsampled on deck and stored in pre-cleaned sample containers provided by Socotec. Each sample was labelled with a unique sample ID and a field log was kept to record the sample location, date and time sample was taken. Samples were kept chilled and sent by overnight courier in coolboxes to the analytical laboratory.

For each of the samples the following chemical analysis was undertaken.

- Sediment water content and density.
- Sediment particle distribution (PSD).
- Total Organic Carbon (TOC).
- Metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn).
- Tributyl Tin (TBT).
- Polycyclic Aromatic Hydrocarbons (EPA 16 PAHs).
- Poly Chlorinated Biphenyls (ICES 7 PCB).
- Total Hydrocarbon Content.
- Presence of asbestos.

Marine Scotland Action Levels are discussed in *Section A1.2* and the sediment sample data are presented in *Section A1.3* to *Section A1.8*.

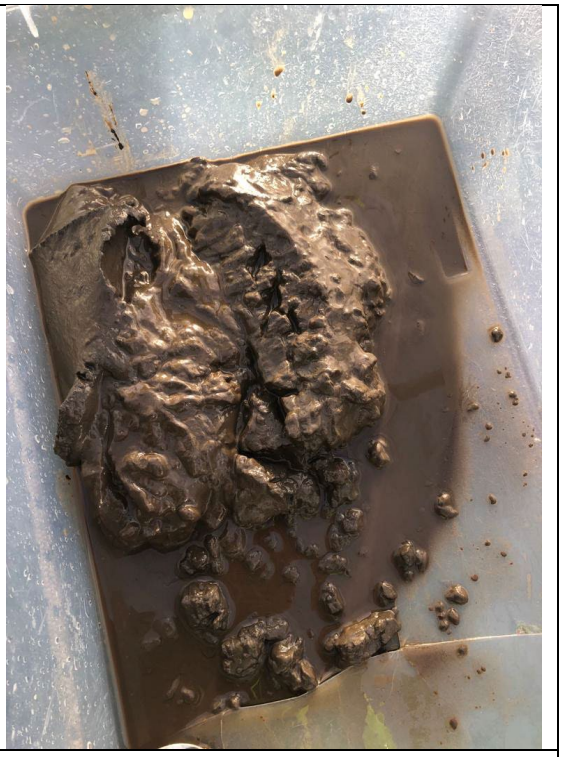
Figure A1.1 Sample Station Locations, Port of Dundee



NAME	LAT_DEC	LON_DEC
D1-2023	56.461083	-2.953367
D2-2023	56.46275	-2.947333
D3-2023	56.46325	-2.94345
D4-2023	56.464167	-2.93805
D5-2023	56.464667	-2.937417
D6-2023	56.465	-2.934133
D7-2023	56.46403	-2.92485
D8-2023	56.46223	-2.9384

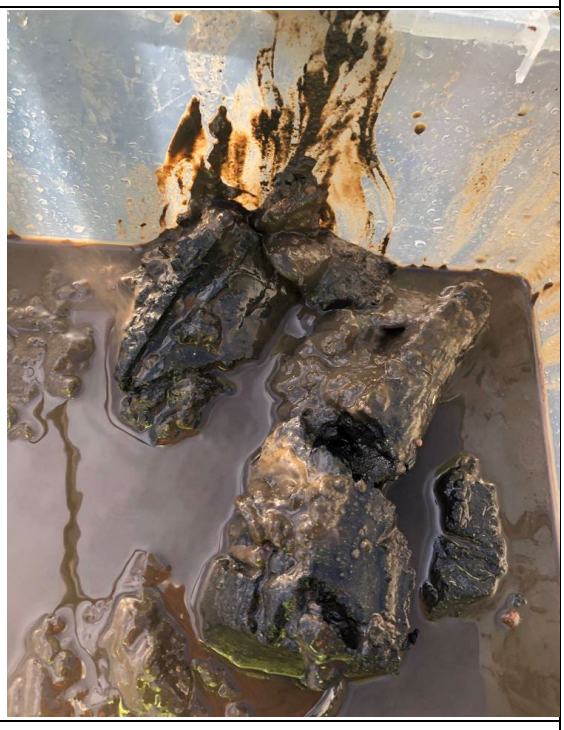
Figure A5.2 Photographs of Sediment Samples

D1-2033

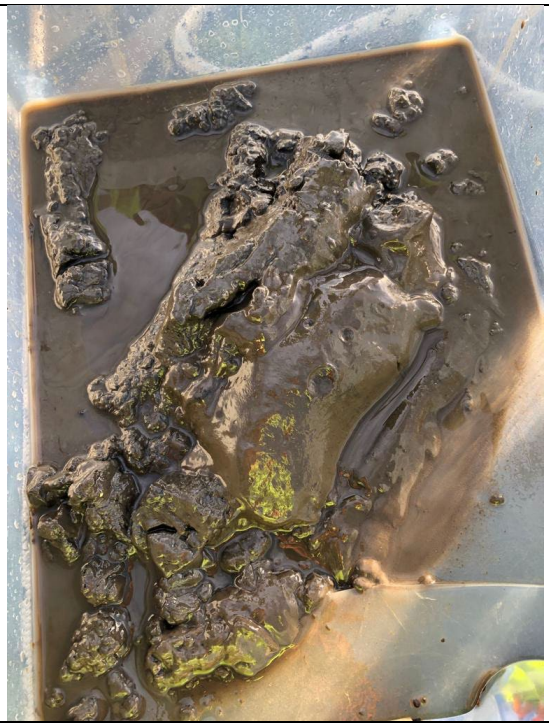


D2-2023

D3-2023



D4-2023

	
D5-2023	D6-2023
	
D7-2023	D8-2023

A1.2 Marine Scotland Action Levels

Table A1.2 and *Table A1.3* set out the Action Levels for metals, PCBs, TBT and PAHs used by Marine Scotland to assess the suitability for disposal of sediments at sea.

In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. A breach of Action Level 1 does not automatically preclude disposal at sea but usually requires further consideration before a decision can be made. Dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for normal sea disposal, but may be suitable for other management options such as treatment or seabed burial/capping, unless a compelling case can be made for normal sea disposal.

Table A1.2 Marine Scotland Action Levels: Metals

Metal	AL1 (mgkg^{-1} dry weight)	AL2 (mgkg^{-1} dry weight)
Arsenic	20	70
Cadmium	0.4	4
Chromium	50	370
Copper	30	300
Mercury	0.25	1.5
Nickel	30	150
Lead	50	400
Zinc	130	600

Table A1.3 Marine Scotland Action Levels: PCBs, TBT and PAHs

Determinand	AL1 (mgkg^{-1} dry weight)	AL2 (mgkg^{-1} dry weight)
ICES 7 PCBs	0.02	0.18
TBT	0.10	0.50
PAHs		
Naphthalene	0.10	
Phenanthrene	0.10	
Anthracene	0.10	
Fluoranthene	0.10	
Pyrene	0.10	
Benz[a]anthracene	0.10	
Chrysene/Triphenylene	0.10	
Benzofluoranthenes	0.10	
Benzo[a]pyrene	0.10	
Indenopyrene	0.10	
Benzoperylene	0.10	
Acenaphthylene	0.10	
Acenaphthene	0.10	
Fluorene	0.10	
Dibenz[a,h]anthracene	0.01	
Total PAHs	100	

A1.3 Metal Results

Concentrations of metals are presented in Table A1.4. Levels above Marine Scotland Action Level 1 are highlighted in blue. No concentrations above Action Level 2 were recorded.

