Ardersier Port (Scotland|) Ltd

Ardersier Port Maintenance Dredging Support

Best Practicable Environmental Option

ASSIGNMENT A101001-S00
DOCUMENT A-101001-S00-A-REPT-001

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REVISIONS & APPROVALS

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REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A02	02/05/2025	Re-Issued for Use	C. French	A. Makela	A. Makela	-
A01	24/04/25	Issued for Use	A. Makela	JO	JO	-
R01	20/03/25	Issued for Review	A. Makela	A. Millais	A. Millais	-

CONTENTS

ACRONYMS

ACRONYM	DEFINITION
AL	Action Level
B_{EA}	Environmental assessment indicator
B_{EC}	Economic cost indicator
B_{HS}	Health and safety indicator
B_i	BPEO indicator
B_P	Practicability indicator
BPEO	Best Practicable Environmental Option
CAT	Carbon Assessment Tool
CD	Chart Datum
DBT	Dibutyltin
GHG	Greenhouse gas
LOD	Limit of detection
m^3	Metres squared
MHWS	Mean High Water Springs
MD-LOT	Marine Directorate – Licensing Operations Team
N	Number of assessment criteria applied in each module
nm	Nautical mile
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
S_{EA}	Sum of assessment criteria scores for environmental assessment
S_{EC}	Sum of assessment criteria scores for economic cost
S_{HS}	Sum of assessment criteria scores health and safety assessment
S_P	Sum of assessment criteria scores for engineering practicability
SEPA	Scottish Environment Protection Agency
SSSI	Site of Special Scientific Interest
TBT	Tributyl tin
THC	Total hydrocarbon
TSHD	Trailing Suction Hopper Dredge

ACRONYM	DEFINITION
W_{EA}	Assessment module weighting for environmental assessment (25%)
W_{EC}	Assessment module weighting for economic cost (25%)
W_{HS}	Assessment module weighting for health and safety (25%)
W_{P}	Assessment module weighting for practicability (25%)

1 INTRODUCTION

Ardersier Port (Scotland) Ltd (herein referred to as 'AP') is the owner and developer of the Ardersier Port near Inverness. Following the completion of AP's capital dredging campaign in 2025, AP has an obligation to maintain the newly deepened navigation channel at the charted depth (-12.9 meters (m) below Chart Datum (CD)) in the case of sudden sedimentation events and gradual sediment build up (Figure 1-1).

AP therefore is applying for a marine licence for dredging and sea deposit of dredged material to allow for maintenance dredging to take place when/if required. The annual maintenance dredge amount is estimated to be between 100,000 and 200,000 m^3. The number of dredging campaigns required per year and the volume of material required to be dredged will depend on weather events and therefore an exact figure is unknown. The dredging campaign will most likely be carried out using a Trailing Suction Hopper Dredge (TSHD), with plough dredging used for seabed levelling, however, mechanical dredging and use of a split barge may be used on occasion.

Under the Marine (Scotland) Act 2010, when deposit of a substance or object, here dredged material, is proposed, the practical availability of any alternative method of dealing with the substance or object must be considered. Dredging guidance from Scottish Government's Marine Directorate – Licensing Operations Team (MD-LOT) states that all sea deposit marine licence applications must be supported by a detailed assessment of the alternative options which sets out the reasons, including financial, that have led to the conclusion that deposit of the materials at sea is the Best Practicable Environmental Option (BPEO) (Scottish Government, 2015). The BPEO assessment also takes into consideration the physical and chemical composition of the dredged material in determining the suitability for the material for use options and sea deposit.

This BPEO report sets out the process and outcomes of the BPEO assessment carried out to determine the best use of the maintenance dredged material.

Figure 1-1 Dredging location

2 CHEMICAL AND PHYSICAL CHARACTERISATION OF THE DREDGED MATERIAL

Chemical and physical characterisation of dredged material must be carried out prior to dredging and sea deposit taking place to ensure that the dredged material does not contain contaminants and is suitable for sea deposit should the BPEO conclude this is the best option for the material. 'OSPAR Guidelines for the Management of Dredged Material at Sea' (OSPAR Commission, 2024) states that the substances that are considered of most concern for the marine environment are those with combined properties of persistence, toxicity and liability to bioaccumulate. Typically, the most important contaminants associated with dredged material include organotin compounds, heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and oils (OSPAR, 2024). The OSPAR Guidelines require each Contracting Party (including the UK) to set national Action Levels (AL) for the common sediment contaminants. The Scottish AL's are set in the Pre-disposal Sampling Guidance Version 2 – November 2017 (Scottish government, 2017). Dredged material with contaminant concentrations below AL1 are considered to be of little environmental concern for sea deposit and are generally accepted for sea deposit should the BPEO conclude this to be the best option. Material with concentrations above AL2 is considered unsuitable for normal deposit at sea but may be suitable for other management options. Material with concentrations between AL1 and AL2 requires more detailed assessment before suitability for deposit at sea can be determined.

Sediment samples of the dredge area were collected and analysed in March and April 2023 to support the capital dredging campaign which covers the same area as the maintenance dredge location. Under the OSPAR Commission 'OSPAR Guidelines for the Management of Dredged Material at Sea', the OSPAR contracting Parties have committed to a standard sampling frequency of three years to support any dredged material deposit applications. While it is acknowledged that the material that will be maintenance dredged will not start to accumulate in the navigation channel until the capital dredging campaign in completed, the regulator, MD-LOT, has confirmed that the samples collected to support the capital dredging application can be used as a proxy for the maintenance dredged material due to the samples being less than three years old.

30 borehole samples were collected, and samples analysed in line with MD-LOT's Pre-disposal Sampling Guidance, Version 2 – November 2017 (Scottish Government, 2017). The sampling locations are shown in Figure 2-1. All samples were collected from their proposed positions with the following exceptions:

- S28 and S29 – due to water depth/shallow dredge depth at these locations, the only material present was for the base of the borehole with samples recovered from 12.5-13.0 m below CD; and
- S30 was not drilled as the seabed is below the target dredge depth. As a result of this, the total number of samples (including sub-samples of the cores) were reduced from 90 to 83.

