FORTH PORTS

Port of Leith: Marine Licence Application for Disposal of Capital Dredge Material

Best Practicable Environmental Option Report

8 April 2022

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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 the disposal of capital dredge material at sea. It compares various options for the disposal of dredge material and identifies the Best Practicable Environmental Option (BPEO).

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 BPEO 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. Marine Licences for capital works are valid for the duration of the activities, to be specified in the Marine Licence application and agreed with Marine Scotland.

1.2 The Need for Dredging and Spoil Disposal

The Port of Leith, located on the south bank of the Firth of Forth at the north of Edinburgh, provides berthing facilities, primarily for cargo vessels transporting cement, grain and bulk goods; oil industry and renewables service support vessels; and regular passenger vessels using the port during the summer. The port has approximately 350 to 450 vessel movements into and out of the port per annum (2017 to 2020 data) (1).

The entrance to the docks is accessed by a 0.7 nautical mile approach channel with a depth of 6.7 m below Chart Datum (CD). Suspended sediments from the action of waves and tides in the Firth of Forth settle in the slack water of a large eddy existing in the lee of the Eastern Breakwater (2). The main sediment accumulation occurs over approximately 200 m of the inward end of the approach channel. Annual maintenance dredging is required to maintain safe navigation in the channel.

Forth Ports has been undertaking annual maintenance dredging at the Port of Leith, including the approach channel, since 1968 with disposal to sea at the Narrow Deep spoil disposal ground.

Forth Ports now wishes to apply for a Marine Licence for the disposal of capital dredge material from the deepening of the outer berth area. In line with *Section 13* of *Scotland's National Marine Plan (Marine Planning Policy Transport 4*), the planned capital dredging operations will continue to maintain and support the sustainable development of the Port of Leith by increasing the depth of the outer berth at Leith and allowing an improved berth to be constructed. It is proposed that the dredged material resulting from the capital dredging will be disposed of at sea at the licenced marine spoil disposal ground at Narrow Deep B. *Figure 1.1* shows the planned dredging areas and the proposed spoil disposal ground at Narrow Deep B.

The need for the proposed outer berth development project and the construction and dredging activities associated with it are described in detail in the Environmental Impact Assessment (3), with relevant information summarised in this report to provide context. Should Forth Ports consider the "Do Nothing" approach, and not undertake the capital dredging operations, the Port of Leith would not be able to accommodate wider vessels that cannot use the lock system to enter the main part of the Port of Leith. Without the ability to accommodate wider vessels, Forth Ports would not be able to service existing and new customers as effectively as they require, for example, to ship in parts for offshore wind farm construction operations.

(1) Forth Ports pers comm February 2021 (pre-Covid-19 data)
(2) HR Wallingford, Forth Ports Siltation and Dredging Study, 1998
(3) Royal Haskoning DNV 2022a Port of Leith Outer Berth Environmental Impact Assessment Report Report number PC2045-RHD-ZZ-XX-RP-EV-0007 Prepared for Forth Ports Ltd

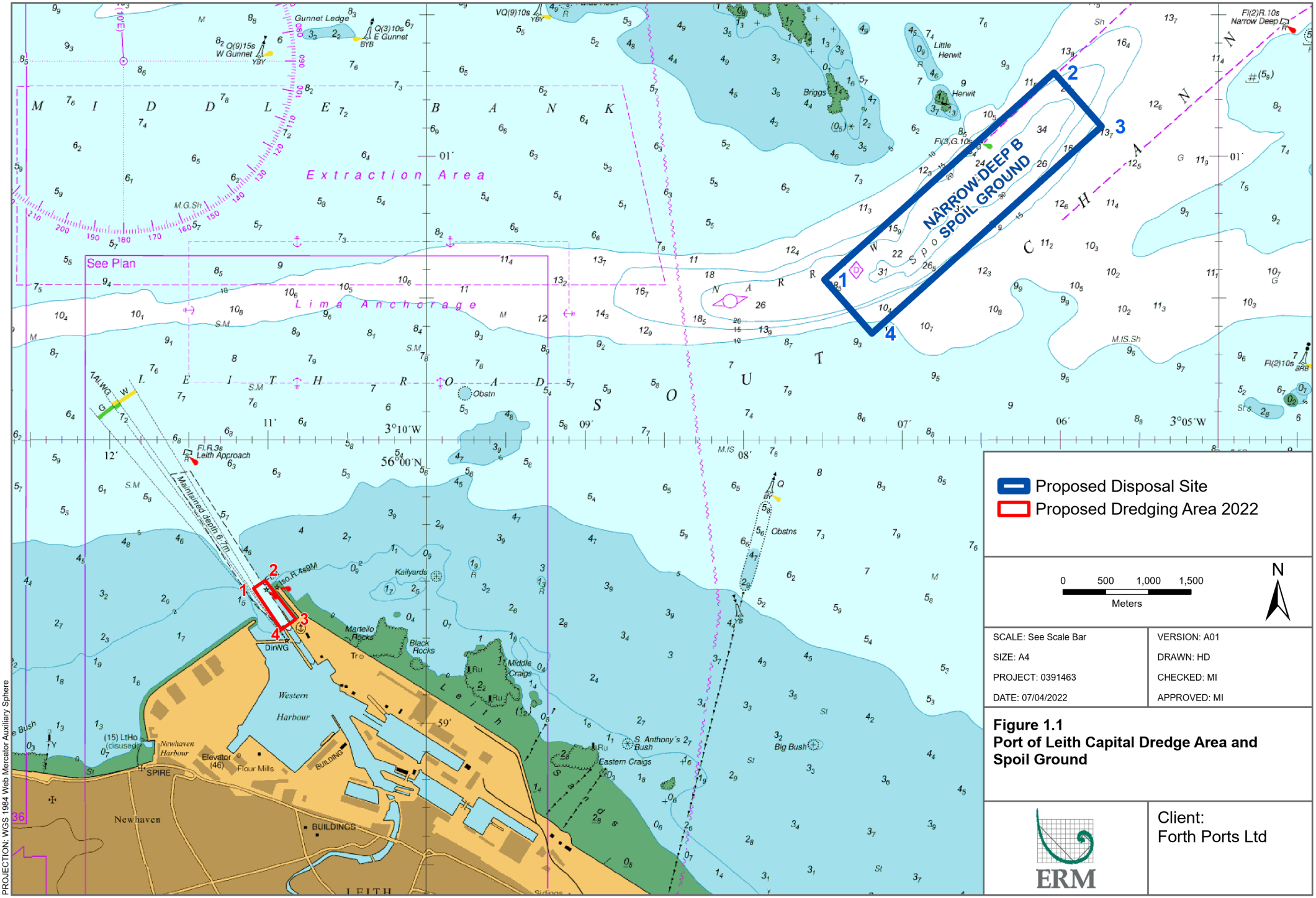


Figure 1.1
Port of Leith Capital Dredge Area and Spoil Ground

Path: Q:\Edinburgh\Projects\0391463 Forth Ports 2017 BPEO.MI\Ph9 Leith 2022\GIS\MAPS\0391463 - 20211216 Update.aprx\Figure 1.1 Port of Leith Capital Dredge Area and Spoil Ground

1.3 Proposed Dredging and Disposal Operations

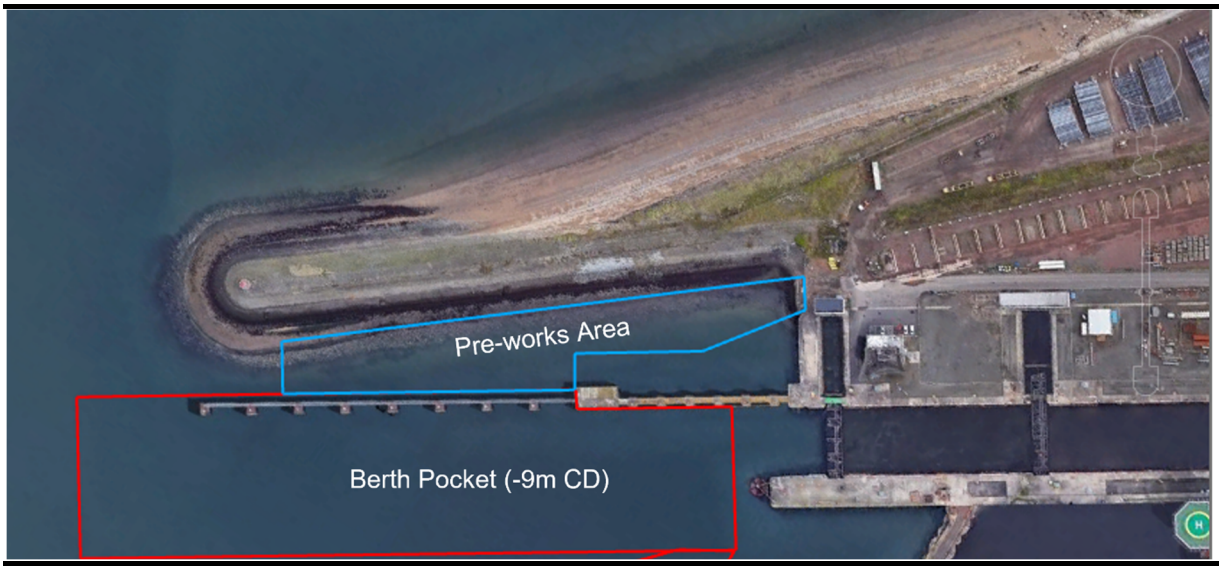
Forth Ports wishes to apply for a licence from Marine Scotland for the dredging and disposal of approximately 101,000 m^3 of dredged material as part of a capital dredge at the outer berth. The boundary co-ordinates of the proposed dredge area are presented in *Table1.1* and shown in *Figure 1.1*. The area to be dredged comprises two sub-areas: a pre-works area where material will require to be removed to allow construction of a new quay platform; and the berth pocket area to be dredged to 9 m below CD to allow access for the vessels to berth that are too wide to use the existing lock system into the main part of the port of Leith. The berth pocket is in part of the approach channel that is currently subject to maintenance dredging to approximately 7 m below CD. *Figure 1.2* shows the two dredge areas.

