

REPORT

Port of Dundee Capital Dredge and Improvement Works

Best Practicable Environmental Option Report

Client: Port of Dundee Limited

Reference: PC6550-RHD-XX-XX-RP-EV-0061

Status: Final/01

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1 Introduction

1.1 Purpose of this Document

Under the Marine (Scotland) Act 2010, Section 21(1), a Marine Licence issued by the Marine Directorate is required for the dredging and the deposit of substances or objects within waters adjacent to Scotland. Under Part 4, Section 27(2), the Marine Directorate has an obligation to consider the availability of practical alternatives when considering applications involving disposal of material at sea, in order to identify the best practicable environmental option. Applications for a Marine Licence to dispose of dredged material at sea therefore require a Best Practicable Environmental Option (BPEO) assessment, demonstrating that alternatives to sea disposal have been investigated in accordance with Scotland's Waste Hierarchy (**Figure 1-1**), as outlined in Scotland's circular economy and waste route map to 2030¹. Marine Licences for capital works are valid for the duration of the activities, to be specified in the Marine Licence application and agreed with the Marine Directorate.



Figure 1-1 Scotland's waste hierarchy²

This report has been produced in support of a Marine Licence application for the disposal of capital dredge material at sea as a result of the proposed deepening of the approaches and berth pockets to the Port of Dundee and a section of the Lady Shoal approach channel. It compares various options for the disposal of dredge material and identifies the BPEO.

1.2 Need for the Dredging and Disposal

One of the primary uses for the Port of Dundee is to service and support the offshore renewables industry. The port already provides facilities for the transshipment and storage of components, such as wind turbine

² Scottish Government (2024) Scotland's Circular Economy and Waste Route Map to 2030.

generators (WTGs) and other component parts associated with wind farm projects. Due to the increasing size of the components and vessels used by the offshore renewables industry, the Port of Dundee Limited is proposing to undertake dredging works at the Port of Dundee and Lady Shoal approach channel in order to be able to continue to accommodate the increasing needs of the offshore renewables industry.

1.3 Previous Dredge and Disposal Activities

In the early 1980s, spoil from maintenance dredging was deposited immediately upstream of the Tay Road Bridge. Subsequently, and during the 1990s, maintenance dredging and sea disposal was conducted by the Abbotsgrange, a trailer suction dredger owned by Forth Ports Limited. This vessel could not pass under the Tay Bridge and therefore a new spoil ground was selected approximately 0.5 km downstream of the bridge. The schedule of ongoing maintenance dredging activities was modified to a short period (typically three to six days) in early summer rather than dredging and depositing regular, smaller volumes throughout the year.

Since January 2001, Forth Ports Limited has contracted United Kingdom Dredging (UKD) for the majority of operations within the Firth of Tay and Firth of Forth. The UKD Marlin is a trailing suction dredger with a hopper capacity of 3,000m³.

BPEO assessments were undertaken in 2019 and 2023 for the disposal of capital and maintenance dredge material from the Port of Dundee. Both reports identified disposal at sea as the best option, with Middle Bank disposal site identified as the most suitable site. Three licences have been granted to Forth Ports Limited (maintenance dredge licences) or Port of Dundee Limited (capital dredging licence) by the Marine Directorate since 2020 for deposit of dredged material from the Port of Dundee to the Middle Bank disposal site. Details are shown in **Table 1-1**.

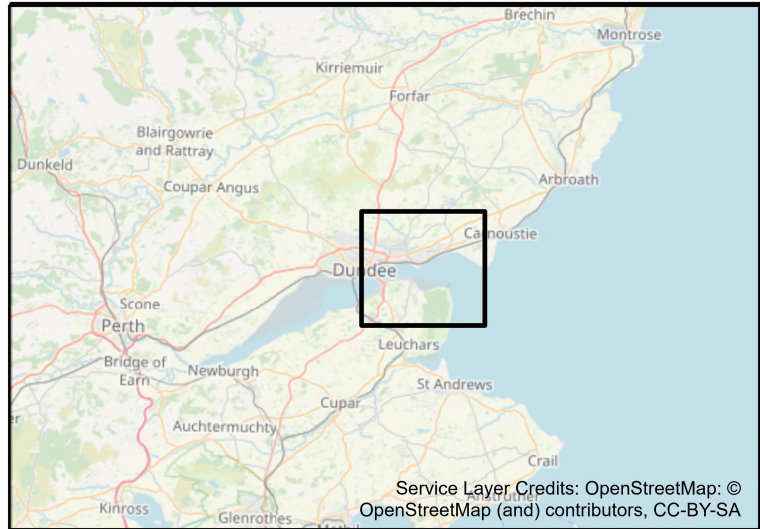
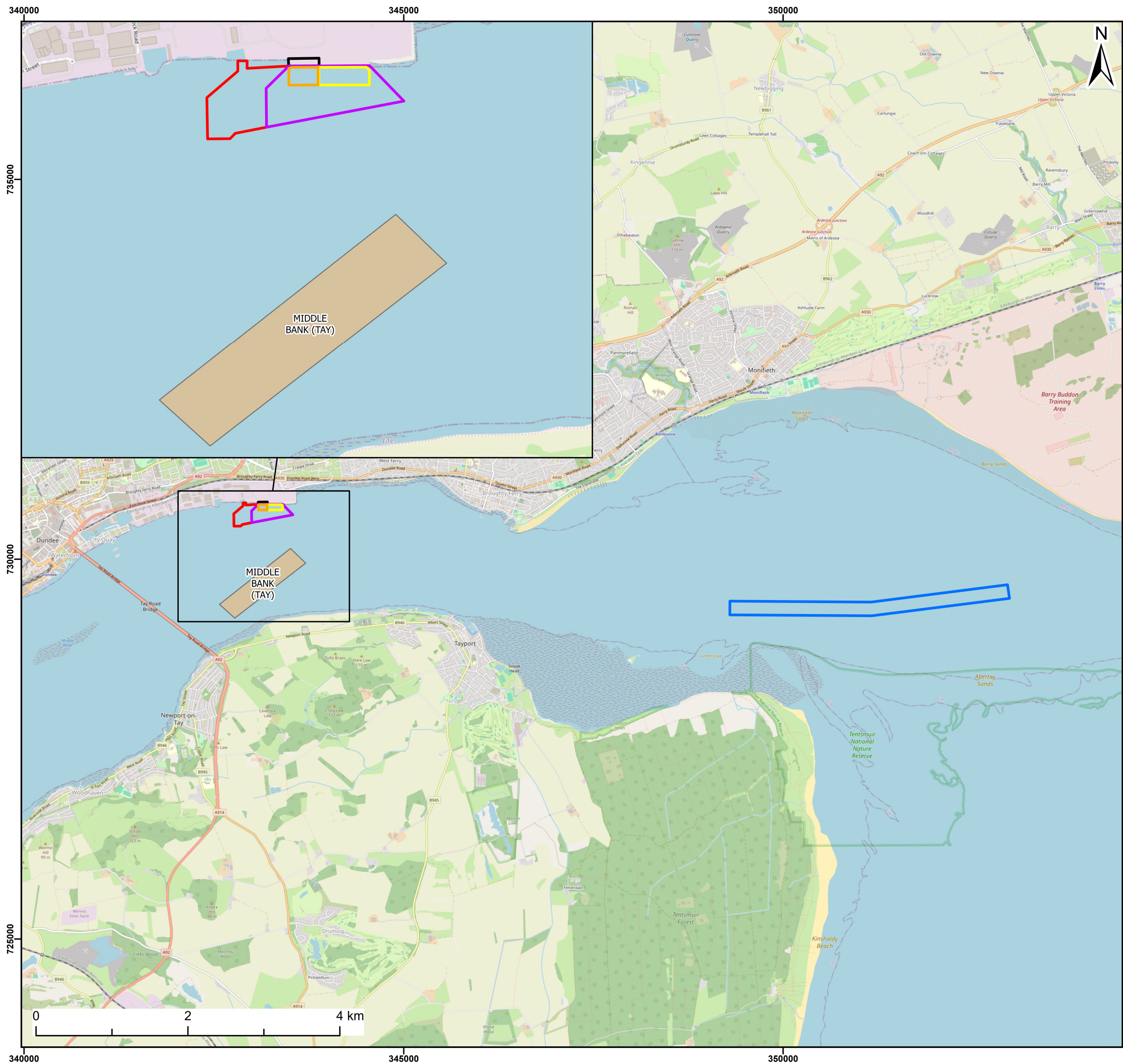
Table 1-1 Recent disposal licences granted for Port of Dundee to dispose of a Middle Bank disposal site