The sampling showed that the sediment type in the dredged area is predominantly sand with varying levels of gravel and silt.

2.1 Chemical analysis

The 83 samples were analysed in accordance with MD-LOT's Pre-disposal Sampling Guidance, Version 2 – November 2017 (Scottish Government, 2017) and assessed against the Scottish AL's. The results are summarised below.

All Tributyl tin (TBT) and dibutyltin (DBT) concentration were below the below the laboratory limit of detection (LOD) and all samples recorded below AL1 (while Scotland has not set an AL1 or AL2 for DBT, the same AL1 is assumed for DBT as for TBT as per Mason *et al.* (2022)).

The PCB and total hydrocarbon (THC) concentrations in all sediment samples were below AL1.

The heavy metals and PAH exceedances of AL1 are summarised in Table 2-1 – no AL2 exceedances were recorded during sampling. If not listed in Table 2-1, the concentrations of other contaminants were below AL1 and considered to be of little environmental concern for sea deposit. Further consideration of the samples where AL1 exceedance were recorded is also provided in Table 2-1. It is concluded that as any exceedance are minor or negligible and highly localised with contaminant averages well below AL1, the material is suitable for sea deposit if this option is chosen following the BPEO assessment.

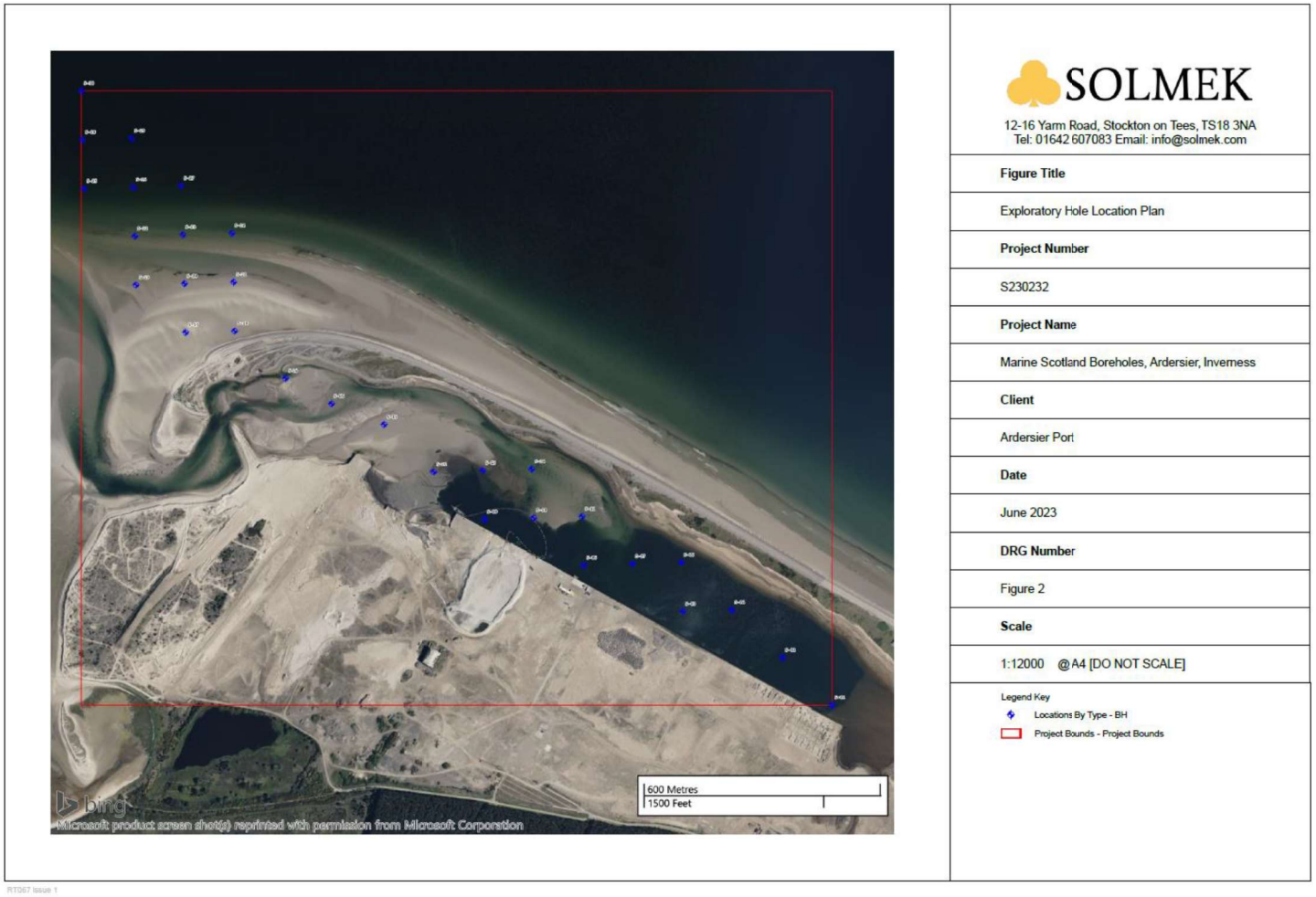

Figure 2-1 Sediment sampling locations

Table 2-1 Sediment sample contaminant AL1 exceedances from 2023 sampling

CONTAMINANTS	AL1 (MG/KG DRY WEIGHT)	AL2 (MG/KG DRY WEIGHT)	ARDERSIER PORT 2023 SAMPLES	FURTHER CONSIDERATION
Chromium	50	370	1/83 samples had an exceedance of AL1 at 90.9 mg/kg	The AL1 exceedance is significantly below AL2. The average concentration of all chromium samples is 14.7 mg/kg which is considerably below AL1.
Copper	30	300	1/83 samples had an exceedance of AL1 at 31.2 mg/kg	The AL1 exceedance is only 1.2 mg/kg above AL1 so considered a marginal exceedance. The average concentration of all copper samples is 9.7 mg/kg and considerably below AL1.
Mercury	0.25	1.5	3/83 samples had an exceedance of AL1. the maximum concentration recorded was 0.35 mg/kg which is 0.10 mg/kg above AL1 and 1.15 mg/kg below AL2.	The average concentration of all mercury samples is 0.04 mg/kg and considerably below AL1. Two of the AL1 exceedances were recorded at one sediment sampling location (S21) so this is likely to be an isolated incident which has been removed during the capital dredging.
Nickel	30	150	1/83 samples had an exceedance of AL1 at 63.5 mg/kg	The AL1 exceedance is significantly below AL2. The average concentration of all nickel samples is 11.9 mg/kg which is considerably below AL1. Two of the exceedances were recorded at the same