Table 1.1 Co-ordinates of Planned Dredge Area at Leith Outer Berth

Node	Co-ordinates (WGS84)	
	Latitude	Longitude
1	55° 59.4745‘ N	003° 11.0891’ W
2	55° 59.5022’ N	003° 11.0158’ W
3	55° 59.3656’ N	003° 10.8232’ W
4	55° 59.3291’ N	003° 10.9140’ W

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

Figure 1.2 Dredging Areas Within Overall Project Area



Source: Royal Haskoning DNV (2022a)

The proposed dredging operations are expected to be undertaken using a barge mounted backhoe dredger with the dredged material being transferred to a 335 m^3 split hopper barge. The barge would be towed to the disposal site by a tug.

The proposed dredging schedule will be dependent on the licence award date, dredger availability and construction periods. Two dredging campaigns are planned, each lasting for about two months. The pre-works area would be dredged at the start of the 15-month construction programme and the berthing pocket would be dredged towards the end of the programme, therefore the two dredging campaigns would be undertaken approximately one year apart.

The dredged material will comprise a mix of sediments (sands and silts) in the top layers of the dredge area with firmer glacial till and mudstones at lower depths. Forth Ports will seek to re-use any suitable rocky/stone pitching material above CD from the pre-works area. Some of this type of material will be mixed with sediments below CD and will be dredged out with the sediments for disposal. An estimation of the quantities of each component of the dredge material is presented in

Table 1.2. It is expected that most of the dredging operations will result in the removal of mixed loads of different types of material.

Table 1.2 Volumes of Dredged Material from each Area

Dredge Area	Pre-works Volume (m^2)	Berth Pocket Volume (m^2)	Total	%
Soft material (clay/silt/sand)	8,755	7,358	16,113	16
Glacial Till	28,825	27,506	56,331	55.8
Mudstone	1,250	19,136	20,386	20.2
Rocky material	8,150	0	8,150	8
Total	**46,980**	**54,000**	**100,980**	**100**

The Narrow Deep B (FO038) spoil disposal ground is situated approximately 2.5 nautical miles east of the Port of Leith and has historically been used by Forth Ports for spoil disposal from the Port of Leith for over 50 years. The water depth within the spoil disposal ground ranges from 10 m below CD at the south-west corner and increases to 31 m below CD through the centre of the site and 34 m below CD at the north-east of the site. The boundary co-ordinates of the spoil disposal ground are presented in *Table 1.3.*

Table 1.3 Coordinates of Narrow Deep B Spoil Disposal Ground

Node	Coordinates (WGS84)	
1	56°01.298’ N	003°06.038’ W
2	56°01.106’ N	003°05.739’ W
3	56°00.374’ N	003°07.184’ W
4	56°00.566’ N	003°07.484’ W

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

The Narrow Deep B spoil disposal ground is the deepest in the Firth of Forth and has mainly been used for dredged sediments from the Port of Leith. The volume of dredged material deposited at the Narrow Deep B spoil disposal ground from the ongoing maintenance dredging activities at the Port of Leith and approach channel from 2001 to 2021 ranged from 3,173 m^3 to 65,719 m^3 per annum. Annual spoil disposal volumes are presented in *Table 1.4*. Due to low levels of siltation during some years (2005, 2012, 2013 and 2017) no dredging was necessary and higher volumes are deposited when both the approach channel and the docks are dredged (*e.g.*, in 2016 and 2020).

Table 1.4 Narrow Deep B Spoil Disposal from Port of Leith (2001-2020)

Year	Quantity (m^3)	Spoil Disposal Ground
2001	65,719	Narrow Deep
2002	23,820	Narrow Deep
2003	21,689	Narrow Deep
2004	10,162	Narrow Deep
2005	NIL	-
2006	14,096	Narrow Deep
2007	3,173	Narrow Deep
2008	28,412	Narrow Deep
2009	28,241	Narrow Deep
2010	23,574	Narrow Deep
2011	21,597	Narrow Deep
2012	NIL	-
2013	NIL	-
2014	25,930	Narrow Deep
2015	18,966	Narrow Deep
2016	47,957	Narrow Deep
2017	NIL	-
2018	22,426	Narrow Deep
2019	6,780	Narrow Deep
2020	41,802	Narrow Deep
2021	11,443	Narrow Deep

Source: Forth Ports February 2022

Table 1.5 presents the total area of the Narrow Deep B spoil disposal ground and the area and volumes below the 20 m and 30 m contours, based on recent (August to November 2021) multibeam surveys undertaken by Forth Ports. The survey was undertaken after the disposal of material from the 2021 capital dredge works at the Fife Energy Park which required material to be disposed of below the 20 m depth contour [(1)].

Table 1.5 Narrow Deep B Spoil Disposal Ground Areas and Volumes

Narrow Deep B	Total Area (m^2)	Volume (m^3)
Whole area	958,331	-
Below 20 m CD depth contour	822,656	6,242,172
Below 30 m CD depth contour	252,305	467,790

Source: Forth Ports February 2022

For the proposed disposal operations, 101,000 m^3 of material spread across the areas below 20 m CD at Narrow Deep B would result in an average deposition depth of 0.122 m which is approximately 0.6% of 20 m. As approximately 25% the Narrow Deep site is below 30 m CD, the average percentage reduction in depth at 20 m would be less than this figure. The majority (c. 84%) of the material to be deposited is considered to be non-erodible or only very slowly erodible (e.g., glacial till).

(1) The Marine Licence was for the disposal of 225,000 wet tonnes of dredge spoil at Methil (FO048) and Narrow Deep (FO038) disposal grounds. Rock material over 300 m was to go to the Narrow Deep site below the 20 m CD contour. It is not known what quantities were disposed of at each site.

1.4 Description of Sediment to be Dredged and Disposed

In line with Marine Scotland guidelines on pre-dredge sampling protocol [(1)], a survey programme was undertaken between 16 and 18 October 2021. Samples were taken at eight stations using a 1.1 tonne, 5 m barrel length, vibrocorer (VC) achieving a maximum coring depth of 2.9 m.

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

- Sediment water content.
- Total Organic Carbon (TOC).
- Sediment particle distribution (PSD).
- Metals: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn).
- Tributyl Tin (TBT).
- Polycyclic Aromatic Hydrocarbons (PAHs): US EPA 16.
- Poly Chlorinated Biphenyls (PCB): ICES 7.

The physico-chemical analysis is presented in *Appendix A.*

The soft sediment samples from the cores from the outer berth area comprised sandy mud, muddy sand and gravelly sand mud. There are concentrations of metals, PAHs and PCBs above Marine Scotland Action Level 1 and in two vibrocore sub-samples there were concentrations of Cd, Hg and PCBs above Marine Scotland Action Level 2 [(2)] in the sediment samples analysed. Details of the chemical analysis of the sediments are provided in *Appendix A.*

Samples from the Narrow Deep spoil disposal ground and other spoil disposal grounds in the Forth Estuary and Firth of Forth have been analysed by Marine Scotland. A summary of the historical sample analysis is provided in presented in *Appendix A.*

1.5 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 *Waste (Scotland) Regulations 2012*. The options on the short-list are then reviewed against strategic, 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 Physical and Chemical Analysis Results.
- *Appendix B:* Consultee Responses.

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

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;
  - health, safety and environment considerations *i.e.,* what the impacts would be; and
  - cost, in terms of capital and operating costs.
- Comparison of the relative merits and performance of the options and identification of the BPEO.

