Crail Harbour
Best Practicable Environmental Options (BPEO) Report

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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

EnviroCentre Limited is registered in Scotland under no. SC161777.

VAT no. GB 348 6770 57.

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1 INTRODUCTION

Fife Council appointed EnviroCentre Ltd to complete a Best Practicable Environmental Option (BPEO) assessment to inform proposed maintenance dredging at Crail Harbour. The assessment has been informed using sediment quality results from sampling undertaken in February 2024.

The previous licence (reference: 07251/20/0) expired on 23rd June 2021. Fife Council is seeking to renew the licence for maintenance dredging works, which are proposed to be undertaken in August 2026.

The proposed dredge volumes are summarised in Table 1-1:

Table 1-1: Proposed (Estimated) Dredge Volumes

Dredge Area	Dredge Depth (mCD)	Proposed Dredge Quantity (m^3)	Estimated Dredge Wet Tonnage
Crail Dredge Area	-1.0	1,500	2,700

An estimated quantity of 2,700 wet tonnes (~1,500 m^3)[1] is proposed to be dredged across the area shown in Drawing No. 783694-GIS005, in Appendix A.

The purpose of the sample analysis is to provide supporting information to the Marine Directorate during the licensing process on sediment quality within the proposed dredge area to assess the suitability for Water Injection Dredging (WID) or sea-based disposal, should that be identified as a viable option. The dredging and disposal activities are regulated by the Marine Directorate under the Marine (Scotland) Act 2010. The licensing conditions require representative samples to be collected and the nature (*i.e.* physical composition), quality and contamination status to be determined.

The results of the February 2024 sediment analysis will then be used to compare the BPEO for each of the available potential disposal options for the dredged materials.

1.1 Scope of Report

The following report details the sampling methodology, field and laboratory analysis and provides a summary of the sediment quality present within the proposed dredge area.

The report will then use the available sediment analysis results to compare the BPEO for each of the available potential disposal options for the dredged materials. The options which are not considered to be practicable are rejected and the reasons for doing so are explained.

Those options which are practicable are examined in detail and assessed against the following considerations:

- Environmental;
- Strategic; and
- Cost.

The report then compares the practicable disposal options and draws a conclusion on the BPEO.

[1] Assumed Bulk Density 1m^3 = 1.8 tonnes.

1.2 Action Levels – AL1 vs AL2

Two action levels are currently used to assess the suitability of sea-based disposal of dredged sediment material: Revised Action Level 1 (RAL1) and Revised Action Level 2 (RAL2).

Sediment with contaminant concentrations below RAL1 is generally considered to be below background levels for contamination and is suitable for disposal at sea.

For samples between RAL1 and RAL2, additional risk assessment may be required including further sampling and testing to fully identify pockets of contamination or implementation of bioassays to assess the materials suitability for sea disposal.

Material above RAL2 is generally considered to be unsuitable for disposal to sea. If the sea disposal route is to be pursued, further testing along the lines of bioassay accompanied by a robust justification for selecting sea disposal as the BPEO may be required. This would need to be supported further with additional information regarding any mitigation measures which could be put in place as part of these works. This would require further discussion and agreement with the Marine Directorate.

1.3 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

2 SAMPLING LOCATIONS AND METHODOLOGY

Sampling works (comprising collection of grab samples from four locations) were undertaken on the 6th February 2024, as per the Sampling Plan agreed with the Marine Directorate Licensing Operations Team (MD-LOT). The following section details the sampling methodology used to retrieve sediment samples.

2.1 Sample Locations

Grab sediment samples were collected from four locations across the dredge area. Sample station locations are outlined in Table 2-1. The sample station locations are broadly the same as the previous sediment sampling campaign.

Table 2-1: Sample Locations Crail Harbour – February 2024

Sample Station ID	Easting	Northing	Latitude	Longitude
Grab A	361163	707378	56°15.43805’	-2°37.70817’
Grab B	361187	707410	56°15.45556’	-2°37.68518’
Grab C	361179	707377	56°15.43755’	-2°37.69191’
Grab D	361211	707383	56°15.44077’	-2°37.66152’

Sample station locations are shown in Drawing No. 783694-GIS006, in Appendix A.

2.2 Survey Vessel

Sampling was undertaken from a Pioner Multi (safety boat), owned and operated by Coastworks.

2.3 Navigation and Sample Location

Pre-determined sample station locations were programmed into a Trimble TDC600 GPS device. The vessel was manoeuvred on to position using the GPS. Upon successful recovery of sample, the location was logged on the GPS device before moving to the next location.