Table A1.4 Metal Contaminants from the Port of Dundee (mg kg^{-1}) 2023

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
D1-2023	11.0	0.21	43.4	23.1	0.12	29.2	27.4	101
D2-2023	13.3	0.23	52.9	24.9	0.14	35.0	35.2	107
D3-2023	14.8	0.22	54.8	26.5	0.15	37.0	37.3	110
D4-2023	7.4	0.20	36.3	18.0	0.11	24.7	21.4	88.5
D5-2023	10.0	0.14	38.6	19.0	0.10	25.2	24.4	74.9
D6-2023	11.3	0.19	43.3	25.2	0.18	29.0	31.9	101
D7-2023	11.3	0.31	44.9	23.3	0.12	29.8	31.5	91.4
D8-2023	5.1	0.21	17.0	9.0	0.09	11.9	10.5	41.7
Mean	**10.53**	**0.21**	**41.40**	**21.13**	**0.13**	**27.73**	**27.45**	**89.44**
Range	5.1-13.3	0.21-0.31	17-54.9	9-26.5	0.1-0.18	11.9-37	10.5-37.3	41.7-107

As = Arsenic, Cd = Cadmium, Cr = Chromium, Cu = Copper, Hg = Mercury, Ni = Nickel, Pb = Lead and Zn = Zinc.

Table A1.5 provides a comparison of metal data from samples analysed from 1989 to 2023. The ranges in results for all metals over the period for which there is available sample data are large and in most surveys the men concentrations of some metal concentrations are above Action Level 1. The mean concentration for Hg was above AL2 in 2000.

The concentrations of chromium from the 2023, 2020 and 2017 surveys were elevated compared to most of the historic sediment samples collected at Dundee. The mean concentrations from 2017 and 2020 were above Action Level 1, however, for the 2023 samples the mean concentrations are below Action Level 1. Chromium in marine sediments is often associated with the discharges from industries such as ferrochrome production, electroplating, pigment production, tanneries or waste incineration. There are no chromium discharges from ongoing Forth Ports' operations. The recorded levels are likely to be related to historic discharges into the Tay and subsequent recirculation of sediments leading to variability in concentrations observed in different years.

Table A1.5 Metal Contaminants from the Port of Dundee (mg kg^{-1}) 1989 to 2023

Year		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1989	Mean	7.7	0.3	57.1	54.0	0.3	26.7	66.6	176.8
	Range	5.7-9.0	0.2-0.6	53.8-59.9	35.6-70.8	0.2-0.4	24.8-28.0	51.4-74.6	125.0-241.0
1990	Mean	3.6	0.2	25.5	25.3	0.2	21.9	52.8	76.5
	Range	1.4-9.8	0.2-0.5	9.1-40.1	9.1-62.0	0.0-0.5	13.7-38.5	5.8-198	31.1-147.0
1992	Mean	20.4	0.5	36.0	30.7	0.4	25.5	46.9	125.0
	Range	16.8-22.8	0.5	35.1-37.0	27.4-35.2	0.3-0.5	25.0-26.2	44.8-50.6	115.0-138.0
1993	Mean	7.1	0.2	23.2	25.9	0.2	29.1	42.9	99.5
	Range	2.2-11.9	0.2	2.7-31.8	8.8-33.7	0.0-0.4	17.6-37.6	4.1-61.1	22.1-133.1
1994	Mean	2.3	0.1	34.4	36.6	0.3	31.8	55.0	110.9
	Range	0.4-3.2	0.1-0.2	25.6-46.2	29.5-46.5	0.2-0.5	25.1-38.9	39.0-65.2	80.0-149.0
1995	Mean	10.6	0.1	27.5	25.6	0.2	28.8	33.0	90.4
	Range	3.7-18.5	0.0-0.2	11.3-46.4	14.3-38.9	0.1-0.4	16.9-39.7	9.3-66.7	35.8-163.0
1996	Mean	4.1	0.2	29.5	46.1	0.3	29.6	56.3	144.5
	Range	3.0-5.6	0.1-0.3	27.5-32.5	34.5-68.6	0.2-0.4	26.7-31.7	46.1-67.8	133.0-156.0
1997	Mean	6.3	0.3	35.6	50.8	0.2	23.9	193.8	250.3
	Range	5.1-8.3	0.2-0.4	24.0-53.4	29.8-66.9	0.2-0.3	18.1-31.9	34.1-501.0	117.0-508.0
1998	Mean	7.8	0.2	32.5	25.0	0.2	61.0	35.3	128.6
	Range	5.3-11.8	0.1-0.4	20.0-45.9	17.1-58.4	0.1-1.0	19.8-158.0	8.4-59.6	35.6-455.0
2000	Mean	10.1	0.3	41.8	28.6	2.8	27.8	46.6	146.0
	Range	8.0-13.0	0.2-0.3	32.5-54.8	21.7-35.5	0.2-13.6	22.5-35.0	36.0-61.3	128-161
2002	Mean	10.4	0.4	44.6	26.8	0.2	30.3	47.4	118.2
	Range	9.4-11.6	0.3-0.7	42.3-47.3	23.6-29.1	0.2-0.3	29.0-31.7	43.3-50.7	108-126
2006	Mean	9.1	BDL	39.3	17.5	0.1	25.9	28.7	83.1
	Range	7.0-44.0	BDL	31.4-44.0	14.2-19.3	0.1-0.2	21.3-28.3	21.9-32.8	69.2-91.7
2007	Mean	10.0	0.2	43.9	21.6	0.1	28.6	34.5	91.9
	Range	8.1-13.1	BDL-0.2	37.2-57.4	15.8-32.5	0.1-0.2	23.3-37.1	25.2-48.2	74.6-113
2011	Mean	11.2	0.2	43.4	19.4	0.1	26.6	37.7	101.5
	Range	9.3-14.3	0.1-0.2	36.0-53.4	16.6-22.2	0.1-0.2	22.7-31.8	30.6-49.2	88.8-112.0
2017	Mean	13.0	0.172	60.5	28.2	0.1	34.6	31.9	143.1
	Range	8.1-21.1	0.1-0.3	40.7-91.0	11.4-82.9	0.0-0.2	20.2-61.0	17.2-41.9	58.6-418.0
2019*	Mean	9.26	0.19	36.17	48.95	0.24	28.27	55.5	205.43
	Range	6.8-14.5	0.12-0.38	25.4-43.1	20.7-128	0.09-0.91	19.4-42	10.4-190	80.2-569
2020	Mean	11.69	0.25	66.37	23.46	0.13	27.9	29.1	103.6
	Range	8.8-13.4	0.18-0.28	54.3-73.2	18.5-28.6	0.1-0.16	23.4-31.2	17.3-35.2	68.6-124
2023	Mean	10.53	0.21	41.40	21.13	0.13	27.73	27.45	89.44
	Range	5.1-13.3	0.21-0.31	17-54.9	9-26.5	0.1-0.18	11.9-37	10.5-37.3	41.7-107
1989-2023	**Mean**	**9.18**	**0.24**	**39.93**	**30.87**	**0.34**	**29.78**	**51.19**	**126.93**
	Range	**0.4-22.8**	**BDL-0.7**	**2.7-91**	**8.8-128**	**0.0-13.6**	**11.9-158**	**4.1-501**	**22.1-569**

*Data from the 2019 capital works core survey has used the data from the surface samples only to allow comparison with other surface samples.

A1.4 Polychlorinated Biphenyls Results

Polychlorinated biphenyls (PCBs) are organic compounds comprising a biphenyl group (composed of two benzene rings) with between one and ten bonded chlorine atoms. PCBs are highly toxic, persistent pollutants and are readily bioaccumulated in animals.