Licence Number	Dredge Type	Licensed Disposal Quantity	Validity Period	Quantity Disposed
MS-00008485	Capital	90,000 (WT in total)	Aug 2020 – June 2022	82,712 WT in total
MS-00008912/MS-00009072/MS-0000966	Maintenance	140,000 (WT per year)	Dec 2020 – Dec 2023	284,368 WT in total
MS-00010329	Maintenance	150,000(WT per year)	Dec 2023 – Dec 2026	127,491 WT in 2024

1.4 Proposed Dredging and Disposal Activities

The capital dredging works would be carried out as follows (see **Figure 1-2**, **Figure 1-3** and **Figure 1-4**, and **Table 1-2** Details of proposed dredge areas):

- Deepen the approach to DunEco Quay to -6m CD;
- Deepen the approach to Prince Charles Wharf (PCW) to -6.5mCD;
- Widen the PCW berth pocket to 70m and deepen to -9m CD;
- Extend the PCW (PCWE) berth pocket 200m to the east and deepen to -10m CD; and
- Deepen a section of the Lady Shoal Approach Channel to -6.5m CD.



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

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

Title:

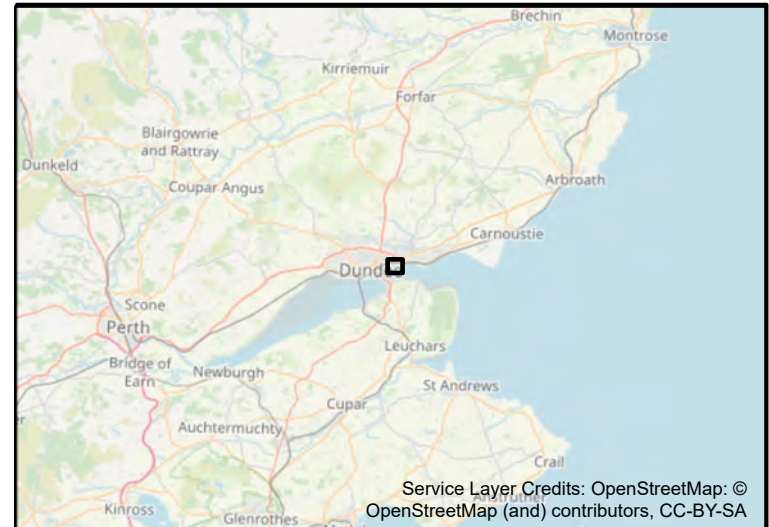
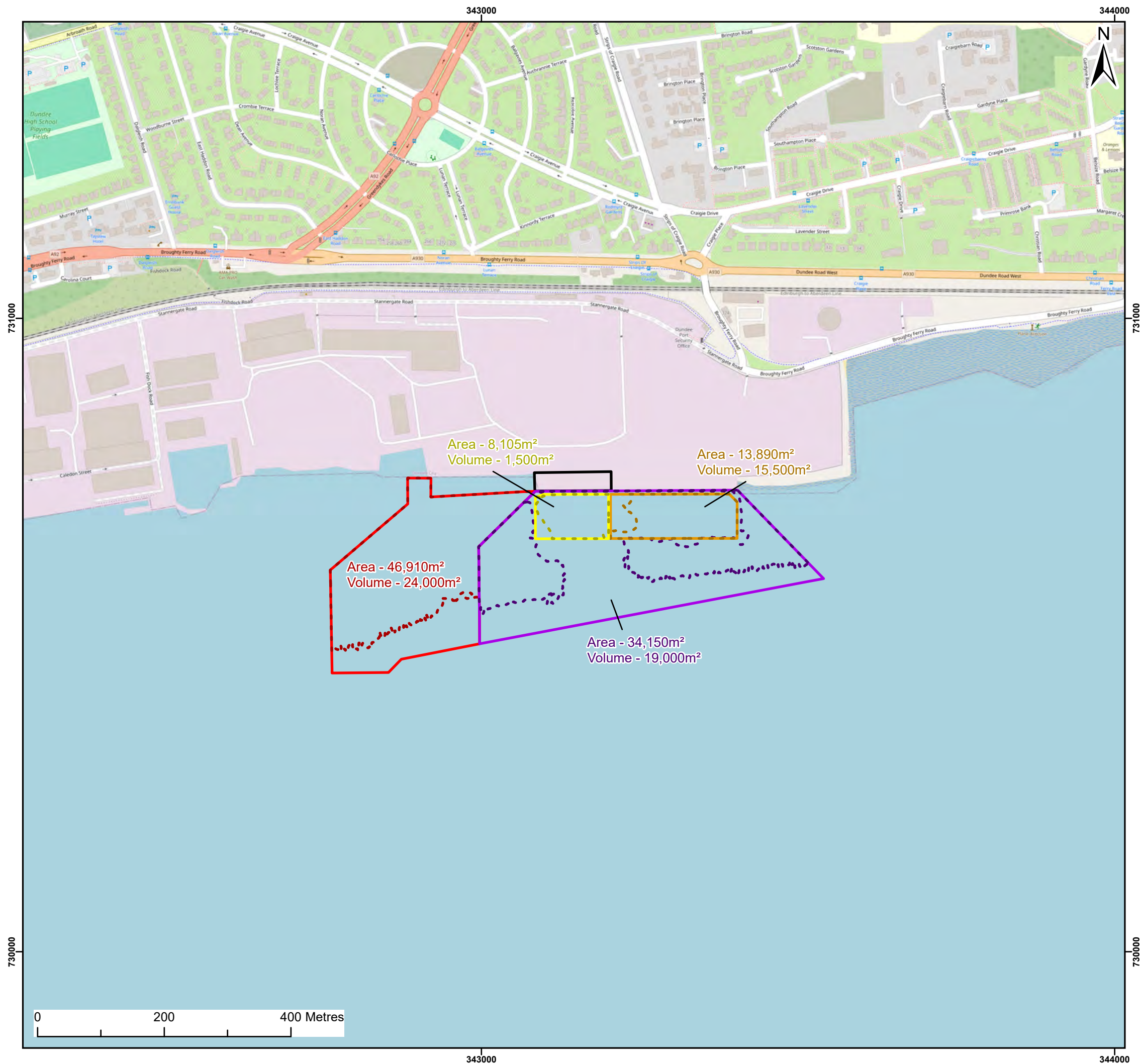
Location Plan showing the Proposed Development