2.4 Sample Collection

Grab samples were collected at all locations to obtain sediment surface material. All grab samples were collected by a 0.045m^2 stainless steel Van Veen grab sampler. Recovered material was emptied into a plastic bucket prior to sub-sampling. Where required, the grab was deployed multiple times to ensure sufficient material was recovered for testing where required.

2.5 Sampling Constraints and Deviation from Sampling Plan

The Grab A sampling position was re-located slightly north of the proposed location due to recovering quantities of seaweed and no sediment at the original location.

2.6 Field Information

The following field data was recorded for each sample obtained:

- A unique sample ID;
- Sample location;
- Sample coordinate in latitude and longitude in degrees, minutes and decimals of minutes;
- Date, time and depth of collection;
- Sampler's ID;
- Sediment description;
- Sample photographs; and,
- Details of any deviation from sampling protocol.

2.7 Sample Preparation

Grab samples were photographed and logged prior to sub-sampling.

Samples for metals and particle size analysis were sub-sampled using a plastic spoon and stored in plastic tubs. Samples for organic analysis were collected using stainless steel spoons and stored in amber glass jars.

Sampling equipment (spoons etc.) were cleaned with fresh water between samples to minimise the risk of cross contamination.

Once samples had been placed within appropriate containers, they were labelled and placed immediately into cool boxes. Samples were frozen as soon as practicable prior to being dispatched to the project laboratory (Socotec Marine) on 8th February 2024.

2.8 Analysis Requirements

The laboratory analysis required by the Marine Directorate (MD-LOT), and undertaken as part of this investigation, was as follows:

- Metals – Arsenic (As), Chromium (Cr), Cadmium (Cd), Copper (Cu), Mercury (Hg), Nickel (Ni), Lead (Pb), and Zinc (Zn);
- Tributyl Tin (TBT);
- Polycyclic Aromatic Hydrocarbons (PAHs) – USEPA 16;
- Polychlorinated Biphenyl (PCBs) – ICES 7;
- Total Hydrocarbons;
- Asbestos Screen; and
- Particle Size Distribution.

Samples were sent to the Socotec Marine Laboratory for analysis, which holds UKAS accreditation.

3 RESULTS

The following section details sample results. Sediment sample logs are provided in Appendix B. The laboratory certificates are provided in Appendix D and a summary sheet highlighting exceedances above the RALs in Excel format accompanies this report in the submission to the Marine Directorate.

3.1 Physical Analysis

3.1.1 Particle Size Analysis (PSA)

The Particle Size Analysis dataset for each sample is given in Table 3-1.

Table 3-1: Particle Size Analysis Data

Sample ID	Gravel % (>2 mm)	Sand % (>63 µm<2 mm)	Silt % (<63 µm)
Grab A	23.61	**59.17**	17.22
Grab B	1.61	42.34	**56.05**
Grab C	8.96	**63.16**	27.88
Grab D	2.26	45.06	**52.69**
Average PSA	9.11	52.43	38.46

Note: PSA value with greatest % content per sample is highlighted in bold.

Particle size within Grab A and Grab C were primarily noted to comprise sand sized particles. The proportion of sand in all samples ranged from 42.34% to 59.17%.

Particle size within Grab B and Grab D samples were primarily noted to comprise silt sized particles. Across all samples, the proportion of silt ranged from 17.22% to 56.05%.

Particle size within Grab A had larger quantities of gravel than silt. The remaining samples contained negligible gravel content.

Average gravel, sand and silt particle percentages sizes are provided to represent the dredge area as a whole.

3.2 Chemical Analysis

3.2.1 Chemical Analysis Assessment Criteria

All chemical analysis results were assessed against Revised Action Levels (RAL) criteria as adopted by Marine Directorate. The results are summarised below. Summary reports detailing exceedances in the Marine Directorate format have been submitted along with the supporting information for the application. The laboratory certificates are provided in Appendix D.

Where contaminants have RALs as adopted by Marine Directorate, exceedances above these criteria are summarised in Table 3-2, along with the maximum concentration recorded for each parameter.

Table 3-2: Exceedances of Revised Action Levels

Contaminant	No. of Exceedances (of 4 samples)		Maximum Concentration (mg/kg) and Location
	RAL 1	RAL 2	
PAH (All Species)	4	N/A	0.148 (Fluoranthene) & 0.148 (Pyrene) at Grab B
THC	3	N/A	244 (Grab B)

3.3 Asbestos

No Asbestos was identified within any of the samples obtained.

3.4 Chemical Results Summary

All four samples recorded at least one PAH species above RAL1. Grab A, Grab B, and Grab D recorded THC results above RAL1.