Although production in the UK ceased in the 1970s, PCBs still enter the marine ecosystem through the disposal of industrial plant, emissions from old electrical equipment and from landfill sites (1).

Dry weight concentrations of ICES 7 PCBs from samples collected in 2023 are presented in *Table A1.6*. No ICES 7 PCB levels exceed Action Level 1 (0.02 mg kg^{-1}) in any of the samples.

Table A1.7 presents a comparison of mean dry weight concentrations of ICES 7 PCBs from samples collected in 1993 to 2023.

Table A1.6 PCB Contaminants from the Port of Dundee (mg kg^{-1}) 2023

Station	Sum of ICES 7 PCB Concentrations
D1-2023	<0.00119
D2-2023	0.00146
D3-2023	0.00144
D4-2023	0.00139
D5-2023	0.00160
D6-2023	0.00159
D7-2023	<0.00084
D8-2023	<0.00038
Mean	**<0.00124**

ICES 7 PCB congeners (with IUPAC numbers): 28 - 2,4,4' - Trichlorobiphenyl, 52 - 2,2',5,5' - Tetrachlorobiphenyl, 101 - 2, 2', 4, 5, 5' - Pentachlorobiphenyl, 118 - 2, 3', 4, 4', 5 - Pentachlorobiphenyl, 138 - 2, 2', 3, 4, 4', 5' - Hexachlorobiphenyl, 153 - 2, 2', 4, 4', 5, 5' - Hexachlorobiphenyl, 180 - 2, 2', 3, 4, 4', 5, 5' - Heptachlorobiphenyl.

Table A1.7 PCB Contaminants from the Port of Dundee (mg kg^{-1}) 1993 – 2023

Year	Mean Sum of ICES 7 PCB Concentrations
1993	0.0045
2000	0.0240
2006	0.0049
2011	0.0041
2017	<0.0130
2019*	0.0032
2020	<0.0019
2023	<0.00124
1993-2023	**<0.006358**

ICES 7 PCB congeners (with IUPAC numbers): 28 - 2,4,4' - Trichlorobiphenyl, 52 - 2,2',5,5' - Tetrachlorobiphenyl, 101 - 2, 2', 4, 5, 5' - Pentachlorobiphenyl, 118 - 2, 3', 4, 4', 5 - Pentachlorobiphenyl, 138 - 2, 2', 3, 4, 4', 5' - Hexachlorobiphenyl, 153 - 2, 2', 4, 4', 5, 5' - Hexachlorobiphenyl, 180 - 2, 2', 3, 4, 4', 5, 5' - Heptachlorobiphenyl.

*Data from the 2019 capital works core survey has used the data from the surface samples only to allow comparison with other surface samples.

(1) Forth Replacement Crossing: Environmental Statement 2009. Available online from http://www.transportscotland.gov.uk/strategy-and-research/publications-and-consultations/j11223-081.htm

A1.5 Polycyclic Aromatic Hydrocarbons

Levels of PAHs are presented in *Table A1.8*. Levels of PAHs are presented in *Table A1.9.* Levels above Marine Scotland Action Level 1 for individual PAHs are highlighted in blue. The Total Hydrocarbon (THC) concentrations are also reported (in $mgkg^{-1}$). There are no Action Levels for THC.

A comparison of mean dry weight concentrations of PAHs from samples collected between 2006 and 2023 are presented in *Table A1.9* which shows that PAH concentrations of the majority of individual PAHs are variable with levels of some PAHs in some years being above Action Level 1.

Table A1.8 Analysis of PAHs from the Port of Dundee (µg kg^{-1} Dry Weight) 2023

Station	D1-2023	D2-2023	D3-2023	D4-2023	D5-2023	D6-2023	D7-2023	D8-2023
LMW PAH								
Acenaphthene	14.1	<5	<5	11.6	<5	78.8	11.3	<5
Acenaphthylene	33.9	<5	<5	10.2	<5	19.8	11.9	<5
Anthracene	69.9	25.1	34.9	23.6	16.3	129	22.3	<5
Fluorene	38.7	<5	<5	15.1	<5	72.4	15.7	<5
Naphthalene	28.4	28.1	37.7	20.1	19.6	39.9	23.5	<5
Phenanthrene	251	80.9	118	70.9	54.3	437	75.8	16.8
HMW PAH								
Benzo(a)anthracene	143	80.9	98.4	76.3	59.0	200	77.0	18.4
Benzo(a)pyrene	177	105	128	104	78.5	226	108	26.7
Benzo(b)fluoranthene	158	151	172	121	106	214	124	39.0
Benzo(ghi)perylene	151	132	152	102	98.0	175	118	33.9
Benzo(k)fluoranthene	144	118	138	100	89.5	190	105	29.5
Chrysene	141	94	109	80	64.6	202	80.5	19.1
Dibenzo(ah)anthracene	24.6	21.8	27.6	17.7	16.4	35.6	19.8	<5
Fluoranthene	284	144	187	136	99.1	480	139	32.1
Indeno(1,2,3-c,d)pyrene	158	140	170	114	105	203	127	35.5
Pyrene	322	145	187	136	99.6	420	136	33.9
THC (mg kg^{-1})	162	221	229	144	132	184	145	57.7

Table A1.9 Comparison of PAHs from the Port of Dundee 2006 to 2023 (mg kg^{-1} Dry Weight)

Year	2006	2007	2011	2017	2019**	2020	2023
PAH	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
LMW PAH							
Acenaphthene	ND	ND	ND	0.013	0.0180	0.0121	0.0170
Acenaphthylene	ND	ND	ND	0.004	0.0399	0.0121	0.0120
Anthracene	0.0330	0.0141	0.0320	0.029	0.0594	0.0237	0.0408
Fluoranthene	0.2390	0.0942	0.2148	0.139	0.5165	0.1297	0.1877
Naphthalene	0.4652	0.1833	0.4187	0.021	0.0573	0.0209	0.0253
Phenanthrene	0.1432	0.0582	0.1301	0.089	0.0871	0.0800	0.1381
MMW PAH							
Benzo(*a*)anthracene	0.1255	0.0499	0.1171	0.065	0.2797	0.0702	0.0941
Benzo(*a*)pyrene	0.1758	0.0632	0.1475	0.079	0.3475	0.0932	0.1192
Benzo fluoranthenes	ND	ND	0.3673	0.094	0.3963	0.1504	0.2499
Benzoperylene	0.1695	0.0561	0.1475	0.090	0.2182	0.0930	0.1202
Chrysene/Triphenylene	0.1440	0.0590	0.1368	0.067	0.2725	0.0799	0.0987
Dibenz[*a,h*]anthracene*	ND	ND	ND	0.020	0.0425	0.0175	0.0211
Fluorene	0.0166	0.0068	0.0196	0.015	0.0252	0.0143	0.0202
Indenopyrene	0.1867	0.0624	0.1607	0.097	0.2253	0.0947	0.1316
Pyrene	0.2333	0.0910	0.2015	0.136	0.5873	0.1336	0.1849

*Action Level 1 is 0.01 mg kg^{-1}

**Data from the 2019 capital works core survey has used the data from the surface samples only to allow comparison with other surface samples.