CONTAMINANTS	AL1 (MG/KG DRY WEIGHT)	AL2 (MG/KG DRY WEIGHT)	ARDERSIER PORT 2023 SAMPLES	FURTHER CONSIDERATION
Zinc	130	600	3/83 samples had an exceedance of AL1. the maximum concentration recorded was 212 mg/kg which is considerably below AL2.	The average concentration of all zinc samples is 41.8 mg/kg and considerably below AL1. All exceedances were recorded in one sediment sampling location (S11) so this is likely to be an isolated incident which has been removed during the capital dredging.
PAHs	Compound specific	No AL2 set for PAHs	2/83 samples recorded individual PAH concentrations above AL1: • Pyrene at 0.11 mg/kg, AL1 is 0.1 mg/kg • Dibenz[a,h]anthracene at 0.0104 mg/kg, AL1 is 0.01 mg/kg	Both exceedances of AL1 are considered marginal. All average concentrations are below AL1.

3 AVAILABLE OPTIONS FOR USE AND DISPOSAL OF DREDGED MATERIAL

The BPEO assessment is a systematic assessment of the practicality and health and safety, environmental and cost implications of alternative dredged material use options. The BPEO determination takes into account the Waste Hierarchy set out in Article 4(1) of the EU Waste Framework Directive (2008/98/EC) (European Parliament and of the Council, 2008). The Waste (Scotland) Regulations 2012 implement the Waste Framework Directive obligations in Scotland. Furthermore, the Environmental Protection Act 1990 section 34 makes it the duty of everyone who produces, keeps or manages controlled waste, or as a broker or dealer has control of such waste, to take all such measures available to that person as are reasonable in the circumstances to apply the waste hierarchy set out in Article 4(1) of the Waste Directive. The waste Hierarchy places emphasis on minimisation and re-use of dredged material, with sea deposit only being used if no alternative options are available.

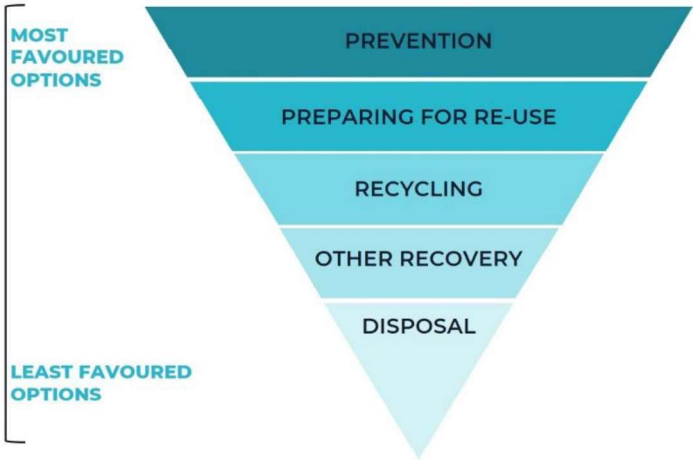

Figure 3-1 Waste Hierarchy for options for use of dredged material

The key stages of the BPEO assessment are:

1. Identification of options (see section 3.1);
2. Screening of options (see section 3.2);
3. Selection of assessment criteria (see section 4.1);
4. Analysis and evaluation of options based on the criteria (see section 4.2); and
5. Evaluation of BPEO (see section 4.3).

The following sections set out the key stages of the BPEO assessment.

3.1 Identification of options

A long list of options for dealing with the dredged material was developed with AP and considered the known opportunities which had been explored during the capital dredging campaign, as well as potential new options. The

identification process also considers the particular of the dredging campaign, including timing and dredge amount over the three-year period for which a licence is applied for. The options considered are provided in Table 3-1.

Table 3-1 Screening of potential dredged material use options

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Sea	N/A	Do nothing/no dredging	On completion of the capital dredging campaign, AP has the obligation to maintain the navigable depth of the channel and approach to the port. Maintenance dredging will be necessary to maintain the channel depth in an event of gradual or sudden accumulation of material in the channel. Any dredging will only take place if and when necessary to minimise the need for dredging. It is however not a viable option to not carry out maintenance dredging when necessary.	No
Land	Disposal	Disposal on land (landfill site)	Dewatering of the dredged material would be required prior to the material being transported to a landfill site by trucks to a landfill site. Dewatering requires extensive space, either for a drying lagoon or a dewatering facility at the quayside, which is not available at the port. This combined with the transportation requirements (multiple truck loads) and additional permit costs would be high. Existing landfill sites would need to cope with receiving up to 200,000 m^3 of dredged material annually. The closest open landfall site to Ardersier Port is the Nether Dallachy landfall site in Moray, located 62 km away from the port. This site can accommodate 122,000 tonnes of waste annually. Due to the distance and processing requirements for the landfill site disposal, this option is discounted.	No
Land	Disposal	Incineration on land	The material that will accumulate in the navigation channel is likely to mostly be composed of local sand and some silt. This material is not combustible, with a high water content. Incineration is therefore not a suitable option for material disposal.	No