No exceedances above RAL1 were recorded for metals, PCBs or TBT within the obtained samples.

Note that on the results provided in the Marine Directorate Excel form, a formatting error means that all samples are incorrectly shown as being in exceedance of RAL2 for dibutyltin (DBT).

No results were recorded which exceeded RAL 2, where an action level is available.

4 DISCUSSION OF AVALIABLE DISPOSAL OPTIONS

The BPEO process is geared towards identifying a preferred overall strategy from the perspective of the environment, as opposed to detailed optimisation of any one selected scheme. It is a structured and systematic process to identify and compare strategic options and transparent manner. Alternatives are evaluated in terms of their projected implications for the environment together with consideration of practicability, social and economic issues as well as within a wider strategic context.

The key stages of a BPEO are:

- Identification of options;
- Screening of options;
- Selection of assessment criteria;
- Analysis and evaluation of criteria; and
- Evaluation of BPEO.

Further details on methodology are provided within each section.

4.1 Identification of Available Disposal Options

A number of options are available for disposal of dredged sediments. The options considered are provided in Table 4-1 along with justification for screening out those options which have not been taken forward for further consideration.

Table 4-1: Initial Best Practicable Available Options

Location	Options	Screening Assessment	Carry forward?
Coastline	Leave in Situ	Not an option due to the requirements to maintain depth to allow vessels to access and berth in the harbour.	No
	Infilling of an existing dry dock/harbour facility (Re-use)	No current or proposed dock/harbour infilling projects are known within a reasonable distance of the dredge site. In addition, given the relatively small volume of sediment to be dredged (~1,500 m^3), it is most likely that this would not be a sufficient amount of material to complete any infilling project and would provide only a small part of the total amount of sediment that would be required. Once material is brought on to land it falls under the jurisdiction of SEPA. Further geotechnical and chemical testing would likely be required before it is permitted for use on any such development.	No
	Beach Nourishment	While sediments with high sand content are suitable for beach replenishment, material with a high silt content are not generally considered suitable. Material sampled and analysed from the site are noted to consist predominantly of silt with smaller fractions of sand and gravel. Typically, the material used in replenishment projects needs to be of a similar nature i.e. grain size proportions similar to that of the receiving beach. Much of the Forth coastline are designated sites (SSSI, SPA) and hold both national and international importance to nature conservation. Specific beach nourishment projects would need to be supported by Environmental Assessments to inform how the project could affect the environment as a result of disturbance to the intertidal area, changes to the sediment levels, the variable composition and quality of the material and measures devised from the assessment outcomes to minimise impacts on the environment.	No
Land	Landfill Disposal	This is possible but it is unlikely that this option will offer a long-term solution due to lack of space at landfills, with other waste types likely to be prioritised. Landfill space is currently at a premium and does not offer a sustainable solution either financially or environmentally for the disposal of dredged arisings. Dredged material is likely to require treatment first in a dewatering facility. Significant cost associated with set up of dewatering facility at the quayside plus transportation and additional costs associated with gaining the necessary planning and regulatory consents.	No
	Land Incineration	The dredged material consists of non-combustible material (silts, sands, gravels, shells) with a low combustible component.	No

Location	Options	Screening Assessment	Carry forward?
	Application to Agricultural Land	The dredged material would need to be treated to reduce salt concentrations to acceptable levels. Would require detailed chemical analysis and assessment as well as an Environmental Authorisation from SEPA. Would require special precautions during spreading in relation to the risk of odour and watercourses / aquifers. Disposal of sediments in this manner would potentially have a detrimental effect on existing terrestrial habitats.	No
	Recycling	Recycling of dredged material is theoretically possible, however, due to the varied lithology there would need to be either segregation during dredging works, or energy and water rich processing on land. EnviroCentre have not been made aware by the harbour authority of an established disposal and reuse route in the Forth at present. In addition, given the relatively small volume of sediment, and the logistics involved, this unlikely to be a cost-effective option.	No
Sea	Water Injection Dredging (WID)	WID offers several sediment-disposal advantages over traditional dredging followed by sea disposal, as primarily the technique relies on natural hydrodynamic forces rather than mechanical excavation and transport. Unlike conventional dredging, which requires sediments to be removed, loaded into barges or pipelines, and transported to designated sea-disposal sites, WID fluidises the seabed sediment into a near-bottom density current that remains close to the bed and is carried away by gravity, tides, and natural water flows, thereby eliminating the need for a dedicated disposal area. The WID approach significantly reduces the operational footprint by avoiding the handling, movement, and double-handling of dredged materials, which are major contributors to fuel consumption, project cost, and environmental disturbance in traditional dredging campaigns. By keeping the sediment within the existing marine system, WID supports more sustainable sediment management practices and avoids the ecological impacts associated with sea disposal, such as increased turbidity and benthic habitat disturbance. Furthermore, its reduced vessel movements and lower fuel requirements contribute to decreased project emissions and overall environmental impact.	Yes
	Aquatic disposal within intertidal area.	While WID is to be explored, it is not clear yet whether the equipment regionally available would be able to enter into Crail Harbour due to the size of the harbour, and a backup plan may be required to facilitate the dredge and disposal. Historically, the material has been excavated landside and dredged material placed out with the harbour wall on rocks to enable natural dispersal of material through wave action in subsequent tidal cycles all under marine licence.	Yes