Figure: 1-2 Drawing No: PC6550-RHD-XX-ZZ-DR-Z-0001

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	10/06/2025	JH	RG	A3	1:50,000
P01	10/12/2024	GC	RG	A3	1:50,000

Co-ordinate system: British National Grid





Legend:

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

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

Title:
Proposed Works at the Port of Dundee

Figure: 1-3		Drawing No: PC6550-RHD-XX-ZZ-DR-Z-0002			
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	10/06/2025	JH	RG	A3	1:6,000
P01	10/12/2024	GC	RG	A3	1:6,000

Co-ordinate system: British National Grid



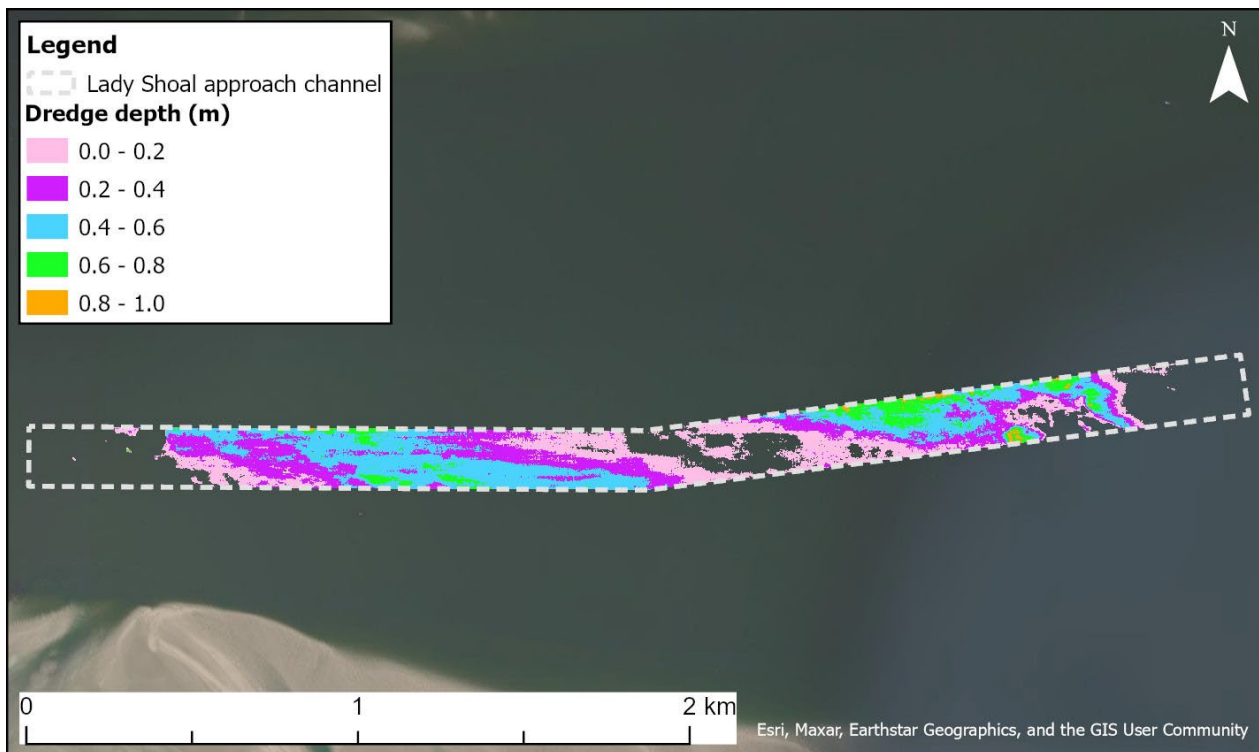


Figure 1-4 Lady Shoal Approach Channel dredge area

All dredging at the Port of Dundee, with the exception of a very small area in the south-west corner of the dredge footprint, is within the Port of Dundee Limited's licenced maintenance dredge area. The proposed dredging would generate approximately 60,000m³ of material (105,000m³ with an over-dredge allowance of 0.5m). The dredge depth would be between approximately 0.5m to 1m, and up to 2.5m within the berth pocket extension area. The dredge depth in the Lady Shoal Approach Channel would mostly be less than 1m and would generate approximately 160,000m³ of material (385,000m³ with an over-dredge allowance of 0.5m).

Total volume of dredged material would therefore be approximately 220,000m³ (490,000m³ with an over-dredge allowance of 0.5m). All dredging would be undertaken by back-hoe dredger, with the material being disposed of at the existing licenced Middle Bank disposal site using hopper barges. A summary of the proposed dredging can be seen in **Table 1-2**.

Table 1-2 Details of proposed dredge areas

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

Coordinates for the Port of Dundee and Lady Shoal dredge areas, and the Middle Bank disposal site are presented in **Table 1-3** and **Table 1-4**, respectively.

Table 1-3 Coordinates of the planned dredge areas

Dredge Area	Latitude	Longitude
Port of Dundee dredge area	56°27.923' N	-2°55.714' W
	56°27.923' N	-2°55.678' W
	56°27.907' N	-2°55.678' W
	56°27.913' N	-2°55.537' W
	56°27.913' N	-2°55.517' W
	56°27.865' N	-2°55.603' W
	56°27.783' N	-2°55.600' W
	56°27.769' N	-2°55.720' W
	56°27.757' N	-2°55.739' W
	56°27.756' N	-2°55.826' W
	56°27.844' N	-2°55.831' W
	56°27.901' N	-2°55.713' W
	56° 27.916' N	-2° 55.207' W
	56° 27.842' N	-2° 55.072' W
	56° 27.783' N	-2° 55.600' W
	56° 27.865' N	-2° 55.603' W
	56° 27.913' N	-2° 55.517' W
Lady Shoal approach channel dredge area	56°27.170' N	-2°49.450' W
	56° 27.267' N	-2°49.451' W
	56° 27.272' N	-2°47.642' W
	56° 27.406' N	-2°45.898' W
	56° 27.310' N	-2°45.871' W
	56° 27.175' N	-2°47.633' W

Table 1-4 Coordinates of the Middle Bank Disposal Site

Latitude	Longitude
56° 27.198' N	2° 55.998' W
56° 27.600' N	2° 55.098' W
56° 27.498' N	2° 54.900' W
56° 27.102' N	2° 55.800' W

1.4.1 Outline of Construction Programme

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

1.4.2 Maintenance Dredging

Hydrodynamic modelling undertaken to inform the Environmental Impact Assessment (EIA) predicted that there would be no substantial change in bed shear stress as a result of the Proposed Scheme and as such there is not anticipated to be any change in maintenance dredging effort required at the Port of Dundee, nor would any maintenance dredging be required at the Lady Shoal approach channel dredge area (see Chapter 7 of the EIA Report (EIAR) accompanying the Marine Licence application.