ND = Not Detected

Note only those 15 PAHs for which there are historic data are reported. Benzo fluoranthenes are the sum of Benzo(b)fluoranthene and Benzo(k)fluoranthene

A1.6 Tributyltin

Tributyltin (TBT) is a highly toxic compound historically used as an anti-biofouling agent in paint used to coat the hulls of vessels. It is also toxic to non-target organisms and is linked to immune-suppression and imposex (1) in snails and bivalves. TBT was also used in various industrial processes as a biocide and can enter the marine environmental through effluent discharges. In some cases, TBT can also be persistent in the marine environment.

Mean dry weight concentrations of TBT from the samples collected are presented in *Table A1.10.* No samples were observed to have TBT concentrations above Marine Scotland Action Level 1 (0.1 mg kg^{-1}).

Table A1.10 TBT from the Port of Dundee (mg kg^{-1} Dry Weight) 2023

Station	TBT Concentration
D1 2020	<0.005
D2 2020	<0.005
D3 2020	<0.005
D4 2020	<0.005
D5 2020	<0.005
D6 2020	<0.005
D7 2020	<0.005
D8-2020	<0.005
Mean	**<0.005**

A comparison of TBT concentrations from samples collected in 2017, 2019, 2020 and 2023 are presented in *Table A1.11,* which shows that TBT concentrations are below Action Level 1 in all years.

Table A1.11 TBT from the Port of Dundee (mg kg^{-1} Dry Weight) 2017 to 2023

Year		TBT Concentration
2017	Mean	<0.0047
	Range	<0.001-<0.006
2019*	Mean	<0.011
	Range	<0.005-0.04
2020	Mean	<0.0257
	Range	<0.005-0.0145
2023	Mean	<0.005
	Range	<0.005 - <0.005
2017-2023	Mean	<0.01044
	Range	<0.001-0.04

*Data from the 2019 capital works core survey has used the data from the surface samples only to allow comparison with other surface samples.

(1) The development of male characteristics in females

A1.7 Asbestos

No asbestos was reported from any of the samples.

A1.8 Sediment Physical Properties

The physical properties of the dredge sediment was analysed on the eight sediment samples taken from Dundee in 2023. Sediments were predominantly sandy mud, with small amounts of gravel in two of the stations (D7-2023 and D8-2023).

Gravel is defined as >2 mm.

Sand is defined as >63 µm<2 mm.

Mud (silts and clays) is defined as <63 µm.

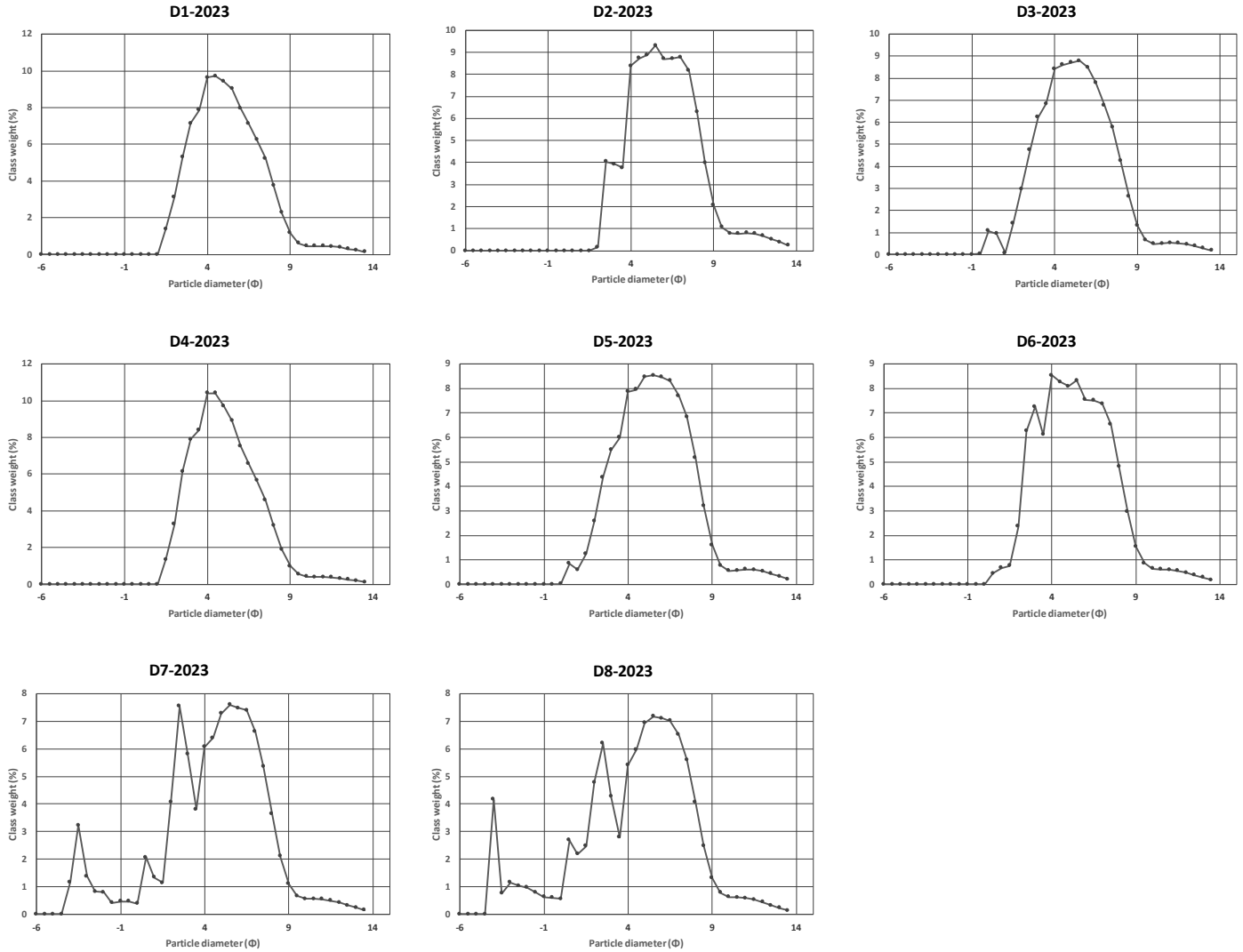
Table A1.12 and *Figure A1.3* present the 2023 data.

Sediment contamination is typically higher in sediments less than 63 µm diameter *e.g.* mud due to the increased surface area providing more adhesion sites for contaminants than the same volume of sand or gravel.

Table A1.12 Port of Dundee 2023 Sediment Data Summary

Station	D1-2023	D2-2023	D3-2023	D4-2023	D5-2023	D6-2023	D7-2023	D8-2023
Textural Group Classification	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	gM: Gravelly Mud	gM: Gravelly Mud
Folk and Ward Description	Very Coarse Silt	Coarse Silt	Coarse Silt	Very Coarse Silt	Coarse Silt	Coarse Silt	Very Coarse Silt	Very Coarse Silt
Folk and Ward Sorting	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
Mean µm	33.15	19.22	30.88	37.20	26.33	29.16	44.34	50.22
Mean phi	4.92	5.70	5.02	4.75	5.25	5.10	4.50	4.32
Sorting Coefficient	1.99	2.04	2.12	1.94	2.14	2.15	3.10	3.37
Skewness	0.11	0.07	0.04	0.14	0.02	0.07	-0.22	-0.26
Kurtosis	0.94	1.01	0.96	0.95	0.94	0.90	1.25	1.17
Gravel (%)	0.00	0.00	0.00	0.00	0.00	0.00	8.28	9.49
Sand (%)	34.48	20.27	32.78	37.47	29.04	32.41	32.72	31.96
Mud (silts and clays) (%)	65.52	79.73	67.22	62.53	70.96	67.59	59.00	58.55
Total Organic Carbon (%)	2.50	3.34	3.68	1.68	3.21	2.22	2.58	0.88
Solids (%)	40.2	33.1	31.8	51.1	48.5	43.3	45.9	52.6
Density	2.62	2.59	2.58	2.62	2.61	2.59	2.58	2.62

Figure A1.3 Port of Dundee 2023 Sediment PSA



A2 DISPOSAL SITE SEDIMENT SAMPLE DATA

Table A1.13 presents metal and PCB concentration data from sediment sampled from within Middle Bank disposal site and from other disposal sites within the Firth of Forth and Forth Estuary for comparison, as there are no other data from the Firth of Tay. Levels above Marine Scotland Action Level 1 for metals and PCBs are highlighted in blue.