Information was obtained through literature review and consultation with Forth Ports and its service suppliers. In addition, the following consultees were asked for any relevant information that they hold or any comment on the options for disposal of the dredged material, including the use of the Narrow Deep B spoil disposal ground (extracts from responses received are provided in *Appendix B*).

- City of Edinburgh Council.
- Crown Estate Scotland.
- Forth District Salmon Fisheries Board (FDSFD).
- Marine Scotland.
- Maritime and Coastguard Agency (MCA).
- NatureScot (NS).
- Northern Lighthouse Board (NLB).
- Scottish Environment Protection Agency (SEPA).

2.2 Identification of Options

The following five general treatment/disposal options for dredged material were identified:

- coastal reclamation and construction fill;
- sacrificial landfill;
- beach nourishment;
- incineration;
- sea disposal.

2.3 Preliminary Appraisal

A preliminary appraisal of each of the options identified above was undertaken, including an assessment of the practicability of each option. Following the preliminary appraisal those options that are considered to be practicable were short-listed for further consideration.

2.4 Assessment of Options

The relative performance of the short-listed options was then assessed against the following criteria.

2.4.1 Strategic Considerations

Strategic considerations included the following.

- Operational feasibility - whether the option is technically practicable.
- Availability of sites/facilities - are there any sites or facilities that 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.
- Likely 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 - assessing compliance with relevant legislation and the potential management control required.

2.4.2 Health, Safety and Environmental Considerations

The factors used to assess the health, safety and environmental performance of the options are summarised below.

- Public health. Assessing 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. Evaluating whether there is potential for contamination or pollution 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 users. Considering whether there are likely to be impacts on other activities, such as other users of the Firth of Forth, local ports or roads.
- Amenity/aesthetic. Assessing whether there is likely to be a visual, olfactory or noise impact resulting from the disposal or any impact on local amenity.

2.4.3 Cost Considerations

Cost of disposing of dredged material was considered in terms of the following.

- Capital costs (construction of facilities).
- Operational costs (transport and disposal costs).

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			
Operational Feasibility	Practical, easy to operate and achievable as process is robust and established. 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 port by road and 10 km by sea.	Suitable site/facility available within 10 km of the port by road and 20 km by sea.	No suitable sites/facilities within the vicinity of the port (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 clearly established with no foreseeable significant problems.	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 developments.	Unlikely to provoke a strong negative or positive reaction based on reaction to similar developments.	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.	Statutory bodies may have major concerns that may not be overcome through consultation.
Legislative Implications	Would easily comply with legislation with a low level of management and physical control.	Requires some control/intervention to achieve compliance.	Requires a high level of management control and intervention to achieve compliance.
Health, Safety and Environmental Considerations			
Safety	No significant risk to workers and the general public.	Low risk to workers and the general public which is easily controlled.	Moderate to high risk to workers and general public.
Public Health	Will not cause workers or public to be exposed to substances potentially hazardous to health.	May cause some low level intermittent exposure to substances potentially hazardous to health.	Risk of exposing workers and general public to substances potentially hazardous to health.
Pollution/Contamination	Compliant with emission standards and water 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.

Consideration	High	Medium	Low
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	£1m or less.	Between £1m and £2.5m.	More than £2.5m.

(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 several steps that are common to 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.

It is noted that the nature of the material to be dredged means that most dredged loads will result in mixtures of soft sediment (silts and sands), firm sediments (glacial till and mudstone), and in the case of the pre-works area, a proportion of rocky material. This limits the options as it is not practical to separate out the different sediment fractions.

The five [(1)] identified disposal options are:

- coastal reclamation;
- sacrificial landfill;
- beach nourishment;
- incineration;
- disposal at sea.

3.2 Common Steps to Land-Based Disposal Options

The disposal options that have land-based components include:

- coastal reclamation and construction fill (for material to be transported by road);
- sacrificial landfill;
- beach nourishment (for sediments to be transported by road);
- incineration (for sediments)

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

- landing the dredge material;
- storage of dredge material;
- dewatering the dredge material; and
- loading and transport for disposal.

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

3.2.1 Landing the Dredged Material

All of the land-based options require transport to on-shore facilities. This could be via a conveyor or grab, depending on the nature of the material being dredged. As Forth Ports does not have suitable facilities at Leith, or elsewhere within the Firth of Forth area, for landing dredged material, a new coastal landing facility would be required to enable the material to be landed.

3.2.2 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 site, capable of retaining the dredged material and associated run-off and dust.

(1) Spreading on agricultural land and re-use for top-soil and brickmaking were not considered in this case given the nature of the capital dredge material

3.2.3 Dewatering the Dredged Material

The land disposal options for sediments require dewatering of the dredged material either to make transport more feasible or to create a material which is suitable for disposal to land. Given the mixed sediments to be dredged, dewatering of the fine sediment fractions would require the construction of settling lagoons, i.e., large, ring-dammed structures into which the dredged material would be offloaded. These could be built within the intertidal area or on land. The dredged material would be piled up in the lagoon and the water drained out under gravity. The lagoons would have a drainage system to collect the water and watery sludge from the dredged material for further treatment or to be transported offsite for disposal. The lagoons must be of sufficient size to contain the dredged material prior to transport. They must also be accessible by road and must have facilities to load the dredged material into sealed heavy goods vehicles (HGVs) for movement to the disposal/treatment centre. To minimise the distance that wet dredge material has to be transported from the dredger they must be located near the quayside. The use of dewatering technologies such as hydrocyclones and filter presses are not considered practical for the type of material to be dredged.

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 settling lagoons close to the port is considered to be very low.

As some samples of the material analysed contain metals, PCBs and PAHs above Marine Scotland Action Levels (see Appendix A) it might be additionally necessary to construct the lagoons with special liners to retain the contaminants and consider treatment of the supernatant water draining out of the lagoons.

3.2.4 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 disposal/treatment sites. The required infrastructure would include hard standing to allow a fleet of HGVs to be loaded by mechanical excavators. Although some hard standing exists at the Port of Leith, there are no available storage or dewatering sites at Leith.

Assuming the dredged sediment materials can be dried to a water content of 10% (by volume) at or adjacent to the Port of Leith, the estimated 100,000 m^3 (1) of dried materials would require transport to a reclamation project or for disposal to landfill. The length of journey required would depend on the location of the re-use or spoil disposal grounds.

A volume of 100,00 m^3 of material equates to approximately 210,000 tonnes (2). Assuming 20 tonne capacity HGVs are used, this would equate to 10,500 return trips or 21,000 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 Leith exits onto the trunk road network where the HGV count is recorded as 87,235 per year or an average of 7,270 per month (2019 data (3)). The additional HGV movements as a result of the transport of dredged material would increase the average HGV volume by approximately 24%, if spread over a whole year, or a 72% increase in monthly HGV movements if the transport was undertaken over approximately two months, during each of the two dredging phases. There may also be an issue with regard to increase in HGV traffic flows if minor roads are used to reach disposal/treatment sites.

(1) 100,980 m^3 total spoil at 85% solids content for the 16% that are fine sediments equals approximately 100,000 m^3 of dried material. It is assumed that the glacial till and mudstone would not dry out.
(2) Based on an average weight of 2.1 tonnes per m^3 of dredge spoil.
(3) 2020 data has reduced counts due to influence of Covid-19 restrictions

3.2.5 Disposal/Treatment Issues

Drying the dredge material would not reduce the concentration of metals, PCBs, PAHs and salt present within the dredged material. This will restrict disposal and reuse options and as the material has elevated levels of some contaminants, pre-treatment may be required 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 outer berth area 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 underlying glacial till and mudstone is unlikely to be contaminated but testing would be required to verify this. The fine sediment fraction (16% of the total volume of material to be dredged) has some contamination from metals, PCBs and PAH.

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.

3.3 Coastal Reclamation and Construction Fill

3.3.1 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, transport and possibly desalination. Coastal use involving pumping or spraying the material directly from the dredger or barge to the site where it was needed is not practical given the nature of the material to be dredged.

3.3.2 Suitable Sites for Reclamation

Forth Ports, Marine Scotland and Edinburgh City Council are the most likely bodies to be responsible for or aware of reclamation projects in the Forth. Whilst the material may be able to be reused for reclamation, no sites for coastal reclamation have been identified through the consultation process as requiring this type of dredged material (mixture of sediment, glacial till, mudstone and rock).

The dredged material could be transferred into bunded lagoons at the edge of the Firth of Forth to create land that could be used for development or similar purposes. The majority of the intertidal area falls within the Firth of Forth Site of Special Scientific Interest (SSSI) and Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA). The SPA is a large estuarine/marine site consisting of the two adjacent Firths of Forth and Tay. NS has previously expressed the view on similar BPEO assessments that further loss of intertidal habitats is not considered a realistic option.