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Land	Habitat creation or improvement	Agricultural use	Dredged material may be suitable for use as an agricultural soil if the material is treated to remove salt and if the material contains a high amount of silt and organic components as opposed to gravel and sand. Further analysis of the material would be required to determine the suitability of the material as agricultural soil and the desalination requires extensive space which is not available at the port. For agricultural use, a Waste Management Exemption from Scottish Environment Protection Agency (SEPA) may be required. North-East of Scotland and Moray Firth regions already have plentiful arable land that can support vegetable, fruit and cereal farming for human consumption (Scottish Government, 2023) and there is no requirement for imported soil material. This option is therefore not considered further.	No
Sea	N/A	Using methods that do not require disposal	Dredging methods such as plough, agitation or water injection dredging do not require the loading of the material on a vessel and transport of dredged material to a location outside of the dredging site. Plough dredging is proposed for seabed levelling, but it is not considered a feasible option due to the requirement of moving the material away from the dredged channel. Plough dredging is most appropriate for moving small amounts of material short distances. If plough dredging alone was used to carry out the dredging campaign, the campaign would take a long time and the material would only be moved to deeper water immediately outside the dredge channel where the material may lead to reduced water depth if used for a long period of time. This option is therefore not considered sustainable alone. Agitation and water injection dredging are not considered sustainable due to lack of water flow that could transport the suspended material away from the dredge location, as well as the sandy composition of the material (fine particles are more suitable for these methods). Furthermore, this option would not achieve the benefit of nourishing Whiteness Sands, as requested by NatureScot. This option is therefore not considered further.	No
Sea/Land	Habitat creation or improvement	Beach/coastal recharge	This option uses the dredged material beneficially for the purposes of habitat creation or enhancement. As the dredged material's physical properties typically have to be similar to those of the receiving environment to ensure no habitat type alteration or loss of visual and	Yes

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
			other amenities takes place, beach or coastal recharge are considered viable options. Whether the dredged material can be used for habitat creation or improvement depends on the availability of suitable receiving environments where environmental enhancement is required. NatureScot has indicated that dredged material may be suitable for relocation to inter- and subtidal areas adjacent to the Whiteness Sands close to the harbour entrance. The material may also be suited for beach recharge offsite. This requires the landowner's permission following identification of a suitable receiving environment. Highland Council has been consulted with regards to potential beach recharge opportunities in its jurisdiction and the council has indicated that West beach at Nairn may be suitable for beach nourishment. This option would, however, require testing of the receiving environment, further permits and an agreement between the parties before the dredging takes place. Discussions have also taken place between Angus Council and AP with regards to potential use of dredged material for dune and beach restoration at Montrose Beach. Angus Council does not yet have the necessary permits to carry out the beach recharge operations, and the transportation distance (180 km) and associated costs are prohibitive. Furthermore, NatureScot has indicated its preference for local use of the material. Due to the surrounding environment around Ardersier Port comprising of subtidal sandbanks, sand dunes and sandflats and the potential local habitat erosion, the material could potentially be used for habitat beach or coastal recharge. This option is considered further.	

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Sea/Land	Engineering uses	On-site reuse in reprofiling or as construction material	The dredged material could potentially be used on site for site reprofiling and as construction material during site development activities. Assuming the material will have similar properties than the material dredged under the recent capital dredging licence (MS-00010940), the material should be suitable for this end use if required. The saline content of the dredged material however makes it unsuitable as a construction material without grading, washing, drying and storage. This may make this option uneconomical and impractical. This option is however assessed further.	Yes
Sea/Land	Engineering uses	Offsite use/recycling as aggregate or construction material	Assuming the material will have similar properties than the material dredged under the recent capital dredging licence (MS-00010940), the dredged sand could be used as aggregate or as construction material if sorted and graded. The saline content of the dredged material however makes it unsuitable as a construction material without grading, washing, drying and storage. This may make this option uneconomical and impractical. The material could be sold to local users if the time of dredging aligned with the needs of potential local users. Due to the unpredictable quantity of the material and the unpredictable timing of the dredging campaign, it would be challenging for the port's commercial team to find suitable end users. The transportation and handling costs of the material would also be higher than the market cost of aggregate and construction materials, limiting potential sale opportunities. AP however continues to investigate potential off-site commercial use opportunities and this option is considered further.	Yes

LOCATION	TYPE	OPTION	ASSESSMENT	SCREENED IN FOR FURTHER CONSIDERATION? (Y/N)
Sea	Aquatic placement	Deposit at a sea deposit site	Whiteness Sands B and C designated sea deposit sites are located in the immediate vicinity of the dredge area and as such the cost and transport requirements associated with deposit at the sea deposit sites are low and logistically feasible. This option would involve deposit of the material into an area intended for receiving dredged material and NatureScot has indicated that placement of the material in shallow water immediately west of the dredge site would ensure the sediment is retained in the local sediment cell. This option is taken forward for further consideration.	Yes

3.2 Options screening

Following the compilation of a long list of potential options for dredged material use, each option was screened 'in' or 'out' from further consideration based on feasibility of the options. The options considered and outcome of the screening are provided in Table 3-1, alongside justification for screening out those options which have not been taken forward for further consideration.

Following the screening of potential dredged material options, the following were carried over to the detailed, quantitative BPEO stage:

1. Beach/coastal recharge;
2. On-site reuse in reprofiling or as construction material;
3. Offsite use/recycling as aggregate or construction material; and
4. Deposit at a sea deposit site.

A summary of the necessary works or methodology for each option being taken forward for detailed BPEO assessment is provided below.

3.2.1 Beach/coastal recharge

This option uses the dredged material beneficially for the purposes of habitat creation or environment enhancement. The dredged material's physical properties typically have to be similar to those of the receiving environment to ensure no habitat type alteration or loss of visual and other amenities takes place. As the material is expected to consist of sand with some fractions of silt, beach or coastal recharge are considered viable options.

Whether the dredged material can be used for habitat creation or improvement depends on the availability of suitable receiving environments where environmental enhancement is required. Under the capital dredging and sea deposit marine licence (MS-00010940), there was a requirement to use 400,000 wet tonnes of the dredged material for Whiteness Head Spit reinforcement, with the rest of the dredged material placed above Mean High Water Springs (MHWS). The spit restoration during capital dredging was carried out to reinstate the spit following historical degradation and monitoring of the success of this activity is ongoing. If in the future the spit is degrading again further reinforcement could be considered, but this is unlikely as the tidal flows inside the harbour are very weak. Currently further restoration is not necessary.