Table A1.13 Concentration of Metals and PCBs (mg kg^{-1}) from Tay Middle Bank Disposal Site and Firth of Forth and Forth Estuary Disposal Sites

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)									
Narrow Deep (Forth) 2015	11.7	0.2	63.8	24.6	0.6	30.0	58.4	105.9	0.003
(*n=5*)									
Methil (Forth) 2015	8.7	0.1	18.0	9.6	BDL	11.2	14.5	72.8	0.000
(*n=1*)									
Kirkcaldy (Forth) 2015	8.9	0.1	43.1	17.0	0.2	22.0	30.6	62.9	0.000
(*n=3*)									
Blae Rock (Forth) 2011	17.2	0.1	39.6	21.9	0.5	21.4	52.1	80.3	0.001
(*n=6*)									
Bo'ness (Forth) 2015	18.6	0.1	59.6	26.5	0.7	27.5	54.2	114.0	0.000
(*n=5*)									

Data provided by Marine Scotland (2019)

Key: n = the number of samples analysed (where known)

Note that monitoring of disposal sites is not mandatory therefore, the data presented in *Table A1.13* are the most recent data available. The data indicates that concentrations of metals within sediment samples from the Middle Bank disposal site in the Tay are lower than those from Narrow Deep, Blae Rock and Bo'ness disposal sites in the Firth of Forth. Metal concentrations in samples from Middle Bank are generally lower than the original material dredged from the Port of Dundee (refer to *Table A1.4* for 1989 to 2023 mean metal concentrations).

APPENDIX B ENVIRONMENTAL IMPACTS OF DISPOSAL OPERATIONS

B1 INTRODUCTION

This Appendix addresses the environmental impacts of the maintenance dredging work at the Port of Dundee and the disposal of dredged material at the licenced Middle Bank disposal site. Impacts on water quality, sediment quality, and habitats and species are considered. *Table B1.1* presents the impact summary. Potential impacts on general vessel movements and fishing due to the dredging operations and disposal operations are not considered to be significant as commercial traffic in the main channel is controlled by Forth Ports' standard operating procedures. The identification and assessment of environmental impacts of the disposal of dredged material in this Appendix follows guidance from the Environment Agency, Clearing the Waters for All (1).

B2 IMPACTS OF DISPOSAL

B2.1 Introduction

As described in *Section 1.3* it is proposed that up to 150,000 m^3 material would be dredged from the Port of Dundee and disposed at Middle Bank disposal site. The material to be disposed consists primarily of sandy mud, with some gravel fractions. The concentrations of contaminants are presented in *Appendix A*. Samples were taken at eight stations (D1-2023 to D8-2023) and the results are summarised here.

- The mean concentrations of metals were all below Action Level 2. Chromium and Nickel concentrations were above Action Level 1 at two stations.
- TBT concentrations were below Action Level 1 at all stations.
- For individual PAHs, all were below Action Level 2 with all stations (except for station D8-2023) having some PAHs above Action Level 1 which were mostly the more persistent HMW PAHs
- The concentration of all PCBs were below Action Level 1.
- No asbestos was recorded.

Metal concentration data from sediment sampled in the Middle Bank disposal site are also presented in *Appendix A.*

B2.2 Impacts on Water and Sediment Quality

Coastal water quality in the Firth of Tay and Tay Estuary is currently Good (2). The disposal site at Middle Bank has been used previously by Forth Ports and it is likely that there will be some accumulation of dredged material in the area. The silt and clay (particle size <63µm) content of sediment in the Firth of Tay is generally less than 11%, with many areas greater than 75% sand (3). Sediment data from Middle Bank has returned samples of 100% sand (1).

The salinity regime in in the inner Tay Estuary is characteristic of the upper reaches of estuaries, varying in range from 0.2–21‰ at Balmerino to 0–0.02‰ at Newburgh (4). Between Invergowrie and Broughty Ferry, in the waters over Middle Bank, the estuary decreases in width leaving only relatively narrow intertidal areas. The salinity range off Newport is 6 to 30‰ and off Tayport is 11 to 32‰. The salinity conditions in the outer Tay Estuary range from 11–32‰ off Tayport to virtually fully marine conditions off Buddon Ness (32–33‰) (1).

(1)Best, M (2016). Clearing the Waters for All: WFD guidance for developers and regulators in estuarine and coastal waters. Environment Agency.
(2)https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=1919. Accessed 17 March 2023
(3) Bates, C. R., Moore, C. G., Malthus, T., Mair, J. M. and Karpouzli, E. (2004). Broad scale mapping of habitats in the Firth of Tay and Eden Estuary, Scotland. Scottish Natural Heritage Commissioned Report No. 007 (ROAME No. F01AA401D).
(4) Buller, A. T., Charlton, J. A. and McManus, J. 1972. Data from Physical and Chemical Measurements in the Tay Estuary for Neap and Spring Tides, June 1972. Tay Estuary Research Centre report.

There are two designated bathing waters within 5 km of the dredging or disposal sites. The nearest is Broughty Ferry which is classed as Excellent and is approximately 4.5 km from the Port of Dundee and the second is Monifieth, classed as Good and approximately 8 km from the Port of Dundee.

The natural levels of suspended sediments in the Firth of Tay vary with seasonal weather conditions and this contributes to the natural sedimentation in the Firth of Tay that aids the removal of contaminants from the water column and incorporates them in the seabed sediments. The material disposed at Middle Bank will fall to the sea bed by gravity and consist of cohesive lumps of dredged material. Fine sediment will be liberated as it sloughs off the descending material and when the clumps reach the seabed. Field measurements of suspended solids in surface waters following similar disposal operations indicate that less than 5% of the discharged material escapes the descending density jet [(1)].

There are no data available which indicate the concentration or dispersion of suspended solids from the disposal operations at Middle Bank in the Firth of Tay. However, data available from dredging fine sediments in Middle Bank in the Firth of Forth in 2008 [(2)] recorded increases of suspended sediments of up to 2.5 times during dredging compared to the baseline conditions (in this case the mean baseline concentration was 9.1 mg l^{-1}). Comparison of these mean baseline suspended solids concentrations with those recorded during dredging activities at Middle Bank in the Firth of Forth indicated peak increases were approximately two and half times above background levels [(1)]. Significant increases in turbidity associated with the disposal operations are therefore likely to be confined to the immediate area of the disposal site.

Any increased nutrient levels may stimulate local algal production, although the effects are predicted to be short-term and confined to the immediate area of the disposal operations. Nitrogen is generally regarded to be the limiting nutrient in estuarine and marine systems and in its reduced form (ammoniacal nitrogen) is also toxic to fish. As a consequence of the reduced (oxygen demanding) nature of the seabed sediments, nitrogenous nutrients are likely to be in this form.