3.3.3 Construction Material

Use of the dredged material as fill in inland construction projects would require 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 metals, PCBs and PAHs in the dredged sediments and its high salt content make this option unattractive.

3.4 Sacrificial Landfill

3.4.1 Process Description

The type of landfill site which can take the spoil is dependent upon the classification of the waste. As discussed in *Section 3.2.5* above it is understood that the waste would likely be classified as

hazardous or non-hazardous rather than inert and therefore a suitably licensed landfill site with sufficient capacity is required.

3.4.2 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 Leith with the facilities to accept the material. This is Avondale Landfill at Polmont, approximately 35 km west of Leith. Previous consultation with the operators confirmed that the site cannot accommodate the dredged material due to the composition, and volume not fitting with their site operations. The Avondale site could consider taking some dredged sediment material if the availability coincided with the closure of one or all of the phases within the plant.

3.4.3 Taxes

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.

3.5 Beach Nourishment

3.5.1 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.

3.5.2 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 material to be dredged from the Leith outer berth is not suitable for beach recharge due to the mixed material and particle size distribution and the presence of contaminants such as metals, PCBs and PAHs. No sites requiring beach nourishment with the grade of sediment material from the Leith outer berth have been identified. Given the conservation status of the Firth of Forth, the lack of available beaches for nourishment, the contamination of the spoil and its particle size composition, beach nourishment is not considered to be a practicable option.

3.6 Incineration

3.6.1 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 ash would then require disposal. Options for disposal of ash include landfill, reclamation and spreading on agricultural land.

The nature of the material to be dredged (glacial till, mudstone, sand/silts and rocks) is not suitable for incineration. The average organic content of the fine sediment samples analysed was 3.41% (range of 0.63 to 9.3%) and the overall organic content including the glacial till and mudstone will be even lower therefore there is only a small combustible component within the material. 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 [(1)].

A further consideration is that the material to be dredged contains some metals, PCBs and PAHs above Action Level 1 and Action Level 2. Following incineration, the leaching potential of metals would be reduced, however, the ash would still be contaminated. Pre-treatment is likely to be required for the removal of metals. Emissions to atmosphere from the incineration processes would

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

also require to be controlled by the Environmental Agency/ SEPA under the *Environmental Protection Act 1990.*

3.6.2 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 388 km south) and transport would be costly and is unlikely to be practicable.

3.7 Disposal to Sea

3.7.1 Process Description

Disposal at sea involves the dredge material being transported to a licensed marine spoil disposal ground in a dredging vessel. Disposal to sea is the normal practice for disposal of dredged spoil from Leith and from other ports and harbours in the Forth Estuary and Firth of Forth. This approach takes place at sea and does not require the landing of any materials. It involves the dredger sailing to a licenced spoil disposal ground and releasing the materials through bottom doors or a split hull (the proposed process will use a 335 m^3 split hopper barge). To ensure that the material is deposited evenly across the disposal site and at the correct depths (below 20 m CD) a grid patten will be applied across the disposal site and each barge load deposited will be tracked using a global positioning system (GPS) to record the spoil discharge locations.

3.7.2 Available Sites

There are seven licenced marine spoil disposal grounds in the Forth Estuary and Firth of Forth: Bo'ness, Oxcars, Blae Rock, Kirkcaldy, Methil and two sites designated at Narrow Deep (A and B). For the dredging operations at Leith, Forth Ports would propose to use the Narrow Deep B spoil disposal ground located approximately 2.5 nm east of the Port of Leith within the Firth of Forth. This site is the deepest of the current licenced sites, has historically been used for the disposal of dredged material from Leith and for rocky material from other capital dredge sites, and is the closest site to the port, thus minimising the distance for vessel transport.

3.8 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
Coastal Reclamation and Construction Fill	This option may be practical although there are a large number of steps involved in storage, dewatering and transport of the dredged material. The potential concentration of contaminants limits the available options for reuse of the dredged material.	Short-list
Sacrificial Landfill	This option may be practicable although there are a large number of steps involved in storage, dewatering and transport of the dredged material. Landfill site operators may be unwilling to accept the material due to the composition of the material and large volumes.	Short-list
Beach Nourishment	This option does not appear to be practicable. There are no beaches within the Forth Estuary or the Firth of Forth, identified by Forth Ports, consultees or in the NCCA (2017) (1) report that require nourishment with this type of sediment material.	Discard
Incineration	This option does not appear to be practicable. The material is not suited to incineration due to low organic content (< 5%) of the sediments 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
Disposal at Sea	This option is practicable and has been the BPEO for previous dredging campaigns at the Port of Leith.	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 the Project EIA [(1)].

4.2 Coastal Reclamation and Construction Fill

4.2.1 Strategic Considerations

Operational Feasibility

The reuse of the dredged material for reclamation requires either transferring material directly from the dredger/barge to a coastal reclamation site or landing and drying the material and desalination prior to transporting the material by HGV for disposal on land. At a coastal reclamation site, the dredged material would also need to be landed, dewatered and spread across the site. This option may be practical if disposal sites were available adjacent to or close to the Firth of Forth. Road transport would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 210,000 tonnes of material would require transport. This option has practical difficulties relating to drying the dredged material and transport of large volumes of material by road to a reclamation or construction site.

Classification: Low to Medium

Availability of Sites

No coastal sites within the Firth of Forth 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) [(2)].

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 dredge material delivery with proposed dredging programme.

Classification: Low

Established Practice

The use of suitable dredged materials, such as marine aggregates, in coastal reclamation and construction fill is common practice and the technologies and techniques to move such material are well established. However, the use of a mixed dredge spoil for such activities is not common.

Classification: Low to Medium

General Public Acceptability

Use of the dredged material for reclamation or construction fill is likely to be acceptable to the general. There may be some concerns regarding the contamination levels in the dredge spoil and the volume of material to be transported by HGVs for reasons relating to air quality and proximity to residential areas. Transport by sea is likely to be viewed as more favourable than transport by land.

Classification: Medium

(1) Royal Haskoning DNV 2022a. Port of Leith Outer Berth Environmental Impact Assessment Report. Report number: PC2045-RHD-ZZ-XX-RP-EV-0007. Prepared for Forth Ports Ltd.
(2) 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

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 contamination levels in the dredge spoil and the volume of material to be transported by HGVs for reasons relating to air quality and proximity to residential areas.

Classification: Medium to High

Legislative Implications

The disposal of dredged material from the Leith outer berth 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 the material has been removed from the port for disposal on land it will 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 may be due to the Crown Estate Scotland.

Classification: Medium

4.2.2 Health, Safety and Environmental Considerations

Public Health

Slight risks to public health are anticipated due to intermittent increase in HGV traffic.

Classification: Medium to High

Safety

Transferring the dredged material ashore has risks associated with operational activities, however, these activities can be managed to reduce risks. 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 HGVs travel through populated areas and along minor roads.

Classification: Medium to High

Pollution / Contamination

The 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 from 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, or if the area to be reclaimed was used for recreation. 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 no 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

Landing at a coastal reclamation site is not viable as not sites requiring this type of material have been identified. If the dredged material was landed, treated and then transported by road, the estimated costs below would apply:

- Constructing discharge berth and dredge spoil offloading operations: £3.5 m;
- lagoons/containment to dewater and stabilise the dredged material: £2.5 m;
- loading and transport (HGVs) – assuming the disposal site is within one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £200/load(1): £2.1 m.

Total £8.1 m

Classification: Low

Note that the dredging costs are not included as these would apply to all the options being evaluated.

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 210,000 tonnes of material would require transport.

This option has practical difficulties relating to drying the dredged material and transport of large volumes of material to a landfill site.

Classification: Low to Medium

Availability of Sites / Facilities

The nearest suitable site is located at Avondale Landfill, Polmont, approximately 23 km from Leith. Avondale has advised that it may be able to receive some of the dredged sediment material, however they would require a more in-depth chemical analysis before confirming acceptance of material and costs. In addition, the timing of receipt of material would need to fit in with its operational requirements when closing exiting landfill cells (2).

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

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

Established Practice

(1) Estimated cost based on consultation with HGV operator at £50/hour and estimated cost of loading at £50/hour.
(2) Avondale pers comm, February 2016.

Dredged material is sometimes disposed of to landfill for small one-off sediment dredging operations, however it is not established practice to routinely dispose of large quantities of mixed 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 Leith to potential landfill sites may be unacceptable to residents and other road users.

Classification: Medium

Likely Agency Acceptability

The National Waste Strategy establishes the direction of the Scottish Executive's policies for sustainable waste management to 2020. One such policy is to reduce landfilling of municipal waste from 90% to 30% 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

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* would 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 Considerations

Public Health

Slight risks to public health are anticipated due to the intermittent increase in HGV traffic.