1.5 Description of Sediment to be Dredged and Disposed

In line with the Marine Directorate's guidelines on pre-dredge sampling protocol³, a site-specific sampling survey was undertaken in February 2025, during which sediment samples were collected for the following chemical and physical analyses:

- Trace metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn) and Organotins (TBT and DBT)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- ICES 7 Poly Chlorinated Biphenyls (PCBs); and
- Particle Size Analysis (PSA).

Sixteen vibrocores were collected from within the proposed dredge areas (sufficient for a dredge volume of up to 600,000m³), with sub-samples taken in accordance with Marine Directorate guidance. In total 35 samples were collected and sent to SOCOTEC for chemical and physical analysis. Results of the sediment analyses are presented in **Appendix A**. Historical sediment sampling results from previous surveys at the Port of Dundee are shown in **Appendix B**.

1.5.1 Historic sediment quality

Data on sediment quality from between 1989 and 2023 are summarised in **Table 1-5** and **Table 1-6** (ERM, 2023). Whilst average concentrations of metals were below AL1 for all but Hg and Pb (**Table 1-5**), concentrations did exceed AL1 for all metals except As and Cd. There were no exceedances of AL2.

Table 1-5 Historic metal concentrations from the Port of Dundee (mg/kg) 1989-2023

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

The mean concentration of TBT was reported to be <0.01044mg/kg between 2017 and 2023. Concentrations of ICES 7 PCBs were found to vary between 0.0019 and 0.240mg/kg between 1993 and 2023. Mean concentrations of PCBs were below AL1, save for one in 2000 with a concentration of 0.0240mg/kg. There were no exceedances of AL2 (ERM, 2023). A comparison of mean concentrations of PAHs from samples collected between 2006 and 2023 showed that PAH concentrations for the majority of individual PAHs were well above AL1 (**Table 1-6**); there is no AL2 for PAHs.

Table 1-6 PAH concentrations from the Port of Dundee (ug/kg) 2006-2023

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

³ Guidance for the sampling and analysis of sediment and dredged material to be submitted in support of applications for sea disposal of dredged material.

Metals and PCB concentrations recorded from the existing Middle Bank disposal site can be seen in **Table 1-7**.

Table 1-7 Metals and ICES 7 PCB congeners concentrations recorded from the Middle Bank Tay disposal site

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

1.5.2 Particle Size Analysis

PSA results show that the sediment to be dredged is highly variable and comprises mixed sediments with an average of 26.4% gravel, 43% sand and 30.7% silt (**Table A1**).

1.5.3 Metals

Although, concentrations of metals, Cd, Cr, Cu, Hg, Ni, Pb and Zn were found in some samples at levels marginally exceeding AL1, average levels across the dredge area did not exceed AL1. No samples exceeded AL2 (**Table A2**).

1.5.4 Polychlorinated Biphenyls

Levels of the sum total of ICES 7 PCB were found to be lower than AL1 in all samples but one. Average levels across the dredge area were well below AL1. No samples exceeded AL2 (**Table A3**).

1.5.5 Polycyclic Aromatic Hydrocarbons

Levels of all PAHs were found to be below AL1 for the vast majority of samples (**Table A4**). There is no AL2 for PAHs; however, an indication of potential toxicity of the levels recorded can be provided by applying the Canadian Interim Sediment Quality Guidelines (ISQG). Comparing PAH levels to the Canadian ISQGs, showed that the PAHs are well below the probable effects level (PEL), the level above which adverse effects may be expected in a wide range of organisms (see Chapter 8 of the EIAR accompanying the Marine Licence application).

2 Assessment of Available Disposal Options

The following disposal options have been reviewed:

- 1 Do nothing;
- 2 Construction fill;
- 3 Beach recharge / habitat creation;
- 4 Incineration;
- 5 Sacrificial landfill; and
- 6 Disposal to sea

The practicality for disposing the dredged material under each option is provided in the Sections below. Disposal options 2-5 above have land-based disposal components. Common steps associated with land-based disposal are:

- Landing – materials would need to be landed onshore from the dredging vessel. A significant area would be required to land the volumes of material to be dredged. This area does not exist at the Port of Dundee and therefore a new / alternative landing facility would be required.
- Storage - landed materials would need to be stored prior to onward transportation to the chosen disposal location. As above, this space does not exist at the Port of Dundee.
- Dewatering – dredged sediments have a high water content; therefore, dewatering would be required prior to onward transport or treatment. The water removed from the sediment would require containment and further sampling to avoid land contamination from the effluent. Depending on the disposal option employed, it may be necessary to further treat the dredged material such as separation of different sediment sizes, or removal of salt.
- Transport - dewatered / treated materials would need to be transported by road using HGVs to the chosen disposal site. The total volume of dredged material is anticipated to be approximately 490,000m³, which includes a 0.5m over dredge allowance, and which equates to around 686,000 wet tonnes (using on a conversion factor of 1.4 based on historical dredge records), or 548,800 tonnes when dewatered (assuming a 20% water content removed). Transportation of material from site to a disposal site would generate significant vehicle movements on local roads (>10,000 return journeys), contributing to traffic congestion, air and noise pollution with associated carbon emissions. Transporting materials to disposal sites will also involve additional financial cost.
- Treatment - Drying the dredge material would not reduce the concentration of metals, 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 dredge 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 fine sediment fraction (approximately 31% of the total volume of material to be dredged) has some contamination from metals and PAHs.
- 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.

2.1 Do Nothing

As described in **Section 1.2**, the proposed dredging and disposal is required to ensure that the Port of Dundee can continue to accommodate the increasing needs of the offshore renewables industry; therefore, the Do Nothing option is not a viable option and has been discounted.

2.2 Construction Fill

Consideration has been given to the use of dredged sediments for construction fill on-site as well as at potential off-site construction locations. This option involves the need for landing, drying and transportation of the dredged material as discussed above.

The material to be dredged has an average of around 31% fine grained particles (silt/clay) mixed with gravel and sand, the dredged material is considered unacceptable as construction fill due to the associated time dependent settlement that would occur and would require additional engineered ground improvement works, such as the addition of concrete. Additionally, the sediments are mixed across samples regardless of depths. As such, the dredged material is not considered suitable to be used as construction fill and this option has been discounted.

2.3 Beach Recharge / Habitat Creation

This option includes use of dredged sediments for beach recharge, either deposited directly by the dredging vessel, or dewatered and deposited by construction plant. Ideally, using dredged materials for beach restoration / recharge would generate a purpose for the material that benefits a local amenity. Beach restoration requires materials of a similar composition to the existing beach materials and usually involves clean sand or gravel. On average, the dredged sediments are made up of 26% gravel, 43% sand and 31% silt/clay. The heterogenous nature of the sediment, as well as its silt content, is likely to make it unsuitable for beach recharge. Additionally, a review of the Angus and Fife Shoreline Management Plans^{4,5} did not identify any requirement for beach recharge.