The oxidation of anoxic sediments released into the water column has been shown to reduce oxygen concentrations by up to 58% [(3)]. Based on the background levels this may reduce the oxygen saturation to between 40 and 50% (equating to approximately 4 to 5 mg l^{-1}). Therefore, if the disposal operations occurred during a period of 'naturally' low dissolved oxygen it is possible that the Water Quality standards for EC Freshwater Fisheries Directive of oxygen concentration greater than 6 mg l^{-1} would not be met [(4)]. It is predicted that this would be short-lived, due to the limited period over which disposal is intended to occur (a few days each year), and localised based on previous dredge plume studies. The impacts are not considered to be significant given the generally high dissolved oxygen levels anticipated at the disposal site and the extent of the area potentially affected.

Although there may be some release of contaminants such as metals and PAHs into the water column during disposal operations the majority of the dredged material will descend to the seabed rapidly. Sediment bound contaminants liberated during the disposal operations will rapidly become complexed with particulate matter in the water column and be re-deposited on the sea bed. It is therefore not anticipated that the disposal operation at Middle Bank will introduce significant amounts of contamination into the water column. Disposal of the dredged material may result in a localised and short-term increase in the levels of some contaminants; however, the deposited sediment will disperse over time. Considering the short-term, localised and intermittent increase in the levels of some contaminants in the water column will not affect the overall water body quality status of the Tay Estuary or Firth of Tay with respect to the Water Framework Directive.

(1) Kennish M.J. 1992. Ecology of Estuaries Anthropogenic Effects Dredging and Dredged Spoil Disposal p 357-397

(2) ERM, 2008. Middle Bank Aggregate Production Licence: Monitoring Report. A report for Westminster Gravels Ltd.

(3) Brown C. 1968. Observations on Dredging and Dissolved Oxygen in a Tidal Waterway. Water Resources Research Vol 4, No 6, p1381.

(4) UKTAG 2010. Water Framework Directive: An approach to the Revoked Directives:- the Freshwater Fish Directive, the Shellfish Directive and the Dangerous Substances Directive. Available online from: http://www.wfduk.org/resources%20/approach-revoked-directives-%E2%80%93-freshwater-fish-directive-shellfish-directive-and-dangerous

The PAHs in the sediment comprise both low molecular weight (LMW) (two and three benzene rings) and high molecular weight (HMW) (more than 3 benzene rings) compounds. PAHs tend not to be volatile and poorly soluble and therefore readily absorb onto particulate matter in the water column and are incorporated into marine sediments. The HMW PAHs are generally the less water soluble, less acutely toxic and slower to biodegrade. Most PAHs over Action Level 1 in the samples were HMW PAHs.

The ratios of individual PAHs have been used to determine the likely anthropogenic source of PAHs in the environment: *e.g.* from combustion sources (pyrolytic) or petroleum hydrocarbons (petrogenic). Petrogenic PAHs are often characterised by phenanthrene to anthracene (Ph/An) values >10, whereas pyrolytic PAH from combustion processes are characterised by Ph/An ratios <10. The ratio of and fluoranthene to pyrene (Fl/Py) greater than 1 generally come from pyrolytic sources while ratios of less than 1 generally indicate petrogenic sources (1).

For all the sediment samples analysed from the Port of Dundee in 2020 the Ph/An ratios were between 3.00 and 3.59 and the Fl/Py ratios were between 0.88 and 1.14. This suggests that these contaminants are from both combustion and petroleum hydrocarbon sources and were similar to previous samples analysed for the Port of Dundee for previous Marine Licence applications by forth Ports. This supports the view that recorded contamination in the sediments has been transported into the port with the accumulated sediments from the wider Firth of Tay sediment circulation system.

B2.3 Impacts on Benthic Ecology

The benthic macrofaunal communities recorded in proximity to Middle Bank disposal site are expected to be typical for estuarine conditions and not considered to be of high conservation significance due to the wide distribution, low diversity and lack of any rare or notable species.

The impact on benthic communities will depend on the comparative rates of natural deposition (currently unknown) and the deposition due to the dredging disposal operations. It is anticipated that the deposition of dredged material at the Middle Bank disposal site may result in the loss (burial) of the benthos within and in the immediate vicinity of the 'deposition zone' within the disposal site. Localised impoverishment of the fauna (in terms of abundance and diversity) is likely along the axis of tidal flow as a result of secondary impacts comprising sediment deposition subsequent to the disposal activities.

Given the relatively homogenous nature of benthic communities and their exposure to the naturally high levels of suspended levels during periods of low river flow and availability of similar habitat within the Firth of Tay, the spatial extent of predicted sediment related impacts to benthos (and resultant impact on prey availability for foraging seabirds) are unlikely to be significant. Dredge spoil from the Port of Dundee has been deposited within the Middle Bank disposal site for over 30 years and significant impacts on benthic ecology outside of the disposal ground are not predicted.

B2.4 Impacts on Seabirds

The Firth of Tay and Eden Estuary Special Protection Area (SPA) lies approximately 1.2 nm southeast of Middle Bank at its closest point. It is designated under EC Directive 79/409/EEC on the Conservation of Wild Birds by supporting populations of species of European importance (little tern, marsh harrier and the bar-tailed godwit) listed on Annex I of the Directive. The site also qualifies under Article 4.2 of the Directive by regularly supporting at least 7,000 seabirds and populations of migratory species of European importance including the following (2).

- Greylag Goose *Anser anser*, 1,355 individuals representing at least 1.4% of the wintering Iceland/UK/Ireland population.

(1)Y.W. Qiu, G. Zhang, G.Q. Liu, L.L. Guo, X.D. Li, O. Wai. Polycyclic aromatic hydrocarbons (PAHs) in the water column and sediment core of Deep Bay, South China. Estuar. Coast. Shelf Sci., 83 (1) (2009), pp. 60-66.

(2) Data obtained for https://sitelink.nature.scot/site/8501

- Pink-footed Goose *Anser brachyrhynchus*, 3,769 individuals representing at least 1.7% of the wintering Eastern Greenland/Iceland/UK population.
- Redshank *Tringa totanus*, 1,800 individuals representing at least 1.2% of the wintering Eastern Atlantic population.
- Puffin *Fratercula arctica*, 21,000 pairs representing at least 2.3% of the breeding population.
- Shag *Phalacrocorax aristotelis*, 2,887 pairs representing at least 2.3% of the breeding Northern Europe population.

The directive requires the maintenance or restoration of natural habitats and species of European interest at a favourable conservation status, and a network of SPAs is one of the main vehicles to achieving this.

West of the Port of Dundee are the most extensive intertidal flats in the Firth of Tay, comprising large areas of fine-grained intertidal sediment which act as the source for much of the sediment deposition within the Port of Dundee. The Inner Tay Estuary Local Nature Reserve, Firth of Tay and Eden Estuary Special Protection Area (SPA)/Ramsar/Special Area of Conservation (SAC) tidal flats are located to the west of the port and the Montifieth Bay SSSI to the east. South of the port is the Balmerino – Wormit Shore SSSI and to the southeast of the port the Tayport – Tentsmuir Coast SSSI and Tentsmuir National Nature Reserve (NNR). Almost all the tidal flats within the Firth of Tay are protected within an SSSI and SPA because of the large (primarily overwintering) bird populations.

There are three potential effects of the disposal of dredge material at sea on seabirds; increased suspended solids, release of contaminated particulates and physical disturbance of birds by the dredging vessel. These effects are unlikely to have a significant effect on the qualifying interests of the SPA. The vessel used for disposal of the material will be travelling to and from the Port of Dundee and the disposal site during each two-to-three day dredging campaigns, a round trip of approximately 1.2 nm.