4.2 Summary of Identified BPEO Options

Following review of the available options, two options were identified for further detailed BPEO assessment which are as follows:

- WID; and
- Disposal within intertidal area.

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

4.2.1 Water Injection Dredging

WID provides several advantages because it does not require sediment to be excavated, transported, or disposed of at sea. Instead, it keeps sediment within the existing system, using natural hydrodynamic forces. There are environmental and cost saving benefits to using the WID method. NatureScot have previously stated in discussion that their preference is to retain sediment within local sediment transport cells where possible, which this method would help facilitate.

4.2.2 Disposal within Intertidal Area

Subject to agreement with MD-LOT, the fall-back position would be disposal of sediment within the intertidal area for dispersal as per previous marine licences. This would entail the use of an excavator on land removing the material from the harbour and placing it with an excavator within the intertidal area as detailed on the appended drawing CRAIL 2020 with the historic Deposit Site, Crail Harbour located at 56 ° 15.460’ N, 02 ° 37.622’ W (Appendix A). This option would only be pursued should the WID not be viable due to access constraints.

5 FURTHER CONSIDERATION OF REMAINING DISPOSAL OPTIONS

5.1 Detailed BPEO Assessment

Each of the identified options was assessed against the criteria detailed in Table 5-1 below.

Table 5-1: BPEO Detailed Assessment Criteria

Primary Criteria	Description and Attributes
Strategic	• Operational aspects, including handling, transport etc. • Availability of suitable sites/facilities • General Public/local acceptability • Legislative Implications • Summary of the outcome of consultation with third parties
Environmental	• Safety Implications • Public Health Implications • Pollution/ Contamination Implications • General Ecological Implications • Interference with other legitimate activities e.g. fishing • Amenity/Aesthetic Implications
Costs	• Operating costs e.g. labour, site operations, • environmental monitoring • Capital *e.g*. Transport, equipment hire

5.1.1 BPEO Strategic Assessment

Table 5-2 below provides details of the strategic assessment for the option taken forward for the detailed BPEO assessment:

Table 5-2: BPEO Strategic Assessment

Criteria	Water Injection Dredging	Disposal within Intertidal Area
Operational Aspects (inc. handling and transport)	WID avoids the need for mechanical excavation, lifting, and vessel-based transport of material because the sediment is fluidised in situ and transported horizontally by gravity, tides, and natural currents. This means no double-handling, no barge transport, and no requirement for disposal-site transfers, significantly reducing operational effort and equipment movements. WID therefore eliminates the major cost and workload associated with transporting dredged material to placement locations, which is a dominant component of conventional dredging operations.	There would be limited double handling of the dredged material. Transportation to the disposal site would be by excavator and placed directly.

Criteria	Water Injection Dredging	Disposal within Intertidal Area
Availability of suitable sites/ facilities	WID does not require designated marine disposal sites, as the technique keeps sediment within the existing water system by enabling it to settle in deeper or naturally depositional areas. Sediment is mobilised only within the local hydrodynamic regime, avoiding dependence on licensed disposal grounds or confined disposal facilities. This makes WID particularly suitable where traditional sea disposal capacity is limited or where regulatory constraints restrict open-water disposal practices.	Deposition of material at Deposit Site, Crail Harbour 56 ° 15.460' N 02 ° 37.622' W has previously been accepted by MD-LOT and successfully used historically by Fife Council.
General Public / Local Acceptability	WID is generally regarded as an environmentally favourable and low-impact method, producing less turbidity and ecosystem disturbance than traditional excavation and sea disposal operations. Because the technique uses natural processes, avoids sea disposal, and requires fewer vessel movements, the overall visibility and disturbance to local communities is reduced. This often leads to improved public and stakeholder acceptability, especially in environmentally sensitive or high-traffic port areas.	Previously accepted disposal route for dredged material with limited public impact.
Legislative Implications	Can be licensed through normal licencing process subject to meeting key criteria.	Would need to be agreed with MD-LOT.

