BEST PRACTICABLE ENVIRONMENTAL OPTION (BPEO) ASSESSMENT

MAINTENANCE DREDGING OF BERTHS AND APPROACHES AT ABERDEEN HARBOUR

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APPENDICES

1. INTRODUCTION

1.1. Background

Aberdeen Harbour is the major port serving the North East of Scotland. There are approximately 8,000 vessel arrivals and 5 million tonnes of cargo handled each year, with the harbour supporting 10,000 full time equivalent jobs. It is also the mainland port for the lifeline service to the Northern Isles and as well as general cargo and passengers. Aberdeen is the largest support harbour for the North Sea Energy Industry.

As a statutory harbour authority, Aberdeen Harbour Board (AHB) is required to carry out maintenance dredging of the main navigation channels and berths (shown on Figure 1) to maintain safe navigable depths and support customers' business needs. Clause 72 of the Aberdeen Harbour Order (Confirmation) Act 1960 gives AHB powers to dredge within its statutory harbour limits.

This report presents the Best Practicable Environmental Option (BPEO) assessment for the fate of maintenance dredged material from Aberdeen Harbour. BPEO assessment is a method for identifying the option that provides the *most environmental benefit* or *least environmental damage*. It assesses the performance of different options using a range of criteria such as environmental impact, technical feasibility and cost.

1.2. Source of Materials

Aberdeen Harbour has been built on the former delta at the mouth of the River Dee. Both the harbour and the entrance channel are susceptible to continued progressive natural infilling from two sources:

a) River-borne silts and muds; and
b) Sea-borne sands

In 1986, AHB commissioned HR Wallingford Ltd to study the siltation at the harbour entrance (see Appendix 1). The results concluded that the sediment transport is due to a complex action of tides, currents and wave action and consequently cannot be controlled.

In addition, the siltation of harbour berths is caused by the river silt being carried down the River Dee to the harbour. There the natural current takes some of this material anticlockwise around the Point Law headland where it is deposited at the harbour berths.