The dredged material has the potential to be used for habitat creation / enhancement schemes, such as creating intertidal mudflat habitat or saltmarsh restoration; however, no opportunities for the use of the dredged material for this purpose have been identified within the Tay and Eden Estuary through a desk based search, including a review of consultation responses received for the 2023 maintenance dredge BPEO⁶. The saline content of the dredged material would make it unsuitable, without significant pre-treatment, for use in terrestrial habitat creation projects.

In light of the above, this option has been discounted.

2.4 Incineration

This process would involve landing the dredged material, dewatering, storing and transportation to an incinerator. The residual incineration ash would then require disposal. Options for disposal of ash include landfill, reclamation and spreading on agricultural land. The dredged material consists broadly of non-combustible material (gravel, sand and silt) with a high-water content. The organic content of the dredged material is low, ranging from 0.05 to 1.37%. 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 threshold⁶.

In light of the above, this option has been discounted.

2.5 Landfill

This option would require transporting the dredged material from the dredge site to a suitably licensed landfill site with sufficient capacity. As detailed above, several dewatering and treatment processes would likely need to be undertaken to make the dredged material suitable for landfill disposal. It is likely that the dredge material would be classed as hazardous or non-hazardous waste rather than inert; however, additional testing would be required to ensure that the material meets the requirements of the waste carrier and waste facility.

⁴ CH2M (2016) *Angus Shoreline Management Plan SMP2*.

⁵ Mouchel (2011). *Fife Shoreline Management Plan*.

⁶ Forth Ports (2023). *Port of Dundee Maintenance Dredge Disposal: Marine Licence Application 2023*.

Operational landfill sites, according to the SEPA Waste Site Capacity Tool⁷, in the vicinity of the Port of Dundee are listed in **Table 2-1**. This demonstrates that there are currently no operational landfill sites in the vicinity of the Proposed Scheme with the landfill classification or capacity to accept the dredged materials.

Table 2-1 Operational landfill sites within 30 miles of Port of Dundee

Site Name	Local Authority	Landfill Type	Annual Capacity	Remaining Lifetime Capacity (as of Dec 2024)	Distance from Port of Dundee
Border Quarry Landfill	Angus	Inert	24,999 tonnes	341,723 tonnes	20 miles
Ardownie Landfill	Angus	Inert	75,000 tonnes	943,240 tonnes	5 miles
Hatton Mill Landfill	Angus	Inert	75,000 tonnes	1,823,535 tonnes	23 miles
Lower Melville Woods	Fife	Non-hazardous	282,500 tonnes	112,408 tonnes	19 miles

In light of the above, this option has been discounted.

2.6 Disposal to Sea

This option involves the transportation and disposal of dredge materials to a licensed marine disposal site, and does not require the landing or dewatering of any materials. The dredger, or support barge(s), transits to a licensed disposal site and releases the materials through bottom doors or a split hull. To ensure even distribution of material across the disposal site and at the correct depths, 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.

There is one open disposal site, Middle Bank (FO028), in the Firth of Tay 600m, from the Port of Dundee. The Newcome Buoy disposal site between the Port of Dundee and the Lady Shoal dredge areas, is shown by Cefas as disused⁸. The current maintenance licence for the Port of Dundee permits the disposal of up to 150,000 wet tonnes of dredged material per year at Middle Bank Dredge Spoil Deposit Site (licence MS-00010329 from 2023-2026) and therefore this is an established and effective practice. While the proposed dredge volume is greater than previous deposits, the results of the deposition modelling (see Chapter 7 of the EIA report accompanying the marine licence application) have shown that deposition will remain predominantly within the bounds of the disposal site and at depths no greater than 0.4m.

Through consultation on previous capital and maintenance dredges NatureScot and Crown Estate Scotland stated their support for disposal at the Middle Tay disposal site⁶.

This option has been taken forward for further consideration.

2.7 Summary of Options

Table 2-2 presents the summary of the options appraisal process.

Table 2-2 Short-listing of disposal options

Option	Assessment	Result
Do nothing	Under the Do Nothing approach, the Port of Dundee would be unable to facilitate future renewable energy industry vessels.	Not taken forward

⁷ SEPA (2025) Waste Capacity Tool. <https://informatics.sepa.org.uk/WasteSiteCapacity/>

⁸ CEFAS (2025). UK Disposal Site Layer

Option	Assessment	Result
Construction fill	Use of dredged material as construction fill would not be appropriate because of the high proportion of fine sediments in the dredged materials.	Not taken forward
Beach recharge / habitat creation	No known sites available near the Proposed Development that require material for beach restoration or habitat creation.	Not taken forward
Incineration	Dredged material is unsuitable for incineration due to the low organic content and high water content.	Not taken forward
Landfill	A significant level of treatment would be required prior to disposal to landfill. There are no suitable landfill sites in the immediate vicinity of the proposed development that could cope with a relatively large volume of material.	Not taken forward
Disposal at sea	This option does not require additional treatment of the dredged material, nor is there a significant transport requirement due to the closeness of disposal sites. This is an established practice.	Taken forward

3 Assessment of Shortlisted Disposal Options

Only one option has been taken forward to the shortlist: disposal at sea. This option is further assessed using the following parameters:

- Practicability – is the option technically and operationally practicable?
- Availability of site – is there an available site within the vicinity of the project that can accommodate the materials?
- General acceptability – would the public object to or support the option?
- Environmental effects – is the option compliant with existing regulations?

3.1 Acceptability of the Shortlisted Disposal Option

The parameters have been evaluated on a scale of acceptability from low to high as shown in **Table 3-1**.

Table 3-1. Definition of acceptability

Options	High	Medium	Low
Practicability	Easy to complete with little or no difficulty.	Some difficulty involved in implementation.	Significant difficulty encountered.
Availability of site	Suitable site easily accessible within 1 km by road and 5 km by sea and thus significantly reducing the travel distance involved.	Suitable site available within 5 km by road and 10 km by sea from project site.	No suitable site available within the vicinity and thus more than 5 km by road and 10 km by sea.
General acceptability	High general acceptability by members of the public.	Not likely to cause negative or positive reactions from the public.	Will potentially cause negative reactions from the public.
Environmental effects	Compliant with regulations and thus would be accepted by regulating agencies.	Partially compliant with regulations and thus would require further development of option.	Not compliant with regulations and thus requires re-development of option.

3.2 Disposal at Sea – Option Acceptability

3.2.1 Practicability

Disposal at the Middle Bank disposal site is straightforward and does not require the landing, storage and drying of the spoil. All the necessary procedures are understood and routine for the Port of Dundee.

Acceptability: High

3.2.2 Availability of Site

The Middle Bank disposal site is only 600m from the Port of Dundee dredge area and approximately 5.5km from the Lady Shoal approach channel dredge area.