NatureScot has indicated that dredged material may be suitable for relocation to intertidal and subtidal areas adjacent to the Whiteness Sands close to the harbour entrance. The reason for this is that the new dredge channel may disrupt the transport of sand along the spit towards Whiteness Sands and NatureScot has concerns that this will lead to future erosion. This area is close to the Whiteness Sands B and C sea deposit sites and subtidal deposit to the deposit sites is explored further in Section 3.2.4. Material placed in the vicinity of the Whiteness Sands would allow for the material, assumed to be predominantly sand, to circulate in the same coastal sediment cell, reinforcing the sand flats associated with the Whiteness Sands Site of Special Scientific Interest (SSSI). Options for beach or coastal recharge at Whiteness Sand could include piping or rainbowing the material from the dredger or sediment barge to the desired

areas west of the harbour mouth (sea deposit at Whiteness Sands B and C is considered in Section 3.2.4). Using pipes or rainbowing is considerably more expensive and slower than bottom dumping (See Section 4 for further details).

Highland Council has been consulted with regards to potential beach recharge opportunities in its jurisdiction and the council has indicated that West beach at Nairn, located approximately 10 km from the port, may be suitable for beach nourishment. This would however require the movement of the material to the beach either by trucks or vessels. Any beach replenishment option would, however, require testing of the receiving environment, further permits and an agreement between the parties before the dredging takes place.

Discussions have also taken place between Angus Council and AP with regards to potential use of dredged material for dune and beach restoration at Montrose Beach. Angus Council does not yet have the necessary permits to carry out the beach recharge operations, and the transportation distance (180 km) and associated costs are prohibitive. Furthermore, NatureScot has indicated its preference for local use of the material. Furthermore, the volume (maximum 200,000 m^3 per year) and reactive timing of the maintenance dredging is likely to make the transport and use of the material by Angus Council logistically challenging and expensive.

Moving the material by trucks would require multiple truck loads (e.g. 200,000 m^3 of sand moved by standard 27 tonne trucks would require approximately 15,000-20,000 truck movements) to be moved through the site and the surrounding protected habitats and is considered a less viable option considering the amount of material potentially dredged. Furthermore, further processing as the material placed on the beach would be required, including potentially evening out the dredged material using bulldozers or similar machinery, unless allowed to disperse naturally with tides. Moving and dispersing the material by vessels is more efficient and also avoids double handling of the material (i.e. moving the material from vessels to land, dewatering, and moving the material onto trucks).

If placed outside of the designated sea deposit sites, any beach or coastal recharge in the intertidal area would require the landowner's permission following identification of a suitable receiving environment. The receiving environmental would also be subject to physical testing to ensure the dredged material (primarily sand) does not change the local habitat type. A communication plan to inform the local resident of the activity would also be required, and the receiving environment would not be available to members of the public during the operations due to health and safety considerations. While AP is looking into providing dredged material available for beneficial use project on non-for-profit basis, the transport requirements and Crown Estate Scotland fees would often lead to the proposal becoming prohibitively expensive or lead to monetary losses. Furthermore, most the of the beneficial use options would not align with the reactive dredging schedule. Consideration of the beneficial use options however continues with third parties.

3.2.2 On-site reuse in reprofiling or as construction material

During the capital dredging carried out under marine licence (MS-00010940) much of the sandy dredged material was utilised on site during construction and site profiling operations (e.g. working platform development on uneven ground) due to suitable engineering properties. The reuse however involved several stages of material handling: pumping of the dredged material onshore, natural dewatering, manual moving and stockpiling, loading onto trucks for transport, grading and compaction of the material to the desired design and loadbearing specification. Due to the surplus of this material and completion of the Ardersier Energy Transition Facility in 2025, there will be less need

for the sand on site. As such any on-site reuse options are limited and storing the material for future use would remove valuable site space away from other uses, making the option less desirable.

3.2.3 Offsite use/recycling as aggregate or construction material

Assuming the material will have similar properties than the material dredged under the recent capital dredging licence (MS-00010940), the dredged sand could be used as aggregate or as construction material if sorted and graded. The saline content of the dredged material however makes it unsuitable as a construction material without grading, washing, drying and storage. This may make this option uneconomical and impractical. The material could be sold to local users if the time of dredging aligned with the needs of potential local users.

Limited options for offsite use were identified during the capital dredging campaign when a known, large amount of sand was available for a period of several years. This illustrated the lack of suitable local use options. Compared to the capital dredging campaign, due to the unpredictable quantity of the material and the unpredictable timing of the maintenance dredging campaign, options for offsite uses are even more limited. The transportation and handling costs of the material would also be higher than the market cost of aggregate and construction materials, limiting potential sale opportunities. AP's commercial team has made significant efforts over the past couple of years to find end users for large quantities of sand, but these efforts have not led to securing commercial or non-commercial uses of the material.

AP however continues to investigate potential off-site commercial use opportunities.

3.2.4 Deposit at a sea deposit site

Whiteness Sands B (CR023) and C (CR021) open sea deposit sites are located in the immediate vicinity of the dredged area, approximately 1.1. km or 0.6 nautical miles (nm) away (Figure 3-2). The deposit site substrates are predominantly sand like the dredged material. Other sea deposit sites also exist in the wider Moray Firth area, but the second closest open site (Sutors, CR019, at 9.3 km away) is significantly further away and as such not considered further. The water depth ranges from >5 m CD (Whiteness Sands C) to intertidal areas (Whiteness Sands B). The dredged material could be directly transported from the dredge site on the TSHD and bottom discharged at the sea deposit sites. AP's geomorphologist identified that depositing dredged material in shallow water immediately west of the dredge site near Whiteness Sands would ensure the sediment is retained in the local sediment cell, thus providing environmental benefits. This suggestion is accepted and supported by NatureScot. The material would therefore be split between the Whiteness Sands B and C sea deposit sites, half within the shallow 0 m CD to -5 m CD section and the other half in deeper water, allowing for natural dispersal to take place and ensuring the natural processes whereby 50% of sand would naturally (in the absence of the navigation channel) go to Whiteness Sands. Dredging and bottom discharge would be quick and unlikely to limit the operations of the port as the dredging will be quickly completed. This also reduced the emissions and costs of the operation.

It should be noted that AP is considering carrying out further environmental studies to support the re-opening and expansion of the currently closed Whiteness Sands A sea deposit site (CR022). The sediment transport modelling carried out to date suggests that Whiteness Sands A would be most optimal location for the dredged material deposit

to ensure the material migrates to the desirable location within Whiteness Sands to coastal recharge. Before further studies are completed, only open sites are considered as an option for sea deposit of dredged material.