Classification: Medium to High

Safety

There may be an increase in safety risks associated with the movement of materials for disposal, particularly if 15,500 HGVs movements pass through populated areas and along minor roads.

Classification: Medium to High

Pollution/Contamination

There may be a small risk of leaching of contaminants that 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 top soil.

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 A901 in the vicinity of the Port of Leith indicates that in 2019 HGVs made up an average of 1.57% of all traffic [(1)] with 87,235 HGV movements per year or an average of 7,270 per month. As a result of the proposed disposal to landfill, the additional HGV movements would increase the average HGV volume by approximately 24%, if spread over a whole year, or 72% increase in HGV movements if the transport was undertaken over approximately two months, during each of the two dredging phases. There may also be an issue with increases in HGV traffic flows if minor roads are used to reach disposal/treatment sites.

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

If the dredged material was landed, treated and then transported by road, the estimated costs below would apply:

- Constructing discharge berth and dredge spoil offloading operations: £3.5 m;
- lagoons/containment to dewater and stabilise the dredged material - £2.5 m;
- loading and transport (HGVs) – assuming the disposal site is within one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £200/load[(2)]: £2.1 m.
- Landfill gate fee at £45 per tonne: £9.45 m

Total £17.55 m

Classification: Low

Note that the dredging costs are not included as these would apply to all the options being evaluated.

4.4 Sea Disposal

4.4.1 Strategic Considerations

Operational Feasibility

Operationally disposal at the Narrow Deep B 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 Leith outer berth, it has been proven as practicable and all the necessary logistics procedures are understood.

Classification: High

Availability of Sites / Facilities

The sites/facilities which are required for the sea disposal option are those which are already used. No other spoil disposal grounds have been indicated by Forth Ports as available at this time or more suitable for the dredged material from the Port of Leith.

Classification: High

Security of Option

(1) Average annual daily counts obtained from https://roadtraffic.dft.gov.uk/local-authorities/29. Accessed 14 January 2022.
(2) Estimated cost based on consultation with HGV operator at £50/hour for transport and an estimated cost of loading at £50/hour. A four hour round trip for each load would be approximately £200.

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 the Narrow Deep B spoil disposal ground is the current practice for the disposal of the maintenance dredged spoil from the Port of Leith. It is, therefore, established and proven as effective.

Classification: High

General Public Acceptability

Forth Ports has confirmed that similar disposal operations from other ports and harbours in the Firth of Forth and Forth Estuary have not attracted any appreciable comment. Dredging operations are unlikely to affect members of the general public, with the possible exception of some recreational users in the Firth of Forth when the vessel is transiting to and from the spoil disposal ground.

Classification: High

Likely Agency Acceptability

Consultations with the regulatory bodies for previous Marine Licences indicate that there is no objection to sea disposal at Narrow Deep. A disposal plan to contain the deposited material within the 20 m depth contour is likely to be required. The Forth District Salmon Fishery Board (FDSFB) has previously highlighted concerns surrounding time of year of disposal coinciding with seaward migration of salmon smolts and requested that disposal is avoided during June and July. Due to the small magnitude of potential effects of disposal operations to migrating salmonids, Forth Ports does not consider that this request is justified. Impacts from the disposal operations are discussed in detail in the Project EIA [(1)].

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 The Crown Estate for disposal of spoil to The Crown Estate owned sea bed.

Classification: Medium to High

4.4.2 Health, Safety and Environmental Considerations

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

Safety

The operations are undertaken at sea, therefore members of the public are not likely to be exposed to risk from the disposal activities. Forth Ports, as the Harbour Authority and client will have oversight of the dredging contractor's operations.

Classification: High

Pollution/Contamination

(1) Royal Haskoning DNV 2022a Port of Leith Outer Berth Environmental Impact Assessment Report Report number PC2045-RHD-ZZ-XX-RP-EV-0007 Prepared for Forth Ports Ltd

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, although based on current evidence this would be localised and short-term. The identification and assessment of environmental impacts of dredged material are presented in the Project EIA (1).

Classification: Medium

Ecological Impacts

The disposal operations may affect the benthic fauna in proximity to the spoil disposal ground due to sediment drifting from the disposal area itself. It is anticipated that there will not be any significant impact on the Forth marine ecosystem as a whole given the scale and duration of effects of continued disposal at this site which has been ongoing for over 50 years. There may be some localised and short-term effects such as displacement on migrating fish due to increased suspended sediments caused by the discharge of dredged material into the water column considering the spatial and temporal scales of the effects of dredge spoil disposal these impacts are not predicted to prevent migration, cause mortalities or affect the viability of fish populations. Under the proposed disposal proposals, cumulative impacts with other operations are not predicted to create a significant impact to the Firth of Forth SSSI, SPAs or SACs farther afield or marine ecosystems.

The ecological impacts of disposal of dredged material to sea is addressed in the Project EIA.

Classification: Medium to High.

Interference with Other Legitimate Activities

The transport and disposal activities may cause some disruption to other users of the Firth of Forth, however as the operations will only be occurring for a limited period of time and are controlled directly by Forth Ports it is not anticipated that there will be any significant interference. In addition, historic operations at Narrow Deep B have not resulted in any reported disruption to other Firth of Forth users.

Classification: High

Amenity/Aesthetic

The disposal activities may cause some short-term disruption to other users of the Firth of Forth but the proposals will contribute to the normal functioning of the Port of Leith.

Classification: Medium to High

4.4.3 Cost Considerations

There would be no capital required to construct new facilities. Costs for disposal at Narrow Deep B are approximately £760,000 (2).

Classification: High

Note that the dredging costs are not included as these would apply to all the options being evaluated.

(1) Royal Haskoning DNV 2022a Port of Leith Outer Berth Environmental Impact Assessment Report Report number PC2045-RHD-ZZ-XX-RP-EV-0007 Prepared for Forth Ports Ltd
(2) Approximately one third of the total dredging contractor costs estimated to cover the dredge spoil disposal operations

5. SUMMARY OF THE BPEO

5.1 Comparison of Options

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

Five options were initially considered for the disposal of the dredged spoil from the Leith outer berth. These were reduced to a short-list of three options, based on operational and technical feasibility. A summary of the key considerations with regard to each of the short-listed options is provided below and illustrated in *Table 5.1.*

5.1.1 Coastal Reclamation and Construction Fill

Operationally, coastal reclamation and construction fill would be possible. As the material to be dredged is a mix of fine sediments, glacial till, mudstone and rock it would be difficult to handle and to dewater before use on land. In addition, the presence of some metals, PCBs and PAHs restricts its suitability for application on land. Currently there are no significant areas of coastal reclamation planned in the Firth of Forth or other sites identified that could take this type of material. 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.

5.1.2 Sacrificial Landfill

Operationally, disposal to landfill would be possible. 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 dredged 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 would 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. 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.

5.1.3 Sea Disposal

Operationally few problems are anticipated with disposal at Narrow Deep B and this site has been historically used for disposal of dredged materials from the Port of Leith.

A recent (2021) multi-beam bathymetric survey of the Narrow Deep B spoil disposal ground has shown that the volume of ground below the 20 m depth contour (below Chart Datum) is approximately 6 million m^3. This survey was undertaken after a capital dredge disposal operation from the Fife Energy Park near Methil. Marine Scotland guidance for disposal of non-erodible material (i.e., rock, glacial till and mudstone) should not exceed 5% of the depth of the spoil disposal ground. The disposal of 101,000 m^3 of dredged material from the Leith outer berth would reduce the depths at Narrow Deep B (assuming all the material is deposited evenly below the 20 m depth contour) by approximately 0.6%.

It is anticipated that this option will be acceptable to both public and agencies, based on previous applications, the long-term use of Narrow Deep and its existing capacity.

The FDSFD has previously sought a seasonal restriction to disposal operations of sediment material in the Firth of Forth during June and July. The assessment presented in the Project EIA [(1)] concludes that there will be no significant impacts on fish and fish passage based on the levels of suspended sediment generated during disposal operations and the intermittent, localised and temporary nature of the effects of dredge spoil disposal, and therefore no seasonal restrictions are considered to be justified. 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 intermittent, short-term and localised 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. The disposal of non-erodible material such as rocks, glacial till and mudstone will change the seabed habitats within the spoil disposal ground. The habitats within the spoil disposal ground are periodically altered due to the deposition of erodible and non-erodible dredged material from capital and maintenance dredging operations within the Firth of Forth. The purpose of licencing spoil disposal grounds in UK waters is to restrict the impact of spoil deposition to a limited number of dedicated areas and therefore the impacts on habitats within these licenced spoil disposal grounds are considered to be acceptable.

There is unlikely to be significant interference with other legitimate activities and there is not anticipated to be any impact on local amenity.