Acceptability: High

3.2.3 General Acceptability

Dredging and disposal operations would not affect members of the public. The only possible exception to this could relate to the activities of some recreational users when the vessel is depositing material at the disposal site; however, this is an existing activity and will be managed by the Port of Dundee as the Statutory Harbour Authority. No concerns have been raised in consultations for previous maintenance and capital dredge licences at the Port of Dundee which entailed disposal at the Middle Bank disposal site.

Acceptability: High

3.2.4 Environmental Effects

Sediment dispersion modelling, presented in Chapter 7 of the EIAR accompanying the marine licence application, has shown that even for the worst case scenario, deposition of sediments were primarily restricted to within the dredge areas and disposal site. At the Port of Dundee, the modelling predicted that sediment deposition was contained within the Port of Dundee area, predominantly in close proximity to the quay wall and remained below 0.1m. At the disposal site, the modelling predicted that sediment was deposited in patchy areas, extending outside of the disposal site bounds by up to 150m. Inside the disposal site area, most patches of deposition remained below 0.4m. The few patches of deposition outside the disposal site area remained below 0.3m. The Lady Shoal approach channel dredge area indicates small patches of sediment deposition, predominantly at the eastern side, which remain below 0.1m. In a dynamic estuary environment, this is not considered likely to have any significant environmental effects.

Increases in SSC as a result of disposal would be short term, returning to baseline levels within 30 minutes. The chemical analysis of the dredge material has indicated that contaminant levels within the sediment are within levels that the disposal site as accepted previously and that it is suitable for offshore disposal.

A full assessment of environmental impacts of the proposed disposal of the dredged material is provided in the EIAR accompanying the marine licence application.

The location and proximity of the disposal site within the Tay Estuary, means that disposal of dredged material at this location could be considered as local placement or sustainable relocation, retaining the

material within the local system rather than removal from the estuary through land based disposal. This is generally considered to be good practice⁹.

Acceptability: High

4 Identification of the BPEO

For the reasons explained in **Section 2** and **Section 3**, disposal to sea is considered to be the only practicable disposal option. Disposal at sea will keep the dredged material within the local system, thereby maintaining the sediment budget, and feeding the existing mudflat habitats within the wider area. The preferred disposal site is the Middle Bank disposal site.

⁹ Manning, W.D., Scott, C.R and Leegwater, E. (eds) (2021). *Restoring Estuarine and Coastal Habitats with Dredged Sediment: A Handbook*. Environment Agency, Bristol, UK.

Appendix A: Analyses of Sediment to be Disposed

A1 Particle Size Analysis

Table A1 Particle Size Analysis

Sample ID	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)
DP01 (ES1)	0	74.5	8.16	25.6	66.24
DP01 (ES2)	0.7	80.4	54.97	33.19	11.84
DP02 (ES1)	0	83.4	53.83	37.98	8.19
DP03 (ES1)	0	78.3	37.62	16.97	45.41
DP03 (ES2)	0.6	78.3	20.65	61.24	18.12
DP03 (ES3)	1.15	67.9	3.18	32.29	64.53
DP04 (ES1)	0	59.4	4.09	34.01	61.9
DP04 (ES2)	0.8	72.5	16.33	35.73	47.94
DP05 (ES1)	0	84.1	24.57	45.13	30.29
DP05 (ES2)	0.5	84.5	27.63	49.53	22.84
DP05 (ES3)	1	84.5	17.47	50.9	31.63
DP05 (ES4)	1.35	86.5	34.49	43.05	22.46
DP06 (ES1)	0	80.1	3.7	77.71	18.58
DP06 (ES2)	0.5	77.3	19.1	42.68	38.22
DP06 (ES3)	1	79.2	33.73	41.81	24.46
DP06 (ES4)	1.2	80.4	18.83	62.42	18.75
DP07 (ES1)	0	77.6	39.33	27.52	33.14
DP07 (ES2)	1	83.9	35.43	41.65	22.92
LS01 (ES1)	0	83.4	48.92	33.21	17.87
LS01 (ES2)	0.5	60.6	7.42	56.26	36.32
LS02 (ES1)	0	83.5	47.64	34.96	17.4
LS02 (ES2)	0.9	80.8	8.35	88.22	3.43
LS03 (ES1)	0	85.3	61.14	9.75	29.11
LS03 (ES2)	0.5	80	0	12.23	87.77
LS04 (ES1)	0	81	1.42	12.2	86.37
LS04 (ES2)	0.65	80.4	3.56	10.23	86.21
LS05 (ES1)	0	88.6	52.01	34.12	13.87
LS05 (ES2)	0.5	82.3	1.13	84.49	14.38

Sample ID	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)
LS06 (ES1)	0	85.5	32.33	49.25	18.42
LS06 (ES2)	0.4	84.2	23.43	53.96	22.61
LS07 (ES1)	0	82.6	32.53	48.41	19.06
LS08 (ES1)	0	81.1	34.65	55.17	10.17
LS08 (ES2)	0.9	74.9	23.18	71.89	4.93
LS09 (ES1)	0	83.4	34.9	52.12	12.98
LS09 (ES2)	0.5	83.1	57.2	37.75	5.05
Average	0.4	79.8	26.40	42.96	30.67

A2 Metals

Table A2 Metal contaminants (mg kg⁻¹) (blue shading indicates values above AL1)

Sample ID	Sample depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
DP01 (ES1)	0	4.6	0.06	16	5.2	<0.01	12.2	4.3	26.7	<0.001	<0.001
DP01 (ES2)	0.7	9.4	0.07	29.2	8.9	<0.01	22.1	4.4	50.7	<0.001	<0.001
DP02 (ES1)	0	6.4	0.13	31.2	11.4	0.03	28.4	5	37.8	<0.001	<0.001
DP03 (ES1)	0	11	0.12	33.9	10.4	<0.01	24.8	8.8	53.8	<0.001	<0.001
DP03 (ES2)	0.6	4.3	0.05	17.1	5.1	<0.01	12.9	4.2	29.1	<0.001	<0.001
DP03 (ES3)	1.15	4.9	0.07	20.8	6.2	<0.01	15.7	5.2	34.6	<0.001	<0.001
DP04 (ES1)	0	8.5	0.14	32.7	10.9	<0.01	23.7	8.4	55.5	<0.001	<0.001
DP04 (ES2)	0.8	4.5	0.06	14.7	4.3	<0.01	11.3	3.6	24.2	<0.001	<0.001
DP05 (ES1)	0	6.4	0.07	27.5	9.9	<0.01	21.3	4.5	33.6	<0.001	<0.001
DP05 (ES2)	0.5	6.8	0.12	21.9	11.6	<0.01	18.7	5.6	31.7	<0.001	<0.001
DP05 (ES3)	1	5.8	0.09	28.6	22.3	<0.01	25.6	4	37.1	<0.001	<0.001
DP05 (ES4)	1.35	5.7	0.1	27.3	8.9	<0.01	21.5	4.8	32.9	<0.001	<0.001
DP06 (ES1)	0	4.2	0.08	31.8	76.2	<0.01	14.7	17.9	313	<0.001	0.002
DP06 (ES2)	0.5	5.7	0.1	31.7	70.6	0.02	16.3	25.6	249	<0.001	0.002
DP06 (ES3)	1	6	0.1	35.1	87.9	<0.01	15.4	27	283	<0.001	0.001
DP06 (ES4)	1.2	6.1	0.09	33.5	85	0.08	16.4	20.6	230	<0.001	0.002
DP07 (ES1)	0	7.1	0.1	31.1	14.7	0.03	25.4	8.4	49.6	<0.001	<0.001
DP07 (ES2)	1	6	0.09	20.9	11.1	<0.01	18.9	6.2	35.3	<0.001	<0.001
LS01 (ES1)	0	4.9	0.05	14.8	6.8	<0.01	12.5	6.4	27.7	<0.001	<0.001