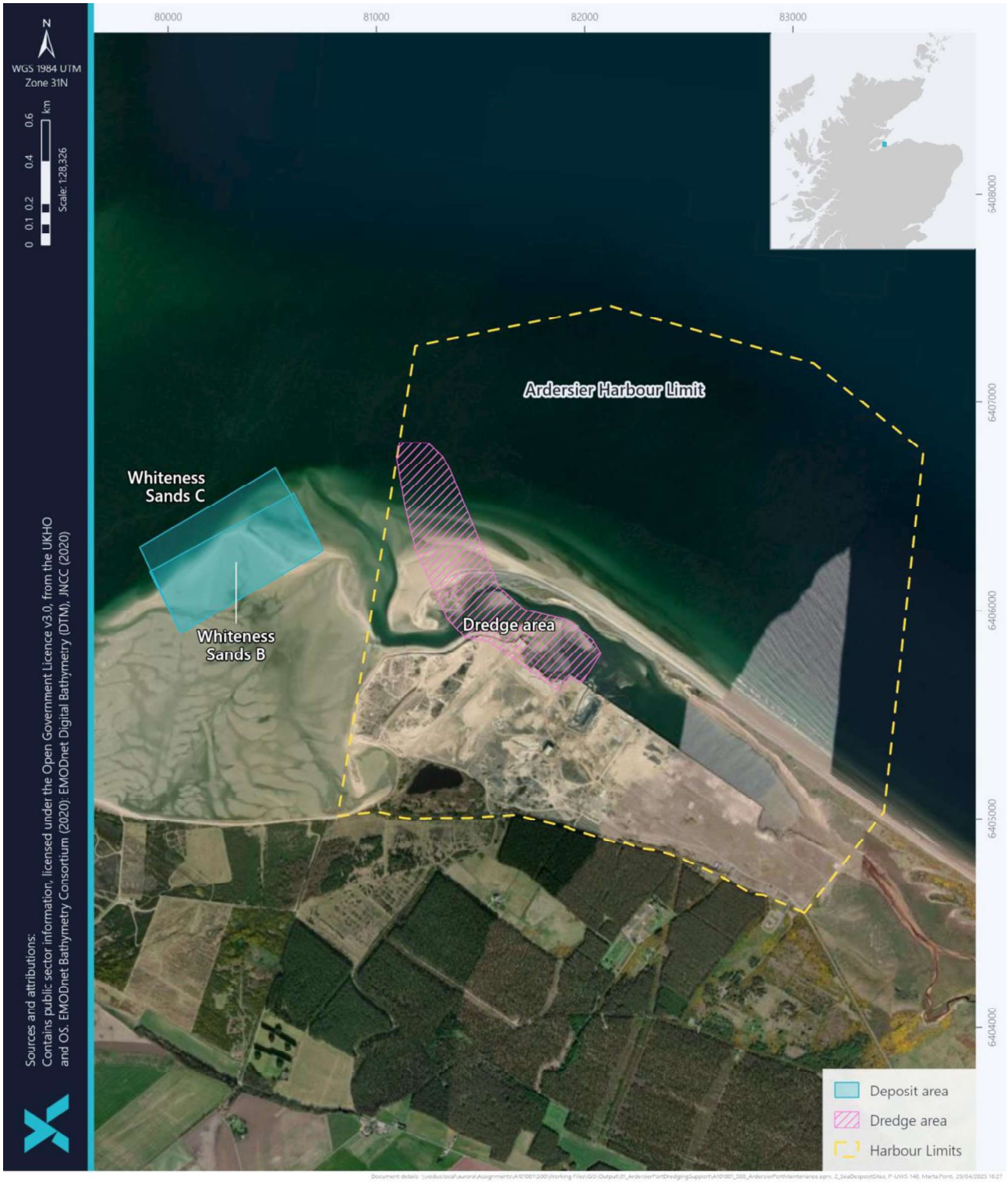

Figure 3-2 Whiteness Sands B and C designated sea deposit sites and the dredge area

4 BPEO EVALUATION

4.1 Selection of BPEO assessment criteria

In order to undertake an impartial and structured comparison of the various BPEO options, a weighted ranking system with a predefined set of assessment criteria was used. The criteria were selected specifically for use for Ardersier Port and the assessment is based on a four-module assessment. Each module contains a set of criteria (Table 4-1) and these were allocated equal. The four modules include:

- Practicability (25%);
- Health and safety (25%);
- Environmental Assessment (25%); and
- Cost assessment (25%).

Table 4-1 BPEO assessment criteria

CRITERIA	SPECIFICS
Environmental	Environmental impacts due to material handling and treatment
	Transport requirements
	Marine environmental impact
	Policy/legislative acceptability
	Public and stakeholder acceptability (including visual and amenity implications, business reputation and impacts on other marine users)
Practicability	Material space and weight requirements if stored
	Downtime/delay risk
	Requirement to treat/process material before use
	Commercial/equipment/technology availability, maturity and deployment speed
	Overall performance
Health and safety	Health and safety implications to personnel
	Health and safety implications to members of the public
	Navigation safety
Cost	Capital cost (e.g. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)
	Operating cost (£ per m^3), including treatment and handling costs

CRITERIA	SPECIFICS
	Additional risks or benefits to port
	Commercial value to port

Each module is broken down into a series of criteria, each with an equal ranking, which is fully presented in Appendix B. It should be noted that whilst each module may contain a different number of questions, because the average result for each module is calculated (by dividing the score by the number of questions) the effect of this variation in module criteria on the result (Section 4.3) is minimised. The criteria were developed by Xodus considering AP's experience with dredging operations, including costs for different options (Table 4-2).