5.2 Identification of the BPEO

The assessment of options highlights the major operational difficulties associated with the coastal reclamation/construction fill and sacrificial landfill that primarily relate to lack of available sites and facilities and the nature of the material to be dredged (a mix of sediment, glacial till, mudstone and rock). There are also major costs associated with the need to construct landing, storage and drying facilities at the Port of Leith or elsewhere in the vicinity of Leith to land, store, treat and transport this type of material.

The proposed project supports the objectives set out in Scotland's National Marine Plan and will allow the planned development of the Port of Leith to provide berthing facilities for the developing offshore renewables industry and other industries.

Disposal at sea of the fine sediment fraction will keep the dredged material within the ecosystem, maintaining the sediment budget for the area. For the non-erodible material such as rocks, glacial till and mudstone, the use of a deep-water spoil disposal ground with high capacities will avoid interference with other navigation interests. In line with guidance from Marine Scotland, the Best Practicable Environmental Option is identified as the disposal at a licensed sea spoil disposal ground. The preferred site for this is the Narrow Deep B spoil disposal ground.

(1) Royal Haskoning DNV 2022a Port of Leith Outer Berth Environmental Impact Assessment Report Report number PC2045-RHD-ZZ-XX-RP-EV-0007 Prepared for Forth Ports Ltd

Table 5.1 Summary of Assessment of Options

	Coastal Reclamation and Construction Fill	Sacrificial Landfill	Sea Disposal
Operational feasibility			
Availability of sites/facilities			
Security of option			
Established practice			
General public acceptability			
Likely agency acceptability			
Legislative implications			
Public health			
Safety			
Pollution/contamination			
Ecological impact			
Interference with other users			
Amenity/aesthetic			
Cost considerations			

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

APPENDIX A SEDIMENT SAMPLE PHYSICAL AND CHEMICAL ANALYSIS

A1 PORT OF LEITH SEDIMENT SAMPLE DATA

A1.1 Introduction

Samples of the seabed sediments to be dredged were collected from the Port of Leith approach channel area by MacGeo Ltd between 16 and 18 October 2021 and were analysed by Socotec Ltd.

The survey plan followed the Marine Scotland guidance and was agreed with Marine Scotland on 12 August 2021. Based on the estimated dredge volumes and depths, core samples from eight sample stations were required. Sample station locations are presented in *Table A1.1* and shown in *Figure A1.1.*

Table A1.1 Positions of the Leith Outer Berth 2021 Sample Stations

Sample Station	Sample Depths (m)	Latitude	Longitude
VC01	0, 1.55, 2.3	55° 59.4787’ N	003° 11.0101’ W
VC02	0, 0.5	55° 59.4517’ N	003° 11.0398’ W
VC03	0, 0.5	55° 59.4387’ N	003° 10.9891’ W
VC04	0, 0.3	55° 59.4111’ N	003° 10.9859’ W
VC05	0, 1.5, 2.9	55° 59.4100’ N	003° 10.9233’ W
VC06	0, 0.24	55° 59.3818’ N	003° 10.9163’ W
VC07	0, 0.5	55° 59.3523’ N	003° 10.9108’ W
VC08	0, 0.5	55° 59.3698’ N	003° 10.8468’ W

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

Samples were taken using a 1.1 tonne, 5 m barrel length, vibrocorer. Core penetration reached over 2 metres at two of the eight sample stations. At the remaining six stations core penetration was 0.24 to 0.5 m before reaching glacial till/mudstone. The core samples retrieved from each survey station was subsampled on deck and stored in pre-cleaned sample containers provided by Socotec Ltd.

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

- Sediment water content.
- Sediment particle distribution (PSD).
- Total Organic Carbon (TOC).
- Metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn);
- Tributyl Tin (TBT).
- Polycyclic Aromatic Hydrocarbons (PAHs): US EPA 16.
- Poly Chlorinated Biphenyls (PCB): ICES 7.

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 Leith Outer Berth Sample Stations

Source: Royal Haskoning (2022a)

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 (mg kg^{-1} Dry Weight)	AL2 (mg kg^{-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 (mg kg^{-1} Dry Weight)	AL2 (mg kg^{-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	

Note there are no Action Level 2 limits for PAHs

A1.3 Metal Results

Concentrations of metals in the sediment samples are presented in *Table A1.4*. Levels above Marine Scotland Action Level 1 are highlighted in blue and levels above Action Level 2 are highlighted in red (see *Table A1.1* for Action Levels for metals). There were elevated concentrations of Cd and Hg in Sample VC01 at 1.55 metre depth and Hg in sample VC05 at 1.55 m depth. These were the two samples stations where deeper cores were retrieved. The deeper samples at 2.3 and 2.9 m depth respectively had markedly lower concentrations of Cd and Hg and in the case of Hg, below Action Level 1. The source of these contaminants is not known but the depths suggest historic deposition when concentrations of metals such as Cd and Hg in the Firth of Forth were higher and these deposited sediments have since been overlaid with more recent sediment deposits with lower levels of contamination. The mean concentrations for all samples were above Action Level 1, other than for As and Cr, and the mean for all samples were below Action Level 2.

Table A1.4 Analysis of Metal Contaminants from the Leith Outer Berth (mg kg^{-1}) 2021

Station	Depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC01	0.0	13.6	3.0	70	63.6	1.16	37	109	181
	1.55	15.5	4.38	88	103	1.67	35.1	156	243
	2.3	4.1	0.44	38.9	33	0.1	50.5	22.5	87.3
VC02	0.0	13.9	0.5	52.2	36.2	0.65	33.3	66.9	124
	0.5	0.9	0.1	7.7	8.4	0.03	11.4	13	22.1
VC03	0.0	13.7	0.4	54.3	36.1	0.69	36	69.5	129
	0.5	4.8	0.32	35.3	29.2	0.06	55.4	19.8	81.1
VC04	0.0	15.8	2.77	77.2	70.4	1.27	39	117	195
	0.3	4.5	0.5	36.8	33.5	0.12	52.9	24.6	88.2
VC05	0.0	12.9	2.53	74.5	64.2	1.12	39.6	108	178
	1.5	16.4	3.08	67.1	111	2.13	38.6	190	272
	2.9	5.3	0.49	31.3	31.8	0.15	39.5	23.8	86.5
VC06	0.0	15.4	0.34	51.4	32.2	0.56	33.1	63.8	126
	0.24	3.9	0.3	36.5	33.1	0.06	50.8	18.1	80.3
VC07	0.0	7.1	0.26	41.2	30.2	0.21	44.8	30	88.3
	0.5	5.1	0.35	32.1	29.8	0.05	45.9	17.9	108
VC08	0.0	5.5	0.3	22.7	24	0.31	19.5	37.4	230
	0.5	8.1	0.23	26.7	13.8	0.04	24.6	13.5	60.5
Mean		9.3	1.1	46.9	43.5	0.6	38.2	61.2	132.2
Range		0.9-16.4	0.1-4.38	7.7-88	8.4-111	0.03-2.13	11.4-55.4	13-190	22.1-272

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 collected in the approach channel as part of the maintenance licence applications in 2017 and 2020. These samples were collected from surface sediment grabs. For most samples the metal concentrations were above Action Level 1 for all metals other than As and Cd. No samples had metal concentrations above Action Level 2.

Table A1.5 Metal Concentrations from the Leith Approach Channel Surface Samples (mg kg^{-1} Dry Wt) 2017 and 2020

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
L5-2017	19.3	0.282	86.6	37.8	0.69	42.1	90.3	160
L6-2017	14	0.411	59.9	27.4	0.58	35.9	65.6	120
L7-2017	15.2	0.261	74.5	26.6	0.57	38.9	66.3	125
L6-2020	19.6	0.38	62.5	40.2	0.73	36.4	78.2	155
L7-2020	13.8	0.25	58.3	32.1	0.70	32.4	65.6	126
Mean	16.4	0.32	68.4	32.8	0.65	37.1	73.2	137
Range	13.8-19.6	0.25-0.41	58.3-86.6	23.6-40.2	0.57-0.73	32.4-42.1	65.6-90.3	120-160

The metal concentration data from the Leith outer berth samples are compared with data from Port of Leith (approach channel and inner docks), and other ports and harbours within the Firth of Forth and the Forth Estuary (*Table* A1.6) (1). The samples for the other ports were from surface grab samples. This shows that the mean concentrations of metals from the outer berth samples are generally lower or within the range the range of samples from other sites. Concentrations of metals outside the main dock areas are generally lower than those within the docks where fine sediment tend to accumulate.