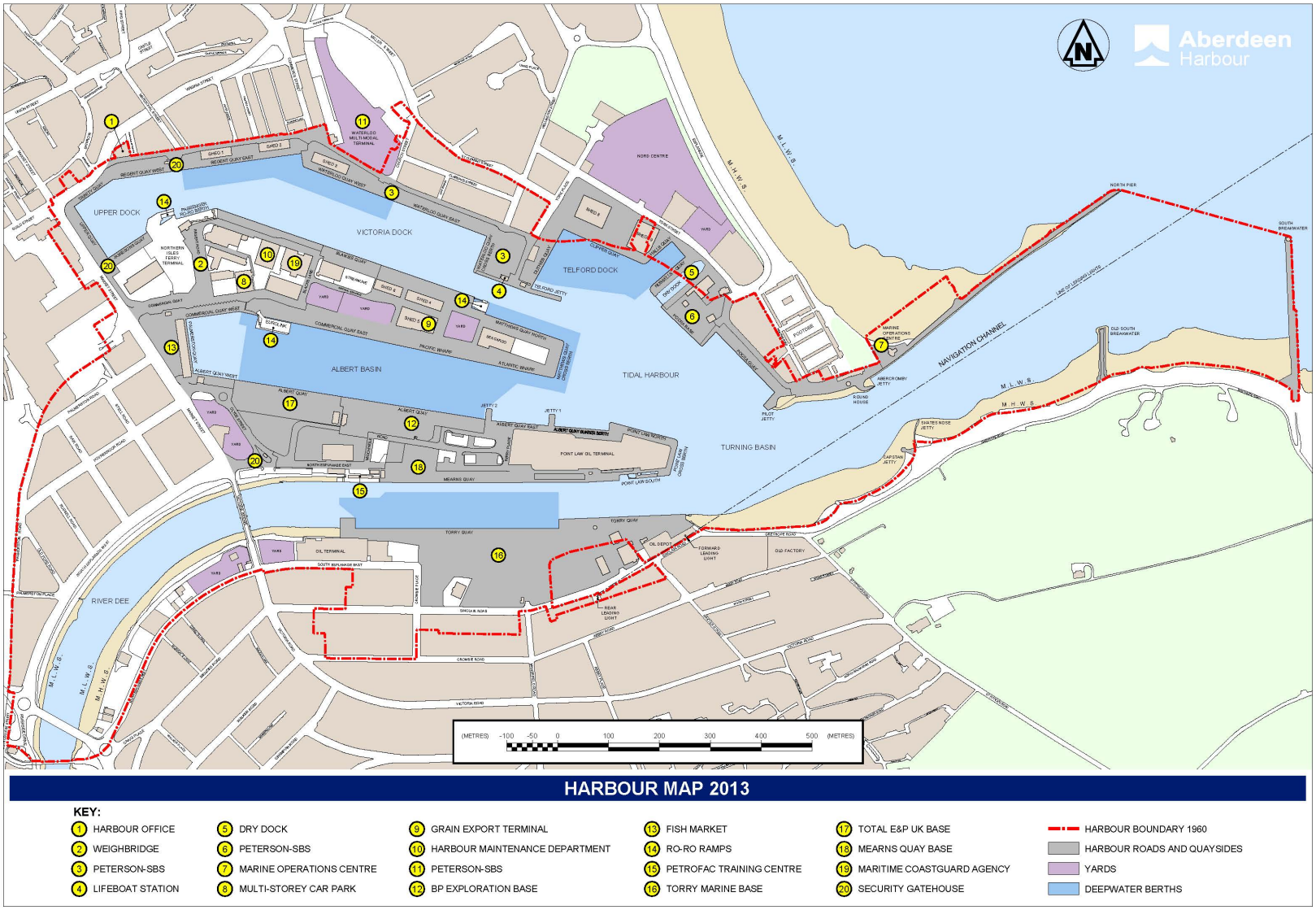

Figure 1 Aberdeen Harbour

2. DESCRIPTION OF PROPOSED DREDGING

2.1. Dredging Methodology

AHB has a record of dredging going back almost 200 years, although it is likely that dredging has been ongoing in some form throughout Aberdeen Harbour's 900+ year history. In recent years, maintenance dredging has been carried out mainly with a trailer suction hopper dredger, working in conjunction with a bed levelling tug. The latter is used to smooth out any high spots left by the suction dredger. The dredged material is taken by the trailer suction hopper dredger to the designated offshore deposit site Aberdeen CR110, approximately 2.5 nautical miles to the southeast of the harbour entrance, as shown in Figure 2.

The annual maintenance dredging campaign is typically carried out once a year within the areas shown in Figure 3; however, there have been occasions where an additional winter dredging campaign has been required due to inundated accretion of material in the navigation channel and River Dee caused by severe winter storms.

The annual maintenance dredging campaign is typically carried out in spring each year, after any winter storms, depending on the availability of dredging plant. The duration of the campaign will vary from one to four weeks depending on the dredge volumes.

The volume of material removed annually from the harbour and channel varies between 100,000 to 200,000 m^3 in-situ sand and silt.

Occasionally, deepening of sections of the harbour beyond the maintained depth is carried out to improve the facilities available to shipping; however, any such capital dredging is subject to a separate marine licence application and is outside the scope of this BPEO Assessment.

2.2. Material to be dredged

In October 2020, 10 surface grab samples were collected from the areas to be dredged, as agreed with Marine Scotland – Licensing Operations Team (MS-LOT). Sediment samples were analysed for the Marine Scotland suite of parameters. A summary of the results is presented in this section and the full results are provided in Appendix 2.

2.2.1 Comparison with Marine Scotland Revised Action Levels

The results have been compared to the Marine Scotland Revised Action Levels, which are used to determine the contaminant loading of the material and its suitability for deposition at sea. Levels of some heavy metals (cadmium, chromium, copper, and nickel) were elevated above Marine Scotland Revised Action Level 1 in up to five of the samples analysed. In all cases the levels were well below Action Level 2. Levels of polychlorinated biphenyls and tributyl tin were below Action Level 1 in all samples.