Table 4-2 Costs of dredged material use options

COSTS (£) PER M3 OF DREDGED MATERIAL				
Option	Beneficial use - coastal replenishment/beach nourishment	Beneficial use - site profiling	Recycling - aggregate as a resource	Sea deposit
Dredging	3-5	4-6	3-5	3-5
Sea deposit	n/a	n/a	n/a	2-3
Pump ashore	6-9	6-9	6-9	n/a
Pipeline for beach recharge	5-10	n/a	n/a	n/a
Onshore handling from point of deposit	2	2	2	n/a
Profiling - on site or on beach	2	2	n/a	n/a
Total	18-28	14-19	11-16	5-8

4.2 Quantitative BPEO assessment

The full quantitative BPEO assessment is provided in Appendix A of this document. For each option, a relative score was allocated. These scores were used to calculate a proportionally weighted BPEO indicator (B_i) to produce a relative ranking of options to assist in the identification of the BPEO. The B_i was calculated using the following formula:

$$B_i = B_P + B_{HS} + B_{EA} + B_{EC}$$

Where

$$B_P = (SP/N)WP$$

$$B_{HS} = (SHS/N)WHS$$

$$B_{EA} = (SEA/N)WEA$$

$$B_{EC} = (SEC/N)WEC$$

- Bi = Overall BPEO indicator
- B_P = Practicability indicator
- B_{HS} = Health and safety practicability indicator
- B_{EA} = Environmental assessment indicator
- B_{EC} = Economic cost indicator
- S_P = Sum of assessment criteria scores for practicability
- S_{HS} = Sum of assessment criteria scores health and safety assessment
- S_{EA} = Sum of assessment criteria scores for environmental assessment
- S_{EC} = Sum of assessment criteria scores for economic cost
- N = Number of assessment criteria applied in each module
- W_P = Assessment module weighting for practicability (25%)
- W_{HS} = Assessment module weighting for health and safety (25%)
- W_{EA} = Assessment module weighting for environmental assessment (25%)
- W_{EC} = Assessment module weighting for economic cost (25%)

The B_i is relatively sensitive to the assessment module weight (hence the importance of correctly setting the module weight at the start of the BPEO process); however, sensitivity analysis of the scoring assured that the resulting outputs were representative.

4.3 BPEO assessment

The quantitative assessment of the different BPEO options is shown in Table 4-3. The quantitative assessment ranks the BPEO options as follows, with the highest index value indicating the overall best option:

- Beneficial use - coastal replenishment/beach nourishment – B_i = 3.58
- Beneficial use - site profiling – B_i = 3.69
- Recycling - aggregate as a resource – B_i = 3.26
- Sea deposit – B_i = 4.44

Taking the engineering and methodology practicability, environmental considerations, cost and health and safety into account as detailed in Appendix A, sea deposit of dredged material at sea deposit sites Whiteness Sands B and Whiteness Sands C is the BPEO.

Table 4-3 BPEO Assessment Results

CRITERIA	BEACH/COASTAL RECHARGE	ON-SITE REUSE IN REPROFILING OR AS CONSTRUCTION MATERIAL	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Practicability				
Additional space and weight requirements.	4	2	2	5
Downtime/delay risk/temporal restrictions	3	3	2	5
Requirement to treat/process material before use, i.e. suitability for deposit (e.g. change chemical and physical properties, desalination, drying)	4	2	2	5
Commercial/equipment/technology availability, maturity and deployment speed (including availability of vessels and facilities) e.g. if specific treatment is required	4	4	3	5
Performance (including discharge rate, excluding down time)	3	2	1	5
B_P ((Sum/N) x W) (W=25%) (N=5) **(2 decimal places)**	*0.90*	*0.65*	*0.50*	*1.25*
Health and Safety				
Personnel Safety Potential effect on injury and plant accident frequency	4	4	4	5
Health and safety implications to members of the public	4	5	4	5

CRITERIA	BEACH/COASTAL RECHARGE	ON-SITE REUSE IN REPROFILING OR AS CONSTRUCTION MATERIAL	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Navigation safety (eg. multiple vessels in close proximity, tight working areas)	4	4	4	5
B_{HS} ((Sum/N) x W) (W=25%) (N=3) (2 decimal places)	*1.0*	*1.08*	*1.00*	*1.25*
Environmental Assessment				
Further treatment or environmental impacts due to treatment	5	4	4	5
Transport requirements	3	3	1	4
Marine environmental impact	5	5	5	3
Policy/legislative acceptability	5	5	4	4
Public and stakeholder acceptability (including visual and amenity implications, business reputation and impacts on other marine users)	4	5	5	4
B_{EA} ((Sum/N x W) (W=25%) (N=5) (2 decimal places)	*1.10*	*1.10*	*0.95*	*1.00*
Cost Assessment				
Capital cost (£) (eg. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)	5	5	5	5
Operating cost to port (£ per m^3), including treatment and handling costs	1	2	3	4

CRITERIA	BEACH/COASTAL RECHARGE	ON-SITE REUSE IN REPROFILING OR AS CONSTRUCTION MATERIAL	OFFSITE USE/RECYCLING AS AGGREGATE OR CONSTRUCTION MATERIAL	DEPOSIT AT A SEA DEPOSIT SITE
Risk on port operations also benefit (money to be made?) third party involvement	3	3	3	5
Commercial value to port	2	2	2	1
B_{EC} *((Sum/N x W) (W=25%) (N=4)* (2 decimal places)	*0.69*	*0.75*	*0.81*	*0.94*
$B_I = B_P + B_{HS} + B_{EA} + B_{EC}$	3.69	3.58	3.26	4.44

4.4 Conclusion

This BPEO assessment was carried out to systematically identify the best option for the disposal of Ardersier Port's maintenance dredge material over three years of dredging. The BPEO assessment showed that considering the environmental, cost, practicability and health and safety of the different dredged material use options, sea deposit at the nearby Whiteness Sands B and C deposit sites is the best option. This assessment was largely driven by the proximity of these sea deposit sites to the dredge area, as well as the cost, transport and handling requirements of the other options assessment.

A marine licence application has therefore been prepared for submission to MD-LOT for dredging of up to 200,000 m^3 of material, with sea deposit at Whiteness Sands B and C deposit sites, over a three-year period. The environmental impacts from the dredging and sea deposit operations are assessed fully in the accompanying Environmental Appraisal (Xodus document no A-101001-S00-A-REPT-002.