The Firth of Tay and Eden Estuary SPA supports seabirds that forage over a wide area. The disposal of the dredged material will result in localised increases in suspended sediment that may reduce the ability of fish-eating birds to forage around the disposal site due to impaired visibility. However the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by.

It is noted that Middle Bank is an established and long-term disposal site with disposal activities being ongoing at the time that the SPA was designated. Given that disposal at this site was an existing activity and ongoing disposal is at a similar scale to previous disposal activities it is considered that the proposals will not have significant effects on the qualifying interest of the SPA, located 1.2 nm south-east of the disposal site.

B2.5 Impacts on Fish

The Middle Bank disposal site is located within the Firth of Tay and Eden Estuary Special Area of Conservation (SAC), designated under the Habitats Directive (1) for its habitats and mammal species of European importance.

Atlantic salmon, river lamprey and sea lamprey inhabit and migrate up and down the Firth of Tay to reach spawning grounds in the River Tay SAC and may therefore pass the Middle Bank disposal site. The river lamprey grows to maturity in estuarine environments and between October and December moves into fresh water to spawn in clean rivers and streams. The sea lamprey spends most of its life at sea, only returning to freshwater to spawn around April and May.

(1) European Communities (1992) Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.

A potential effect of disposal at sea is for increased levels of suspended solids to disturb fish migration routes and areas they occupy. The concentration of suspended sediment at which the passage of salmonid fish is affected has been observed to be approximately 500 mg l^{-1}[(1)].

The disposal activities will take place within a very small area of the Firth of Tay where Atlantic salmon, river and sea lamprey may be present or may pass through. The species are highly mobile and will be able to move to abundant suitable habitat nearby if they are initially present within the footprint of the proposed disposal activities. The species will also be able to avoid the area during periods of raised suspended sediment during disposal and migrate using an alternative route through the Firth of Tay. For context, at the Middle Bank site the Firth of Tay is approximately 1,485 m wide and the disposal site is approximately 320 m in width, representing approximately 22% the width of the Firth of Tay at that point. As discussed in *Section B.2.2*, significant increases in turbidity associated with the disposal operations are likely to be short term and confined to the immediate area of the disposal site, which at Middle Bank represents a small part of the cross section of the Firth of Tay.

It is not anticipated that the disposal operation at Middle Bank will introduce significant amounts of contamination into the water column although the dispersive nature of disposal operation and resuspension of contaminated surface sediment may increase the partitioning of metals and organics into the aqueous phase.

Due to the scale of the proposed operations and the likely impacts on water quality and seabed habitat it is predicted that the proposals are not likely to have a significant effect on migratory fish species.

B2.6 Impacts on Marine Mammals

The Firth of Tay and Eden Estuary SAC is designated for its populations of harbour seal (*Phoca vitulina*) including the presence of a nationally important breeding colony of intertidal sandbanks and mudflats[(2)]. Harbour seals forage widely and may forage at the Middle Bank disposal site. Potential effects on harbour seals resulting from the disposal activities are disturbance and noise due to vessel movements and disposal activities and displacement of prey species as a result of increased levels of suspended sediment at the disposal site.

The proposals are not likely to have a significant effect on harbour seals for the following reasons.

- The small area of potential foraging affected by disposal activities at the Middle Bank disposal site.
- The short duration of the disposal activities.
- The small increase in total vessel movements associated with the disposal activities in relation to total vessel movements within the Firth of Tay.
- The long term existing disposal operations in the area which pre-date the site designation.

Bottlenose dolphins are a Habitats Directive Annex II species and are resident in the Moray Firth SAC. They are infrequent summer visitors to the Firth of Tay, mainly between May and September [(3)].

Potential effects on bottlenose dolphins resulting from the disposal activities include disturbance and noise due to vessel movements and displacement of prey species as a result of increased levels of suspended sediment at the disposal site.

(1) Redding M.J. and Schreck C.B. 1987, Physiological effects on coho salmon and steelhead of exposure to suspended solids, Transactions of the American Fisheries Society, Vol116 pp737-747
(2) JNCC. Site Details for Firth of Tay and Eden Estuary Special Protection Area. Available online http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030311 Accessed 21/05/2019
(3) Quick, N., Arso, M., Cheney, B., Islas, V., Janik, V., Thompson, P.M. and Hammond, P.S. 2014. The east coast of Scotland bottlenose dolphin population: Improving understanding of ecology outside the Moray Firth SAC.

The proposals are not likely to have a significant effect on bottlenose dolphins for the following reasons.

- The distance between the disposal site and the SAC is large and the proportion of the bottlenose dolphin population anticipated to pass through the area affected by disposal activities is anticipated to be low.
- The short duration of disposal activities.
- The small increase in total vessel movements associated with the disposal activities in relation to total vessel movements within the Firth of Tay.
- The long term existing disposal operations in the area which pre-date the site designation.

B2.6 Summary of Impacts

Table B1.14 presents a summary of the impacts and an assessment of significance of the impacts in relation to the sensitivity/importance of the disposal site.

Table B1.14 Summary of Significance of Impacts

Receptor	Impact Significance Justification	Impact Significance
Water quality at dredging and disposal site	Disposal will be periodic and sediment will descend to the seabed rapidly. Any impacts will be localised and short-term.	Not Significant
Sediment quality at disposal site	Increase in the levels of some contaminants will be localised and short-term and the deposited sediment will disperse within the open water system over time.	Not Significant
Benthic ecology at disposal site	Middle Bank is designated as a disposal site. Disposal will occur over a relatively short period and similar seabed habitat is available in close proximity to the site.	Not Significant
Seabirds	Proposed disposal operations are over a relatively short period and the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by. The SPA is located 1.2 nm south east of the Middle Bank disposal site and was designated after the Middle Bank site was designated.	Not Significant
Marine mammals and fish	Proposed disposal operations are over a short period of time and the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by. Due to the scale of the proposed operations and the likely impacts on water quality and seabed habitat it is predicted that the proposals are not likely to have a significant effect on migratory fish species and marine mammals. The volume of dredger vessel traffic will not be significant in relation to the existing traffic in the Firth of Tay.	Not Significant

B3 Cumulative Effects within the Firth of Tay

B3.1 Introduction

The potential impacts of the sea disposal option have been assessed within *Section B1.2* in isolation from other activities within the Firth of Tay. The impacts associated with the sea disposal option are

not predicted to result in adverse effects on the integrity of the SPA, SAC, Ramsar and SSSI sites however, it is possible that cumulative impacts with other projects could result in significant impacts.

A definition of cumulative impacts as 'impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions, together with the project' (1) has been adopted. For the purposes of this report, the assessment of potential cumulative impacts have been restricted to activities and proposed activities with the potential to directly impact the water and / or sediment quality within the SPA.

The limitations of assessing the cumulative impact of disposal activities with other operations, for example, coastal land reclamation or commercial fishing activities, is recognised given the lack of historical and current environmental data and a detailed understanding of sediment transport regimes within the Firth or Tay.

B3.2 Past and Current Activities within the Tay Estuary and Firth of Tay

B3.2.1 Introduction

Dundee at the mouth of the Firth of Tay and Perth at the head of the Tay Estuary (and the tidal limit) contribute to the contamination within the Tay Estuary and Firth of Tay. The current key issues influencing water quality in the firth and estuary are, however, recognised as pollution from agricultural run-off and treated effluent discharge from septic tanks. Treated sewage from Perth is discharged to the Tay estuary, upstream of Newburgh whilst sewage from Dundee is taken to a treatment works away from the Firth of Tay, and has been since 2002. Since the removal of this secondary sewage input to the Firth of Tay from Dundee, levels of ammonium and nitrogen have shown a significant decrease(2).