Levels of polycyclic aromatic hydrocarbons (PAHs) were elevated above Action Level 1 in seven of the samples analysed. Levels in the 2020 samples did not exceed the levels observed in samples collected for recent marine licence applications for deposition (2015 – 2019). PAH levels are within those expected from the Aberdeen Harbour area.

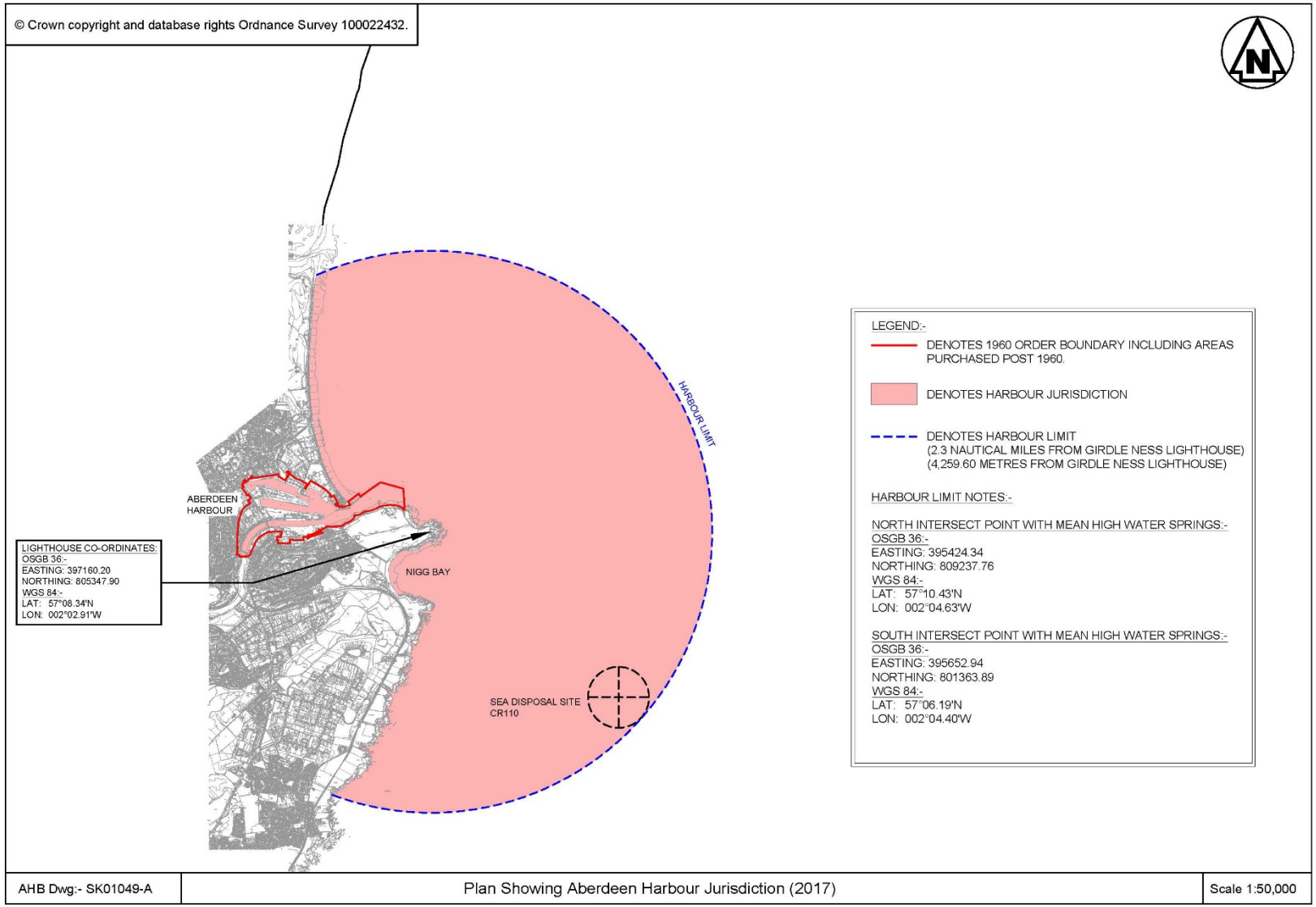

Figure 2 Offshore deposit site Aberdeen CR110

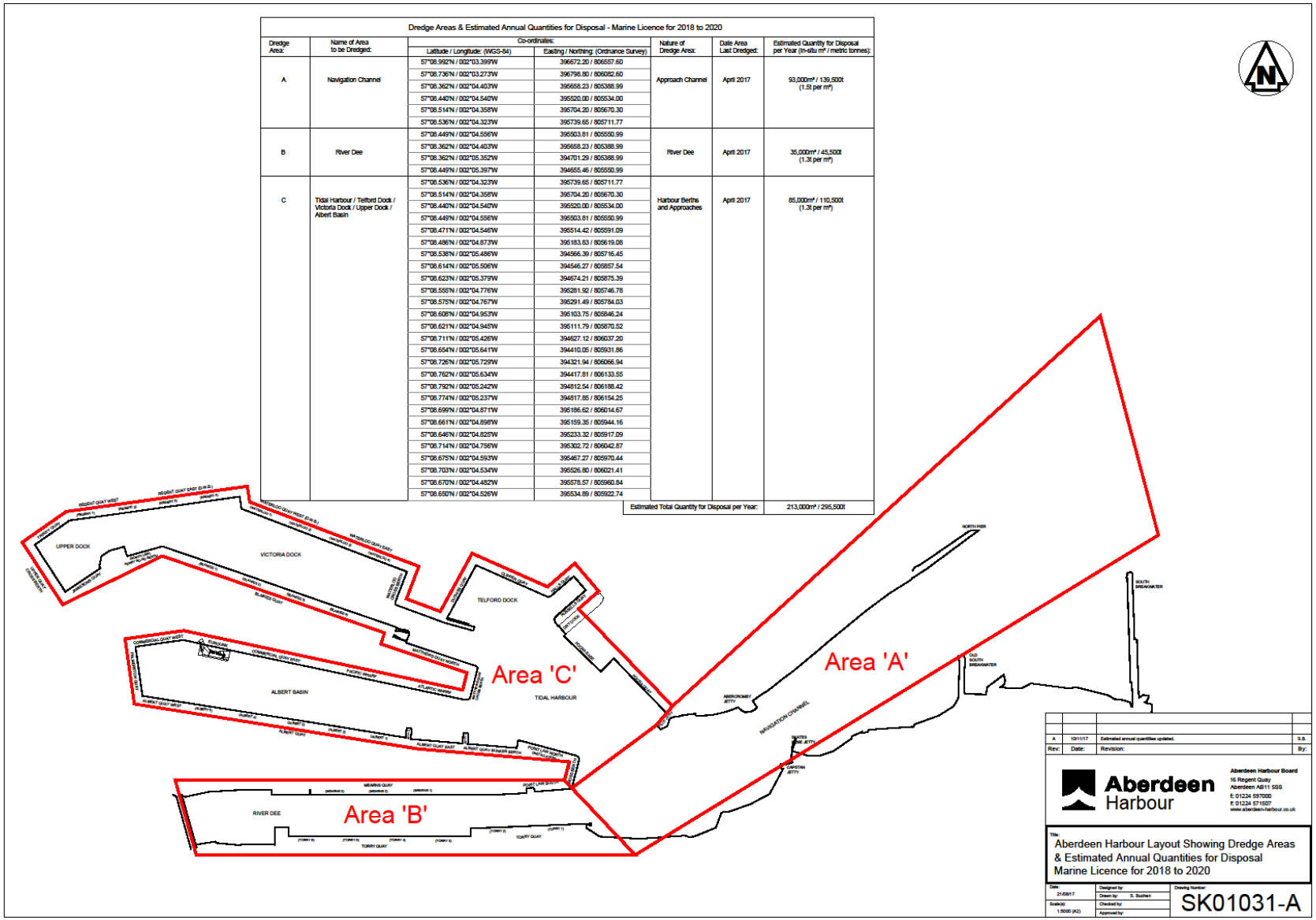

Figure 3 Areas to be dredged

To set these results into context, Marine Scotland has undertaken regular analysis of the material from the dredge hopper during AHB's maintenance dredging campaigns as far back as 1988, and the results of the analysis are provided in Appendix 3. The levels of heavy metals range between below the detection limit to above Revised Action Level 2. For example, a set of samples collected in 1998 and 1999 show elevated levels of copper, zinc, nickel and cadmium above Action Levels 1 and 2, and there are notable samples that are far in excess of Action Level 2. [The licensing regime for dredging and disposal activities has changed substantially since 1988; disposal activities were carried out in accordance with the regulations of the time.]

A report by the Marine Laboratory (Hayes *et al*., 2005) examined the concentration of heavy metals at the Aberdeen offshore deposit site CR110, along with other deposit sites off the east coast of Scotland. The majority of samples were collected from surveys undertaken in 2002 and 2003; however, historical data collected and analysed in a similar manner was also included. Table 1 presents the average and maximum concentrations of heavy metals at Aberdeen CR110.