5 REFERENCES

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APPENDIX A BPEO ASSESSMENT

Practicability (W = 25%)						Beach/coastal recharge	On-site reuse in reprofiling or as construction material	Offsite use/recycling as aggregate or construction material	Deposit at a sea deposit site
Criteria	1	2	3	4	5				
Additional space and weight requirements.	Major space & weight issues (e.g. storage of material)	High space & weight issues (e.g. storage of material)	Moderate space & weight issues (e.g. storage of material)	Low space & weight issues can be managed within existing layout	No space & weight issues	4	2	2	5
Downtime/delay risk/temporal restrictions due to selected method	Likely downtime risks or temporal restrictions	High downtime risks or temporal restrictions (weeks)	Moderate downtime risks or temporal restrictions (days)	Low downtime risks or temporal restrictions (hours)	No downtime or temporal restrictions	3	3	2	5
Requirement to treat/process material before use, i.e. suitability for deposit (e.g. change chemical and physical properties, desalination, drying)	Extensive treatment/processing required	High amount of treatment/processing required	Some treatment/processing required	Minimal treatment/processing required	No treatment/processing required	4	2	2	5
Commercial/equipment/technology availability, maturity and deployment speed (including availability of vessels and facilities) e.g. if specific treatment is required	Technology available in Europe or available within 5 years	Technology should be available within 3 to 5 years	Process at pilot trial stage	Can quickly be made available to port or recently implemented	Currently available to port, proven track record	4	4	3	5
Performance (including discharge rate, excluding down time)	Poor performance to date or significant uncertainty over performance. Very slow (e.g. discharge requires transportation elsewhere)	Mixed performance to date or slow discharge rate (e.g. via a pipeline)	Acceptable performance. and has potential to meet objective. Moderate discharge rate (e.g. rainbowing)	Sound performance. Performs consistently to meet objective. Quick but controlled discharge	Technology better than requirements of objective. Immediate and uncontrolled discharge (e.g. bottom dumping)	3	2	1	5
Health & Safety (W = 25%)						Beach/coastal recharge	On-site reuse in reprofiling or as construction material	Offsite use/recycling as aggregate or construction material	Deposit at a sea deposit site
Personnel Safety Potential effect on injury and plant accident frequency	Likely/expected injuries to occur	Occasional conditions may allow injuries to occur	Seldom/in exceptional conditions injuries may occur	Unlikely/reasonable to expect no injures to occur.	Negligible potential for increased illness or injury.	4	4	4	5
Health and safety implications to members of the public	Likely/expected injuries to occur	Occasional conditions may allow injuries to occur	Seldom/in exceptional conditions injuries may occur	Unlikely/reasonable to expect no injures to occur.	Negligible potential for increased illness or injury.	4	5	4	5
Navigation safety (e.g. multiple vessels in close proximity, tight working areas)	Severely restricted site with multiple vessels and trips	Highly restricted site with multiple vessels and trips	Seldom/in exceptional conditions navigation safety issues may arise	Unlikely/reasonable to expect no navigation safety issues due to small amount of vessel traffic and space available	Negligible navigation safety issues, minimal additional vessel traffic needed	4	4	4	5
Environmental Assessment (W = 25%)						Beach/coastal recharge	On-site reuse in reprofiling or as construction material	Offsite use/recycling as aggregate or construction material	Deposit at a sea deposit site

Further treatment or environmental impacts due to treatment	Unacceptable – waste to energy, incineration and/or treatment/disposal outwith UK	Additional treatment to separate waste, but still landfill required.	Further treatment via onshore centrifuge/incineration/solvent recycling process/composting within the UK	Minor waste generated during operation or further treatment/residual oil management within Scotland	Negligible wastes arising or additional onward transport.	5	4	4	5
Transport requirements	Major transport requirements, >50 km distance and multiple vessels and land transport options required	High transport requirements, 10-50 km, multiple vessels and/or land transportation option required	Moderate transport requirements, >10 km or multiple a vessel and land transportation required	Minimal/local transport requirements (< 2 km), using a single vessel	No transport requirements	3	3	1	4
Marine environmental impact	Persistent/ irreversible landscape scale environmental impact. With widespread impacts to sensitive environments and/or major water bodies	Localized, severe but reversible impact, medium-long term environmental impact. Marine environment is able to fully recover from the impact	Localized, short-medium term environmental impact. Marine environment is able to fully recover from the impact	Localized, short term environmental impact. Marine environment is able to fully recover from the impact or slightly benefit from the proposal	Low probability of any adverse environmental impact to the marine environment - potential for environmental benefits	5	5	5	3
Policy/legislative acceptability	Not in line with policies	Aligns poorly with policies	Acceptable alignment with policies	In line with policies but not top option	In line with all policies	5	5	4	4
Public and stakeholder acceptability (including visual and amenity implications, business reputation and impacts on other marine users)	Not acceptable, major and permanent adverse impacts	Low acceptability, long lasting major adverse impacts	Moderate acceptability, moderate duration and adverse impact	High acceptability, short duration and low adverse impacts, some benefits	Public support, negligible or temporary adverse impacts or added benefits	4	5	5	4
Cost Assessment (W = 25%)						**Beach/coastal recharge**	**On-site reuse in reprofiling or as construction material**	**Offsite use/recycling as aggregate or construction material**	**Deposit at a sea deposit site**
Capital cost (£) (e.g. requirement to purchase pipes or a vessel, new deposit site opening, treatment facility)	High >50000	Medium to high 15000-50000	Medium 5000-15000	Low <5000	No capital cost	5	5	5	5
Operating cost to port (£ per m^3), including treatment and handling costs	High >20	Medium to high 15-20	Medium 10-15	Low to medium 5-10	Low <5	1	2	3	4
Risk on port operations	Risk of stopping dredging	High risk of slowing down dredging (> 1 day additional time)	Medium risk of slowing down dredging (up to 1 day additional dredging time)	Low risk of slowing down dredging (up to half a day additional dredging time)	Slowing down dredging unlikely/limited	3	3	3	5
Commercial value to port	No value, only high costs to port	Limited value to port	+/- 0	Low commercial value - some costs recoverable or alternative use options to port	High commercial value internally or externally	2	2	2	1