SEPA controls the discharge consents and monitors the water quality of the watercourses feeding into the Tay. Scottish Water provides and maintains public water, sewerage infrastructure and conducts monitoring of water quality.

B3.2.2 Commercial Fishing Activity

There are no commercial fisheries within the vicinity of the proposed dredging and disposal operations. Some low level, recreational fishing takes place for Norway lobster (*Nephrops norvegicus*) and Altantic salmon (*Salmo salar*). The Atlantic salmon uses the River Tay at two points in their life-cycle, seaward migration as smolts and on return as adults to breed. Passage is likely to be rapid and fish do not appear to feed at this time. There is a net salmon fishery at Usan, over 30 km north east of the Port of Dundee. Historically, there has been a small smelt (*Osmerus eperlanus*) fishery which supported low catches, normally caught using nets in the main channel immediately upstream of the Tay Rail Bridge.

B3.2.3 Offshore Wind Farms

There are no wind farms located within the Firth of Tay. Three large offshore wind farm developments are to be established in the waters near the mouth of the Tay.

Inch Cape Offshore Wind Farm

Consent was granted for the proposed Inch Cape Offshore Wind Farm in October 2014. Consent was delayed following an objection lodged by the Royal Society for the Protection of Birds and final approval was given in 2017. A revised scope of design was granted by Scottish Ministers in June 2019. This scope reduced the number of wind turbine generators from 110 to 72. The turbines will

(1) European Union. Guidelines for the Assessment of Indirect and Cumulative Impacts, as well as Impact Interactions, DG XI Brussels

Downloaded from http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf

(2) Haskoning UK Ltd, 2013. Port of Dundee Expansion and Marine Aggregate Extraction EIA Scoping Report and HRA Screening Report. Report for Scottish Enterprise.

occupy an area of 150 km^2. The windfarm will connect to the National Grid at Cockenzie. Once fully operational the wind farm will have an export capacity of approximately 1,000 megawatts. The Port of Dundee has been selected to be the site for pre-assembly and marshalling of the wind turbines.

Seagreen Offshore Wind Farm

Scottish and Southern Electric (SSE) and Fluor joint venture partnership Seagreen Wind Energy was awarded the exclusive development rights for the Firth of Forth Zone by Crown Estate Scotland. The zone covers an area of 2,852 km2 in the outer Firth of Forth. Seagreen was awarded consent by the Scottish Government in October 2014 to develop the northern part of the Firth of Forth Zone to generate up to 1,050 megawatts of power from up to 150 turbines. The design was updated and approved in 2018 to comprise fewer, larger wind turbines. Currently the plan is for 1075 MW from 114 turbines which are currently under construction and are expected to be operational by early 2023. Montrose port is the preferred location for the operations and maintenance base and the export cable will go to Dundee. A further phase of 36 turbines in proposed with the export cable going to Cockenzie.

Neart na Gaoithe Offshore Wind Farm

NnG Offshore Wind was granted consent by the Scottish Government in 2018 to build a 448 megawatt offshore wind farm in the outer Firth of Forth comprising up to 54 wind turbines up to 208 m high occupying an area of approximately 105 km^2. Construction commenced in 2020 with seabed preparations being undertaken prior to piling works. An onshore operations and maintenance base at Eyemouth received planning permission in September 2020. The wind farm is expected to be operational in 2023.

B3.2.4 Capital and Maintenance Dredging Activities

All disposal operations require license renewals every three years by Marine Scotland. Potential impacts are therefore assessed and reviewed every three years prior to granting a Marine Licence. The historical disposal route for spoil from previous dredging operations at the Port of Dundee has been deposition at sea, and to date, no environmental impacts, other than direct impacts within the disposal site, have been observed.

B3.3 Foreseeable Future Activities within the Firth of Tay

The National Renewables Infrastructure Plan (NRIP) has identified the Port of Dundee as a potential manufacturing location for Scotland's offshore wind, wave and tidal energy market. In addition, there is the potential for the Port of Dundee to attract work related to the decommissioning of offshore oil and gas platforms. To prepare for this potential work, and In line with Section 13 of Scotland's National Marine Plan (Marine Planning Policy Transport 4), Forth Ports undertook a capital dredging project in 2019 to increase the depth within two wharves in the Port of Dundee: Caledon East Wharf and Prince Charles Wharf with the later wharf extended with an upgraded quay wall. For that work approximately 75,000 m^3 of dredged material from the capital dredging was disposed of at sea at the licenced marine disposal site at Middle Bank.

B3.4 Conclusions

Potential cumulative impacts associated with the above activities can be broadly categorised as either comprising re-suspension of sediments resulting in loss or smothering of benthos, or the discharge of contaminants with the potential to impact both water and sediment quality.

Given that the point source discharge of contaminants into the Tay has decreased over the last decade, it is unlikely that the levels of current contamination will increase and more likely it will decrease as a result of net contaminant export from the system exceeding input.

There is no available evidence to suggest that the past and current disposal operations managed by Forth Ports have impacted the integrity of any of the SAC, SPA, Ramsar sites or SSSIs with the current levels of disposal and sediment contaminants. It is likely that the gradual improvement in sediment quality in the Firth of Tay will result in a reduction in water quality impacts from dredging and disposal of dredged material.

At the current levels of dredging/disposal and point source discharge related impacts, available data do not indicate any significant detrimental impacts to SAC,SPA, Ramsar sites or SSSIs integrity and any significant future developments are likely to be subject to their own EIA and Appropriate Assessment.

APPENDIX C CONSULTEE RESPONSES (EXTRACTS FROM LETTERS/EMAILS)

1 Dundee City Council 17/02/2023

I refer to your email below and attached letter (as passed to myself) and can confirm that we have no comments.

Regulatory Services Manager, Neighbourhood Services Department

2 NatureScot 15/03/2023

Thank you for consulting NatureScot regarding the options for the dredge spoil from Port of Dundee. The activity forms part of the baseline activity which occurs within the relevant European sites (Firth of Tay SAC and Outer Firth of Forth and St Andrews Bay Complex SPA) and disposal at Middle Bank Tay is long-established. We note that the proposed maximum annual dredge volume is stated as 150,000m^3 which is more than the current licence - MS-00008912 (100,000m^3). At this time we are not aware of any beneficial use of the spoil, therefore we would recommend the spoil disposal site is continued to be used.

Area Officer, Central Highland

3 Northern Lighthouse Board 15/02/2023

Northern Lighthouse Board has no objections to the proposed dredging and/ or disposal of dredged spoil to the charted and approved spoil ground at Middle Bank, and will respond formally to the Marine Licence application, however we would advise the following:

- **Forth Ports Ltd** issue marine safety information as considered appropriate prior to the commencement of each dredge campaign.
- **Forth Ports Ltd** advise the UK Hydrographic Office (sdr@ukho.gov.uk) of any revised water depths in order that chart updates are completed.

Navigation Manager

4 Crown Estate Scotland 16/02/2023

I can confirm that Crown Estate Scotland has no objections to the proposed maintenance dredging at Port of Dundee and the use of the Tay Middle Bank disposal site as long as this is approved by Marine Scotland. We are not currently aware of any viable alternative disposal options in the area.

Bidwells, on behalf of Crown Estate Scotland.

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