In addition to the Hayes *et al*. study (2005), additional sampling was undertaken by Marine Scotland at Aberdeen CR110 between 1995 and 2011: the results are presented in Appendix 4, and the average concentrations of heavy metals are presented in Table 2. The results from this dataset and the study by Hayes *et al*. (2005) show that levels of heavy metals at the deposit site are consistently below Action Level 1, even during times when material above Action Level 1 (and in some cases above Action Level 2) was deposited at the site. As the average levels are considerably lower in the sediments at the deposit site than at the source of dredging, there is no evidence of an accumulation of heavy metals at the deposit site at levels that could cause biological harm. As such, the current practice of depositing material at the offshore site that is either below Action Level 1, or between Action Level 1 and 2, is considered to have a negligible effect on water quality or biological receptors.

Table 1 Concentrations of heavy metals at Aberdeen offshore disposal site (~2003)

Metal	**Average (mg/kg dry weight)**	**Maximum (mg/kg dry weight)**
Arsenic	6.1	14.0
Cadmium	0	0.2
Chromium	13.1	32.5
Copper	7.9	34.9
Mercury	0.1	0.3
Nickel	7.8	21.2
Lead	13.6	28.5
Zinc	35.9	75.8

(Reproduced from Hayes et al. (2005))

Table 2 Average concentration of heavy metals at Aberdeen offshore disposal site (1995 – 2011)

Metal	**Average concentration (mg/kg dry weight)**
Arsenic	5.65
Cadmium	0.07
Chromium	12.78
Copper	6.17
Mercury	0.07
Nickel	7.19
Lead	10.93
Zinc	35.95

3. SCOPING OF POTENTIAL OPTIONS

3.1. Introduction

This section describes potential options for the dredged material. When an option is not considered feasible, the reason is given and it is not taken forward to the assessment stage. Those options which are considered to be practicable are considered in Section 4 of this report.

3.2. Option 1: Landfill

The most common use of dredged material within landfill sites is as capping or restoration material. Material would need to be brought ashore within the existing harbour and dewatered before being transported to trucks and taken to the landfill site by road.

There are no suitable sites in the immediate vicinity of the harbour that could cope with a large quantity of material on an annual basis. The closest operational landfill site to Aberdeen Harbour is Loch Hills Quarry in Dyce, approximately 12 km to the north by road from Aberdeen Harbour (SEPA, 2020). Existing landfill sites must cope with large volumes of domestic and industrial requirements, and marine dredgings on the present scale would place an intolerable burden on such sites. Dredged material is relatively inert by landfill standards, so disposal at a landfill site is not usually necessary or recommended unless it is significantly contaminated, which it is not in this case (see Section 2.2).