Table A1.6 Concentrations of Metals from Leith Outer Berth 2021 and other Firth of Forth and Forth Estuary Ports

	Metal Concentration (expressed as mg kg^{-1} Dry Weight)							
	As	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**
Leith Outer Berth 2021								
Mean	9.3	1.1	46.9	43.5	0.6	38.2	61.2	132.2
Range	0.9-16.4	0.1-4.38	7.7-88	8.4-111	0.03-2.13	11.4-55.4	13-190	22.1-272
Leith Docks 1990-2020								
Mean	13.1	1.1	61.4	71.1	1.2	39.8	134.5	261.3
Range	4.6-21.6	0.0-3.9	14.1-84.3	12.8-144	0.2-4.4	13.0-59.3	29.0-787	62.6-687
Newhaven 2014-2021								
Mean	17.1	0.82	68.7	71.8	1.05	34.7	114.2	191.8
Range	13.1-20.8	0.3-2.2	55.1-97.5	33.5-156.0	0.6-2.7	28.0-50.8	74.9-170.0	145.0-289.0
Methil 2003-2020								
Mean	11.27	0.38	32.70	40.94	0.20	23.32	33.62	142.38
Range	2.8-17.3	BDL-0.7	10.1-72.8	11.2-90.1	0.1-0.3	7.1-39.5	7.5-76.3	26.2-347
Rosyth 2000-2020								
Mean	17.04	0.23	74.3	38.8	0.95	34.0	70.0	150.1
Range	12.4-21.9	BDL-4.5	46.3-106	22.5-189.9	0.4-2.6	24.6-43.4	43.1-137.5	88.4-1,730
Grangemouth 1988-2019								
Mean	14.5	0.1	73.3	49.6	1.1	32.2	69.9	147.3
Range	0.0-43.6	0.0-1.2	10.7-211	3.0-353	0.0-3.8	7.6-80.6	9.3-209	28.9-743

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

BDL: Below Detection Level

Blue shading indicates concentrations above Marine Scotland Action Level 1.

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.

(1) Historic Data for Grangemouth, Rosyth and Leith provided by Marine Scotland, Aberdeen.

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 2021 are presented in *Table A1.7*. Samples with concentrations above Action Level 1 were recorded at five of the eight stations with two samples (VC01 at 1.55 m depth and VC05 at 1.5 m depth) having concentrations of PCBs above Action Level 2 (a similar pattern seen with the metals data). The concentrations of PCBs were below Action Level 1 at the deeper samples at both these stations. The location of these elevated concentrations within the cores suggests historical contamination.

Table 1.8 presents a comparison of mean dry weight concentrations of ICES 7 PCBs from samples collected in 2017 and 2020 from the Leith Approach Channel. These were surface samples, and the concentrations of PCBs were all below Action Level 1.

Table A1.7 Analysis of PCBs (mg kg^{-1}) from Leith Outer Berth 2021

Station	Depth (m)	Sum of ICES 7 PCB Concentrations
VC01	0.0	0.1237
	1.55	0.2392
	2.3	0.0040
VC02	0.0	0.0248
	0.5	0.0008
VC03	0	0.0164
	0.5	0.0008
VC04	0	0.1014
	0.3	0.0021
VC05	0.0	0.0627
	1.5	0.3393
	2.9	0.0037
VC06	0.0	0.0120
	0.24	0.0006
VC07	0	0.0029
	0.5	0.0006
VC08	0	0.0623
	0.5	0.0012
Mean		0.0555
Range		0.0006-0.3393

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.

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

Table A1.8 Analysis of PCBs (mg kg^{-1} Dry Wt) from the Leith Approach Channel in 2017 and 2020

Station	Sum of ICES 7 PCB Concentrations
L5-2017	0.0102
L6-2017	0.0146
L7-2017	0.0094
L6-2020	0.01779
L7-2020	0.01578
Mean	0.01355
Range	0.0094-0.01779

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.

A1.5 Polycyclic Aromatic Hydrocarbons

Levels of PAHs are presented in *Table A1.9.* Levels above Marine Scotland Action Level 1 for individual PAHs are highlighted in blue. Action Level 1 for Total PAHs is 100 mg kg^{-1}, and all the samples are below that level. A comparison of mean dry weight concentrations of PAHs from samples collected in 2017 and 2020 from the Leith Approach Channel are presented in *Table A1.10*, which shows that PAH concentrations of the majority of individual PAHs are above Action Level 1 in both years.

Table A1.9 Analysis of PAHs from the Leith Outer Berth 2021 (mg kg^{-1} Dry Weight)

Station	VC01			VC02		VC03		VC04		VC05			VC06		VC07		VC08	
Depth (m)	0	1.55	2.3	0	0.5	0	0.5	0	0.3	0	1.5	2.9	0	0.24	0	0.5	0	0.5
LMW PAH																		
Acenaphthene	0.346	0.801	0.018	0.081	0.016	0.060	0.022	0.063	0.021	0.174	0.322	0.016	0.057	0.023	0.062	0.009	0.002	0.136
Acenaphthylene	0.075	0.243	0.009	0.049	0.008	0.041	0.010	0.036	0.009	0.093	0.110	0.007	0.034	0.026	0.036	0.006	<0.001	0.037
Anthracene	0.787	1.560	0.023	0.307	0.022	0.223	0.032	0.203	0.026	1.050	0.769	0.024	0.218	0.096	0.164	0.032	0.004	0.217
Fluorene	0.407	0.910	0.085	0.132	0.086	0.116	0.086	0.114	0.089	0.285	0.468	0.067	0.094	0.046	0.190	0.016	0.008	0.179
Naphthalene	0.435	1.120	0.140	0.253	0.098	0.246	0.106	0.185	0.109	0.369	0.557	0.074	0.205	0.104	0.277	0.043	0.012	0.365
Phenanthrene	1.990	4.210	0.382	0.727	0.367	0.541	0.386	0.438	0.308	2.140	1.800	0.261	0.575	0.239	0.705	0.093	0.039	0.738
HMW PAH																		
Benzo(a)anthracene	1.40	3.580	0.051	0.595	0.042	0.456	0.065	0.388	0.047	2.960	1.250	0.045	0.462	0.205	0.287	0.052	0.009	0.495
Benzo(a)pyrene	1.33	5.030	0.061	0.593	0.046	0.484	0.078	0.401	0.053	2.030	1.210	0.050	0.498	0.217	0.315	0.057	0.010	0.457
Benzo(b)fluoranthene	1.32	4.590	0.105	0.606	0.092	0.531	0.114	0.434	0.079	2.140	1.160	0.070	0.537	0.229	0.384	0.061	0.016	0.489
Benzo(ghi)perylene	1.11	4.000	0.171	0.547	0.135	0.498	0.180	0.385	0.145	1.100	0.960	0.125	0.490	0.215	0.434	0.056	0.023	0.362
Benzo(k)fluoranthene	0.626	2.300	0.016	0.280	0.021	0.252	0.033	0.165	0.020	1.330	0.670	0.017	0.274	0.115	0.149	0.034	0.003	0.239
Chrysene	1.49	3.920	0.151	0.606	0.133	0.489	0.169	0.417	0.128	3.120	1.440	0.108	0.487	0.217	0.454	0.062	0.016	0.551
Dibenzo(ah)anthracene	0.171	0.542	0.019	0.081	0.013	0.094	0.018	0.075	0.014	0.263	0.149	0.014	0.072	0.030	0.057	0.011	0.002	0.090
Fluoranthene	2.88	6.520	0.084	1.230	0.081	0.800	0.104	0.732	0.086	5.610	2.630	0.073	0.841	0.363	0.571	0.122	0.014	1.030
Indeno(1,2,3-c,d)pyrene	0.953	3.640	0.045	0.483	0.034	0.433	0.056	0.349	0.038	1.080	0.805	0.032	0.430	0.183	0.253	0.047	0.007	0.342
Pyrene	3.07	6.740	0.119	1.310	0.117	0.919	0.156	0.826	0.123	5.460	2.700	0.104	0.973	0.438	0.735	0.130	0.019	0.879

BDL = Below Detection Level

LMW = Low Molecular Weight. HMW = High Molecular Weight

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

Table A1.10 Analysis of PAHs from Leith Approach Channel (mg kg^{-1} Dry Weight) 2017 and 2020

	Sample Station				
LMW PAH	**L5-2017**	**L6-2017**	**L7-2017**	**L6-2020**	**L7-2020**
Acenaphthene	0.057	0.144	0.058	0.131	0.0417
Acenaphthylene	0.012	0.020	0.016	0.0603	0.037
Anthracene	0.150	0.401	0.163	0.514	0.183
Fluorene	0.064	0.155	0.081	0.168	0.0811
Naphthalene	0.175	0.268	0.184	1.310	0.429
Phenanthrene	0.345	0.964	0.366	0.131	0.0417
HMW PAH					
Benzo(a)anthracene	0.247	1.020	0.348	1.050	0.326
Benzo(a)pyrene	0.291	0.927	0.368	1.140	0.380
Benzo(b)fluoranthene	0.327	0.888	0.370	1.110	0.417
Benzo(ghi)perylene	0.329	0.752	0.374	0.873	0.356
Benzo(k)fluoranthene	0.165	0.402	0.182	0.379	0.201
Chrysene	0.158	0.757	0.242	1.070	0.341
Dibenzo(ah)anthracene	0.078	0.157	0.075	0.179	0.0668
Fluoranthene	0.432	1.810	0.667	2.230	0.573
Indeno(1,2,3-c,d)pyrene	0.299	0.696	0.317	0.841	0.306
Pyrene	0.508	1.770	0.702	0.294	0.172

LMW = Low Molecular Weight. HMW = High Molecular Weight

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 A1.11*. No samples were observed to have TBT concentrations above Marine Scotland Action Level 1 (0.1 mg kg^{-1}).