Sample ID	Sample depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
LS01 (ES2)	0.5	5.1	0.08	17.8	6.4	<0.01	14.9	5.8	28.3	<0.001	<0.001
LS02 (ES1)	0	6.3	0.09	20.9	8.1	0.02	15	7.8	37.4	<0.001	<0.001
LS02 (ES2)	0.9	3	0.06	16.7	7.6	0.04	14.5	4	22.8	<0.001	<0.001
LS03 (ES1)	0	7	0.13	43.8	22.3	0.02	44.1	8.3	57.5	<0.001	<0.001
LS03 (ES2)	0.5	7.6	0.12	39	20.2	<0.01	36.4	7.9	51.1	<0.001	<0.001
LS04 (ES1)	0	11	0.13	53.9	26.8	<0.01	55.8	10.7	69.4	<0.001	<0.001
LS04 (ES2)	0.65	6.3	0.16	44.7	24.7	<0.01	46	9.1	67.4	<0.001	<0.001
LS05 (ES1)	0	7	0.05	12.1	5.5	0.03	11.9	10.6	23.8	<0.001	<0.001
LS05 (ES2)	0.5	2	0.1	20.3	10.1	<0.01	19	4.3	27.5	<0.001	<0.001
LS06 (ES1)	0	6.5	0.05	13.9	6.5	0.03	13.2	6.5	33.1	<0.001	<0.001
LS06 (ES2)	0.4	4.4	0.1	30.5	17.5	<0.01	27.9	8.9	48.9	<0.001	<0.001
LS07 (ES1)	0	13.3	0.09	19.7	12.2	<0.01	18.4	6.2	34.9	<0.001	<0.001
LS08 (ES1)	0	3.5	0.08	18.8	12.4	<0.01	16.2	4.5	25.4	<0.001	<0.001
LS08 (ES2)	0.9	2.2	0.06	16	7.2	<0.01	13.6	3.8	20.5	<0.001	<0.001
LS09 (ES1)	0	7.2	0.06	15.9	9.4	<0.01	14	5.3	32.4	<0.001	<0.001
LS09 (ES2)	0.5	7.4	0.06	10.9	6.1	<0.01	9.8	3.9	20.6	<0.001	<0.001
Average	0.4	6.2	0.09	25.6	19.1	<0.01	20.8	8.1	63.9	<0.001	<0.001

A3 Polychlorinated Biphenyls (PCBs)

Table A3 ICES 7 PCB congeners results (ug/kg)

Sample ID	Sample depth (m)	ICES7
DP01 (ES1)	0	<0.56
DP01 (ES2)	0.7	<0.56
DP02 (ES1)	0	<0.56
DP03 (ES1)	0	<0.56
DP03 (ES2)	0.6	<0.56
DP03 (ES3)	1.15	<0.56
DP04 (ES1)	0	<0.56
DP04 (ES2)	0.8	<0.56
DP05 (ES1)	0	3.22
DP05 (ES2)	0.5	<0.56

Project related



Sample ID	Sample depth (m)	ICES7
DP05 (ES3)	1	<0.56
DP05 (ES4)	1.35	<0.56
DP06 (ES1)	0	41.46
DP06 (ES2)	0.5	0.65
DP06 (ES3)	1	0.6
DP06 (ES4)	1.2	0.57
DP07 (ES1)	0	<0.56
DP07 (ES2)	1	<0.56
LS01 (ES1)	0	0.58
LS01 (ES2)	0.5	<0.56
LS02 (ES1)	0	0.78
LS02 (ES2)	0.9	<0.56
LS03 (ES1)	0	<0.56
LS03 (ES2)	0.5	0.58
LS04 (ES1)	0	<0.56
LS04 (ES2)	0.65	<0.56
LS05 (ES1)	0	<0.56
LS05 (ES2)	0.5	<0.56
LS06 (ES1)	0	<0.56
LS06 (ES2)	0.4	0.58
LS07 (ES1)	0	<0.56
LS08 (ES1)	0	<0.56
LS08 (ES2)	0.9	<0.56
LS09 (ES1)	0	<0.56
LS09 (ES2)	0.5	<0.56
Average	0.4	1.49

A4 Polycyclic Aromatic Hydrocarbons (PAHs)

Table A4 Results of PAH analysis (ug/kg) (blue shading indicates values above AL1)

Station	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BENZGHIIP	BKF	CHRYSENE	DBENZAIIH	FLUORANT	FLUORENE	INDPYR	NAPTH	PHENANT	PYRENE	THC
DP01 (ES1 - 0.00m)	5.54	<1	<1	<1	<1	1.36	1.99	<1	<1	<1	1.52	2.03	<1	3.76	3.42	1.81	10,300
DP01 (ES2 - 0.70m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.67	1.97	<1	5,320
DP02 (ES1 - 0.00-0.30m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.03	1.7	<1	4,460
DP03 (ES1 - 0.00m)	<1	<1	1.41	6.28	9.83	9.04	8.18	8.11	8.64	1.31	12.7	<1	7.42	4.28	5.47	13.7	3,910
DP03 (ES2 - 0.60m)	<1	<1	<1	<1	<1	<1	1.5	<1	<1	<1	<1	2.04	<1	2.82	2.95	<1	7,680
DP03 (ES3 - 1.15m)	2.02	<1	<1	<1	<1	2.47	1.89	<1	2.25	<1	2.83	2.22	<1	4.43	5.89	3.42	12,300
DP04 (ES1 - 0.00m)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	14.4	13.1	<5	29,700
DP04 (ES2 - 0.80m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.41	3.55	1.64	7,640
DP05 (ES1 - 0.00m)	<1	<1	<1	1.48	1.9	2.65	3.82	1.96	3.74	<1	1.99	3.82	1.33	3.78	9.39	2.65	8,590
DP05 (ES2 - 0.50m)	<1	<1	<1	1.5	1.95	2.98	3.21	1.3	3.22	<1	1.92	2.44	1.48	4.48	6.89	2.48	7,090
DP05 (ES3 - 1.00m)	<1	<1	<1	1.95	2.26	3.09	4.61	1.72	2.62	<1	2.62	1.6	1.57	4.71	6.58	3.28	3,380
DP05 (ES4 - 1.35m)	<1	<1	<1	<1	<1	1.19	1.91	<1	1.5	<1	<1	1.49	<1	3.97	3.95	1.68	6,370
DP06 (ES1 - 0.00m)	4.02	3.78	9.6	30.9	35	32.2	19.5	29.6	35.4	3.19	63.7	6.94	16.4	6.98	38.5	78.4	33,400
DP06 (ES2 - 0.50m)	4.82	2.25	6.35	16.6	17.8	20.1	13.3	18.9	18.9	1.64	30.8	5.41	11.2	17.1	18	51.7	41,500