Dredged material would have to be dried in lagoons before being transported by road to the landfill site. Suitable land for drying lagoons is not available within the harbour estate.

Transportation of material from the harbour to the landfill would generate significant vehicle movements on local roads, contributing to congestion and air and noise pollution, as well as road safety concerns.

On these grounds this option has been discounted.

3.3. Option 2: Agriculture Use

The North East of Scotland is a rural farming area with an abundance of good arable land and there is no known requirement for a supplement of imported material. The dredged material would have to be de-watered and desalinated to make it suitable for soil conditioning or spreading, and no land is available to locate a drying lagoon. This option has been discounted.

3.4. Option 3: Reclamation

Dredged material can be suitable for land reclamation. The material grade and quality are critical: material suitable for reclamation is generally medium to coarse sands and gravel fractions, typically in large volumes. As the material to be dredged is variable and cannot easily be dredged according to material type, use in reclamation projects is not considered appropriate. This option has been discounted.

3.5. Option 4: Beach Recharge

The use of dredged material for beach recharge is a sustainable beneficial use: it generates a purpose for the material that benefits a local amenity. Material is typically deposited direct from the dredging vessel via a pipeline or by 'rainbowing' onto the beach, where it is reprofiled using land-based plant. This option is considered further in Section 4.

3.6. Option 5: Construction Material

The saline content of the dredged material makes it unsuitable as a construction material. The grading and washing required coupled with the drying and storage challenges previously identified makes this option uneconomical and unpractical. This option has been discounted.

3.7. Option 6: Sea Disposal

The present sea deposit site for dredged material originating from Aberdeen Harbour (CR110 - shown on Figure 2) is approximately 20 minutes' sailing time from the harbour. It is a long-established deposit site.

The nature of the dredged material and the proximity of a suitable licensed deposit site makes deposition at sea a viable option, which will be considered in detail in Section 4.

3.8. Summary of options scoping

The identification of available options concludes that Options 1 (landfill), 2 (agricultural use), 3 (reclamation) and 5 (construction material) are not viable for the reasons described above. The following options will be taken forward to assessment:

- Option 4: Beach recharge
- Option 6: Sea disposal

4. ASSESSMENT OF OPTIONS

In this section, Options 4 and 6 are considered in greater detail. The BPEO assessment comprises three aspects: strategic, environmental and cost considerations.

4.1. Option 4: Beach Recharge

4.1.1. Strategic Considerations

Operational Aspects

Beach recharge (sometimes called beach nourishment) requires clean, sandy material. Such material is typically found in the outer part of the Aberdeen Harbour entrance channel; the remaining mixed silty material from the berths would be unacceptable (see Appendix 5 showing areas of sand and mixed clays/silts/sands). A volume computation based on the 2020 post-dredge survey versus the pre-dredge survey revealed that approximately 10,900 m^3 of the 54,400 m^3 dredged was likely to be sandy material. For this BPEO the proportion of material that is potentially suitable for beach recharge is estimated at 20%, but this will vary annually.

The material is typically dredged using a trailer suction hopper dredger. However, since the material has to be deposited on an exposed open beach, this type of dredger could not sail close to the beach and strong pipelines through the breaker zone would be required to deposit sand on the beach. Once ashore, the material would typically be stockpiled in a bund and recovered and spread during low water.

The sediment transport study completed by HR Wallingford in 1986 (see Appendix 1) concluded that the beach material from Aberdeen Bay moves in a cyclical motion; thus, with this type of motion and the groynes located on the beach there has never been a regular need for beach recharge in the area.

The following points have emerged from studies of beach recharge projects:

1) Replenishment sand should have a medium grain size 1½ to 2 times that occurring naturally on the beach. A high content of fine particles should be avoided since this will lead to initial instability and rapid loss of the fine fraction.

   As described above, the particle size of maintenance dredged material is unlikely to be suitable in this case.

2) About 20 to 30% of the bulk replacement volume is normally lost during the process.