A comparison of TBT concentrations from samples collected in 2017 and 2020 are presented in *Table A1.12*, which shows that TBT concentrations are below Action Level 1 in both years.

(1) The development of male characteristics in females

Table A1.11 Analysis of TBT from the Leith Outer Berth 2021 (mg kg^{-1} Dry Weight)

Station	Depth (m)	TBT Concentration
VC01	0.0	0.0127
	1.55	<0.005
	2.3	<0.005
VC02	0.0	<0.005
	0.5	<0.005
VC03	0	<0.005
	0.5	<0.005
VC04	0	<0.005
	0.3	<0.005
VC05	0.0	0.0161
	1.5	<0.005
	2.9	<0.005
VC06	0.0	<0.005
	0.24	<0.005
VC07	0	<0.005
	0.5	<0.005
VC08	0	0.0157
	0.5	<0.005
Mean		**<0.0066**

Table A1.12 Analysis of TBT from the Leith Approach Channel (mg kg^{-1} Dry Weight)

Station	TBT Concentration
L5-2017	0.006
L6-2017	0.010
L7-2017	0.020
L6-2020	<0.005
L7-2020	<0.005
Mean	**0.0092**
Range	**<0.005 to 0.02**

A1.8 Sediment Physical Properties

Sediment Particle Size Analysis (PSA) was undertaken on the sediment samples taken from the Leith outer berth in 2021. Sediments in the retrieved samples were predominantly muddy, with fractions of sand and gravel. *Table A1.13* presents the 2021 sediment analysis data.

- Gravel is defined as >2 mm,
- Sand is defined as >63 µm<2 mm, and

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

Total Organic Content is generally low with an average of 3.41% from the samples collected. The TOC is generally higher in the surface samples compared with those at 0.5 m depth from lower in the core samples (exception is VC01 and VC05 where the TOC concertation was slightly higher at the mid core level). It is noted that the only the fine sediments overlying the glacial till, mudstone and rocky material was sampled and analyses and that the fine sediment material comprises approximately 16% of the total volume to be dredged.

Table A1.13 Leith Outer Berth 2021 Sediment PSA Data

Station	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	TOC
VC01	0.0	4.5	38.8	56.6	5.13
	1.55	0	19.4	80.6	8.3
	2.3	12	32.1	55.9	1.63
VC02	0.0	0	21.9	78.1	5.07
	0.5	26.3	30.8	42.9	1.59
VC03	0	0	23.4	76.6	4.73
	0.5	23	22.6	54.4	1.45
VC04	0	17.6	27.9	54.5	6.21
	0.3	22	15.9	62.2	1.56
VC05	0.0	1	27.3	71.8	5.55
	1.5	0	20.4	79.6	5.92
	2.9	28.8	14.9	56.3	1.19
VC06	0.0	0	19.3	80.7	5.17
	0.24	36.3	18.2	45.5	1.47
VC07	0	3.8	20.6	75.6	2.1
	0.5	0	21.6	78.4	1.24
VC08	0	25.3	39.2	35.4	2.43
	0.5	16.2	50.7	33.1	0.63
Mean		**12.0**	**25.8**	**62.1**	**3.41**

A2 SPOIL DISPOSAL GROUND SEDIMENT SAMPLE DATA

Table A1.15 presents metal and PCB concentration data from sediment sampled from spoil disposal grounds within the Firth of Forth and Forth Estuary. Levels above Marine Scotland Action Level 1 for metals and PCBs are highlighted in blue. Monitoring of spoil disposal grounds is not mandatory therefore, the data presented in *Table A1.15* are the most recent data available.

Table 1.14 Concentration of Metals and PCBs (mg kg^{-1} Dry Weight) from Forth Spoil disposal grounds

Site Name/Date	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
Narrow Deep 2011	9.5	0.2	42.9	21.6	0.49	22.9	53.4	109.4	0.008 (n=3)
(n=6)									
Narrow Deep 2015	11.7	0.2	63.8	24.6	0.6	30.0	58.4	105.9	0.03 (n=3)
(n=4)									
Oxcars 2011	11.2	0.1	42.5	22.2	0.6	22.3	153.5	92.2	0.007 (2007, n=6)
(n=6)									
Oxcars 2015	15.7	0.3	79.6	41.6	1.0	35.8	78.1	141.7	0.008
(n=3)									
Methil 1993	8.2	0.2	9.8	10.7	0.1	19.2	10.5	51.0	
(n=1)									
Methil 2011	6.9	0.07	13.7	7.14	0.07	8.97	20.2	39.8	0.0004 (n=3)
(n=3)									
Methil 2015	8.7	0.1	18.0	9.6	BDL	11.2	14.5	72.8	0.003 (n=1)
(n=1)									
Kirkcaldy 2011	6.24	0.1	21.9	16.2	0.14	16.4	21.7	45.9	-
N=3									
Kirkcaldy 2015	8.9	0.1	43.1	17.0	0.2	22.0	30.6	62.9	0.0025 (n=3)
(n=3)									
Blae Rock 2007	13.4	BDL	59.7	32.4	0.8	28.2	63.9	108.6	0.008 (n=5)
n=3)									
Blae Rock 2011	17.2	0.1	39.6	21.9	0.5	21.4	52.1	80.3	0.01 (n=2)
(n=6)									
Bo'ness 2011	14.5	0.1	50.8	23.3	0.8	23.6	56.9	95.7	0.005 (n=3)
(n=7)									
Bo'ness 2015	18.6	0.1	59.6	26.5	0.7	27.5	54.2	114.0	0.004 (n=3)
(n=5)									

* Data provided by Marine Scotland (2019)

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

APPENDIX B CONSULTEE RESPONSES (EXTRACTS FROM LETTERS/EMAILS RECEIVED)

B1 City of Edinburgh Council

I refer to your consultation in relation to proposals to place dredged material from the Port of Leith Outer Berth in a marine disposal ground at Narrow Deep under licence from Marine Scotland. It is understood that the materials to be disposed of will be analysed for contamination in line with Marine Scotland's requirements prior to disposal.

Having given consideration to your request, it is confirmed that no relevant information or suggestions concerning alternative disposal options is held and no further comment is made in relation to the proposed disposal. It is assumed that you will also be contacting the Scottish Environment Protection Agency (SEPA), as the waste regulation authority, in relation to feasible alternative disposal options, such as landfill or reclamation.

B2 Marine Coastguard Agency

Thank you very much for your letter notifying the MCA of your intended dredging and deposit activities within the Port of Leith. You have specifically asked for 'any relevant information or suggestions you may have regarding disposal options'. As a policy team in MCA HQ, our role is to assess the impact of your proposals on the safety of navigation, what risk mitigation measures are put in place for the works, and whether the risk is ALARP. We therefore have no further information to provide at this time on the disposal options.

The MCA is consulted on all Marine Licence applications under Marine (Scotland) Act 2010, and we consider the impact of any works or deployments in the marine environment on the safety of navigation and emergency response. We would always expect the application form to include consideration of the impact on safety, other marine users, and the potential risk mitigation measures, relative to the scale of the works

The MCA provides a series of conditions and advisories to ensure the safety of navigation can be maintained during the construction and decommissioning of the works, and during the site operational phase.

B3 NatureScot

We have no substantive comments on this proposal. We are not aware of any current beneficial reuse options for the Leith spoil, and no issues to raise regarding the use of Narrow Deep spoil grounds.

B4 Northern Lighthouse Board

Thank you for your e-mail correspondence dated 25th January 2022 regarding the proposal by Forth Ports Ltd for capital dredging and disposal operations at Port of Leith outer berth, Firth of Forth.

We note that the works are for a 2-month period and focus on deepening the existing outer berth.

Northern Lighthouse Board has no objections to the proposed dredging and/ or disposal of dredged spoil to the charted and approved spoil ground at Narrow Deep, 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 the dredging.
- **Forth Ports Ltd** advise the UK Hydrographic Office (sdr@ukho.gov.uk) of the revised water depths in order that chart updates are completed.

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