Station	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BENZHIP	BKF	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PHENANT	PYRENE	THC
DP06 (ES3 - 1.00m)	2.39	17.1	41	84.7	124	83.2	72.6	79	85.5	12.6	208	11.2	69.5	18.3	69.2	249	41,500
DP06 (ES4 - 1.20m)	109	560	2270	1600	1190	926	562	1080	1940	178	7820	489	402	368	5100	8630	114,000
DP07 (ES1 - 0.00m)	<1	<1	1.43	2.7	3.47	5.44	8.28	4.08	4.55	<1	3.88	2.98	3.29	5.93	9.43	5.91	20,900
DP07 (ES2 - 1.00m)	<1	<1	<1	1.3	1.3	1.95	2.55	1.25	2	<1	1.77	1.68	1.04	4.02	4.85	2.04	7,820
LS01 (ES1 - 0.00m)	4.25	1.47	1.35	3.79	4.77	6.98	4.92	5.47	4.61	<1	7.07	2.01	4.36	2.83	4.55	8.15	25,600
LS01 (ES2 - 0.50m)	<1	1.48	1.99	4.57	5.87	8.73	9.8	3.85	6.92	<1	5.66	7.73	4.74	11	18.5	8.2	35,700
LS02 (ES1 - 0.00m)	4.32	4.7	11	27.5	34.5	44.4	31.5	30.1	27.7	5.52	35	8.32	28.5	23.5	26.3	50.6	49,000
LS02 (ES2 - 0.90m)	<1	<1	<1	<1	<1	<1	<1	<1	1.21	<1	<1	2.24	<1	4.73	4.58	<1	7,290
LS03 (ES1 - 0.00m)	<1	<1	1.2	2.17	2.62	2.72	2.07	3.24	2.92	<1	3.52	1.7	1.64	5.91	4.84	6.55	11,100
LS03 (ES2 - 0.50m)	<1	<1	<1	2.13	2.54	3.98	3.42	1.52	4.18	<1	3.27	2.69	1.44	5.39	10.1	5.47	4,490
LS04 (ES1 - 0.00m)	<1	<1	<1	<1	<1	1.47	<1	1.89	2.14	<1	1.53	2.17	<1	7.83	5.97	2.58	5,320
LS04 (ES2 - 0.65m)	<1	<1	<1	1.1	<1	1.47	1	<1	2.48	<1	1.39	3.41	<1	6.64	6.38	2.37	8,480
LS05 (ES1 - 0.00m)	<1	<1	<1	1.6	1.56	2.26	1.33	1.85	2.85	<1	2.47	4.09	1.31	12.4	8.02	3.01	15,700
LS05 (ES2 - 0.50m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.25	<1	4.03	3.15	<1	3,250
LS06 (ES1 - 0.00m)	4.5	1.04	1.3	2.3	3.16	4.16	3.5	3.99	2.96	<1	4.38	2.12	2.89	4.4	4.78	5.15	14,600

Station	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BENZHIP	BKF	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PHENANT	PYRENE	THC
LS06 (ES2 - 0.40m)	<1	<1	<1	1.71	1.4	2.82	3.03	1.9	3.17	<1	4.95	1.76	1.22	3.13	5.69	5.63	10,200
LS07 (ES1 - 0.00-0.30m)	<1	2.08	3.52	8.55	11.4	15.4	16.9	18.1	11.2	2.16	14.5	4.27	13.7	8.33	12.5	17.2	25,700
LS08 (ES1 - 0.00m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.69	1.39	<1	4,400
LS08 (ES2 - 0.90m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.05	<1	<1	4,720
LS09 (ES1 - 0.00m)	<1	1.76	1.32	1.86	2.31	2.1	2.44	2.14	4.12	<1	4.84	5.69	1.86	14.2	11.6	4.81	14,700
LS09 (ES2 - 0.50m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.45	<1	5.67	5.35	<1	5,080
Average	4.51	14.6	55.1	42.7	35	28.6	19.2	28.6	51.3	5.7	191	14.1	14.5	14.4	126	213	13,720

Appendix B: Historical Sample Results

Table B1. Average Metal Contaminants from the Port of Dundee (mg kg⁻¹) 1989 to 2023⁶ (blue shading indicates values above AL1)

Year	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1989	7.7	0.3	51.1	54	0.3	26.7	66.6	176.8
1990	3.6	0.2	25.5	25.3	0.2	21.9	52.8	76.5
1992	20.4	0.5	36	30.7	0.4	25.5	46.9	125
1993	7.1	0.2	23.2	25.9	0.2	29.1	42.9	99.5
1994	2.3	0.1	34.4	36.6	0.3	31.8	55	110.9
1995	10.6	0.1	27.5	25.6	0.2	28.8	33	90.4
1996	4.1	0.2	29.5	46.1	0.3	29.6	56.3	144.5
1997	6.3	0.3	35.6	50.8	0.2	23.9	193.8	250.3
1998	7.8	0.2	32.5	25	0.2	61	35.3	128.6
2000	10.1	0.3	41.8	28.6	2.8	27.8	46.6	146
2002	10.4	0.4	44.6	26.8	0.2	30.3	47.4	118.2
2006	9.1	BDL	39.3	17.5	0.1	25.9	28.7	83.1
2007	10	0.2	43.9	21.6	0.1	28.6	34.5	91.9
2011	11.2	0.2	43.4	19.4	0.1	26.6	37.7	101.5
2017	13	0.172	60.5	28.2	0.1	34.6	31.9	143.1
2020	11.69	0.25	66.37	23.46	0.13	27.9	29.1	103.6
2023	10.53	0.21	41.4	21.13	0.13	27.73	27.45	89.44

Table B2 Mean PAH levels (µg/kg) from Port of Dundee samples between 2006 and 2023⁶ (blue shading indicates values above AL1).

Station	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BENZHIP	BKF	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PHENANT	PYRENE
2006 (Mean)	ND	ND	33	125.5	175.8	NR	169.5	NR	144	ND	239	16.6	186.7	465.2	143.2	233.3
2007 (Mean)	ND	ND	14.1	49.9	63.2	NR	56.1	NR	59	ND	94.2	6.8	62.4	183.3	58.2	91
2011 (Mean)	ND	ND	32	117.1	147.5	NR	147.5	NR	136.8	ND	214.8	19.6	160.7	418.7	130.1	201.5
2017 (Mean)	13	4	29	65	79	NR	90	NR	67	20	139	15	97	21	89	136
2019 (Mean)	18	39.9	59.4	279.7	347.5	NR	218.2	NR	272.5	42.5	516.5	25.2	225.3	57.3	87.1	587.3
2020 (Mean)	12.1	12.1	23.7	70.2	93.2	NR	93	NR	79.9	17.5	129.7	14.3	94.7	20.9	80	133.6
2023 (Mean)	17	12	40.8	94.1	119.2	NR	120.2	NR	98.7	21.1	187.7	20.2	131.6	25.3	138.1	184.9