As stated in Section 2.1, the overall dredge volume may vary from 100,000 m^3 to 200,000 m^3 per annum, so the volume of material suitable for beach recharge may vary from 20,000 m^3 out of 100,000 m^3, to 40,000 m^3 out of 200,000 m^3. Therefore, with a 20% loss this drops to 16,000 m^3 – 32,000 m^3.

Availability of Suitable Sites/Facility

Analysis of the Coastal Erosion Susceptibility Model, an output of the Dynamic Coast (Coastal Change Assessment) project, reveals that areas of erosion are predicted in the 'Future Look (2050)' condition along the sandy coastline between the Bridge of Don and Newburgh.

Since 2017, AHB have contacted Aberdeen City Council (ACC) and Aberdeenshire Council annually to enquire whether there are any opportunities for using dredged material for beach recharge or other projects. Both Councils have confirmed that they have no plans for beach recharge works in Aberdeen or Aberdeenshire in the next 12-18 months so there would be no potential to use dredged material (see correspondence in Appendix 6). There are, therefore, no beach recharge sites available within a reasonable sailing distance of Aberdeen.

General Public Acceptability

The pipework and bunds required to pump the dredged material ashore would create a temporary barrier along the beach. This would prevent the public from accessing parts of the beach in the spring when the dredging and beach recharge would take place. This is likely to be manageable through a communications plan.

Legislative Implications

Standing advice from the Scottish Environment Protection Agency (SEPA) states that waste material, which includes dredged material, deposited above the low water mark is subject to Waste Management Licensing controls regulated by SEPA unless it is subject to a licence issued under Part 4 of the Marine (Scotland) Act 2010, in which case it is excluded from such controls (SEPA, 2016), provided that it does not constitute a landfill (which is not applicable to this project). As beach recharge would require a marine licence, it is assumed that a separate Waste Management Licence would not be required.

Section 34 of the Environmental Protection Act 1990 (as amended) makes it a duty to take all measures available as are reasonable in the circumstances to apply the waste hierarchy set out in Article 4(1) of the Waste Directive. The waste hierarchy ranks waste management options according to the best environmental outcome taking into consideration the lifecycle of the material. In its simplest form, the waste hierarchy gives top priority to preventing waste. When waste is created, it gives priority to reuse, then recycling, then other recovery, and last of all disposal. The option to reuse the material for beach recharge ranks highly on the waste hierarchy; it negates the need to otherwise dispose of the material.

4.1.2. Environmental Considerations

Safety Implications

A pipeline over a beach could pose a tripping hazard or falling from height hazard and would have to be cordoned off. The construction plant required to spread the material would present a small risk to users of the beach.

Public Health Implications

There is no public health risk given that the dredged material is naturally occurring sands that is suitable for deposition at sea (see Section 2.2).

Pollution/Contamination

There would be little or no risk of pollution or contamination resulting from the inert material.

Amenity/Aesthetic Implications

The temporary stockpiling of the dredged material would not be aesthetically pleasing, but otherwise of little implication. There would be temporary access restrictions on the beach whilst the recharge activity was on-going.

4.1.3. Cost considerations

Estimated annual costs of dredging 100,000 m^3 of sand, of which 20,000 m^3 is used for beach recharge:

Lag Pipeline	£400,000
Dismantle Pipeline	£100,000
Hire of Plant	£ 50,000
Pumping Costs @ £1/m^3	£ 20,000
Dredger Mobilisation	£ 50,000
Dredge Costs @ £2.50/m^3	£250,000
TOTAL	£870,000

4.2. Option 6: Sea disposal

Dredging and deposition at sea has been carried out at Aberdeen Harbour throughout its history. For the past 80 years at least, the material has been deposited at the same offshore site used solely by the harbour: Aberdeen CR110, as shown on Figure 2.

4.2.1. Strategic considerations

Operational Aspects

The practicalities of depositing dredged material at the designated Aberdeen CR110 site are straightforward: it is likely that a split hopper barge would be used, which would discharge directly at the deposit site. No preparation of the material is required prior to deposition.

Availability of Suitable Sites/Facility

The licensed deposit site is available for the acceptance of dredged material and has been used for many years by the harbour.

General Public Acceptability

The deposit site has a long history of use for dredged material. As there is no requirement for the dredged material to come ashore for onward transportation, there is no associated impact on the local road network.

Local Acceptability

There are no anticipated local acceptability issues associated with the continuation of a long-standing method of disposing of dredged material. AHB has never received a complaint or enquiry from a member of the public regarding the deposition of maintenance dredged material at sea. No known objections have been received from members of the public relating to previous marine licence applications.

Legislative Implications

Clause 72 of the Aberdeen Harbour Order (Confirmation) Act 1960 gives AHB powers to dredge provided that the activity is approved by the Scottish Ministers before it is carried on. A marine licence is required from Marine Scotland to deposit material at the offshore site.

The option to deposit the material at an offshore site ranks poorly on the waste hierarchy (see Section 4.1.1 for details). To minimise waste generation and to manage the high costs and logistical challenges of accommodating a dredger in the harbour, AHB dredges only the volume of material required to maintain the navigation channel and berths at the published depths. [Applying for a marine licence to deposit the maximum volume reduces the risk of breaching the marine licence by exceeding the licensed volume, and/or having to re-apply for a licence to amend the volume.]

4.2.2. Environmental considerations

Safety Implications

Deposition at sea would have negligible implications for safety providing that normal navigational and maritime procedures are observed.

Public Health Implications

There are no known threats to public health associated with deposition at sea.

Pollution/Contamination Implications

As presented in Section 2.2, the material to be dredged contains isolated elevations above Marine Scotland Revised Action Level 1 for heavy metals and PAHs, but not to an extent that would prevent deposition of the material in the marine environment. The risk of pollution/contamination is very low.

Interference with other Legitimate Activities

There is the potential for interference between the dredging vessel and other users of the sea (e.g. fishing vessels). This is managed through compliance with harbour byelaws and standard communications between the dredging crew, AHB and other users.

Amenity/Aesthetic Implications

There are no amenity or aesthetic implications of depositing material at a designated offshore site.

Ecological Implications

Deposition at sea can smother marine life on the seabed within the site. As the site has been in use for many years and is subject to annual deposition of material, it is likely that any benthic species in or around the site can tolerate the periodic disturbance caused by deposition and temporary increased turbidity.

A dedicated Marine Mammal Observer (MMO) watch is kept by a nominated crew member, following the general guidance for and acting in the role of a MMO, on the dredging vessel to ensure that marine mammals are not in the vicinity when deposition takes place.

4.2.3. Cost Considerations

Estimated cost of sea deposit of 100,000m^3

Dredger Mobilisation	£50,000
Dredger Costs @ £2.50/m^3	£250,000
TOTAL	£300,000

5. BEST PRACTICABLE ENVIRONMENTAL OPTION

Table 2 summarises the BPEO assessment presented in Section 4 by allocating a relative score of 0 or 1 for each option in each of the three areas considered, where a score of 0 is the least favourable option.

	Option 4: Beach recharge	Option 6: Sea disposal
Strategic considerations	0	1
Environmental considerations	1	0
Cost considerations	0	1
Total	**1**	**2**

Table 2: Relative scoring of BPEO assessment

It is concluded that the best practicable environmental option is deposition at sea. Beach recharge is a more sustainable option as it uses a material that would otherwise be deposited at sea; however, no suitable beach recharge schemes have been identified within a reasonable sailing distance of Aberdeen Harbour, and it is a significantly more expensive option.

AHB remains open to discussions with local authorities and landowners who require material for coastal defence projects such as beach recharge; however, none have been identified within the duration of the proposed marine licence (2021).

6. REFERENCES

Hayes, P., Russell, M. & Packer, G. (2005) Surveys of dredged material and wastewater sludge sea disposal sites for the east coast of Scotland. Fisheries Research Services Internal Report No. 08/05.

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