5.1.2 BPEO Environmental Assessment

Table 5-3 details the environmental assessment for the option taken forward for the detailed BPEO assessment.

Table 5-3: BPEO Environmental Assessment

Criteria	Water Injection Dredging	Disposal within Intertidal Area
Safety Implications	WID involves minimal material handling, as sediment is fluidised in-situ and transported horizontally by natural hydrodynamic forces rather than excavated, lifted, or relocated using barges. This reduces manual handling, lifting risks, and vessel-to-vessel transfer operations compared with traditional dredging, where the majority of safety risk arises during transport and placement activities. WID operations are undertaken using standard marine plant procedures and remain compliant with standard health and safety legislation.	Low amount of material handling required as it is directly placed at the disposal site. Work would be undertaken in accordance with H&S legislation.
Public Health	Public exposure pathways are limited as WID does not involve transporting or offloading	Low potential for human contact during dredging and disposal

Criteria	Water Injection Dredging	Disposal within Intertidal Area
	dredged material at sea or on land, thereby significantly reducing opportunities for human contact with sediments or its operations. The fluidised sediment layer remains close to the seabed and disperses naturally within the water column before settling in deeper areas, which further limits the potential for exposure.	operations. Once deposited at disposal site pathways for human contact greatly reduced.
Pollution/ contamination	As WID retains sediment within the existing system rather than exporting it to a sea disposal site, it reduces pollution risks associated with handling, transport, and sea disposal. WID creates a near-bed density current that minimises turbidity and restricts sediment dispersion to predictable pathways, lowering the risk of contaminant mobilisation into the wider water column. Importantly, WID also avoids emissions from transporting dredged material to sea disposal sites, thereby lowering the project's carbon footprint.	Pollutant concentrations in dredged material to be disposed are limited to acceptable levels through regulatory licensing processes.
General Ecological Implications	WID is considered an environmentally favourable method, as it limits disturbance to benthic habitats compared with traditional dredging and sea disposal. Turbidity generation is lower than with excavation-based methods, and sediment is retained within the local system, supporting natural sediment transport processes rather than creating artificial deposition at licensed sea disposal grounds. This reduces ecological pressure on protected sites where traditional disposal operations might otherwise occur.	The impact to ecology is considered to be limited given the anticipated relatively small footprint of placed material.
Interference with other legitimate activities	WID generates a smaller operational footprint than conventional dredging and disposal campaigns. With no barge transport or offshore placement runs required, there is significantly less interaction with shipping lanes, fishing activity, or navigational routes. The technique relies on a single, highly manoeuvrable dredging vessel, reducing congestion and the likelihood of interference. Standard navigational controls (such as Notices to Mariners) remain sufficient to manage any residual risks.	It is not anticipated that the placement of the material would interfere with other activities. There would be a period where material was visible on the rocks, but it is expected to disperse reasonably quickly over subsequent tidal cycles.
Amenity / Aesthetic Implications	WID typically results in fewer visible and audible impacts for harbour users and nearby communities. As no barges or disposal vessel convoys are required, noise, visual intrusion, and odour are significantly reduced compared with traditional dredging followed by offshore disposal. Any temporary effects are confined to the presence and operation of the WID vessel within the	Some potential for temporary visual / odour / noise effects while marine plant is in the harbour. However, no significant additional visual/ odour/noise effects following disposal at the proposed site.

Criteria	Water Injection Dredging	Disposal within Intertidal Area
	harbour, with no subsequent disposal phase impacts occurring offshore or nearshore.	

5.1.3 BPEO Cost Assessment

Costs were assessed for each of the options taken forward for detailed BPEO assessment. The BPEO assessment considered the typical costs associated with dredging, transportation to the disposal site (where applicable) and methods employed to protect the environment for each of the identified options.

For the purposes of comparing costs associated with each option a benchmark of 2,700 tonnes (~1,500 m^3)[1] of dredged material has been set.

Table 5-4 provides details on the Cost assessment for each option taken forward for detailed BPEO assessment:

Table 5-4: BPEO Cost Analysis (based on 2,700 tonnes)

Activity	Water Injection Dredging	Sea Disposal Within Intertidal Disposal Area
Dredging	£ 20,100	£ 35,000

The costs above have been obtained from recent tendering processes by the Council. The cost for placement in intertidal area is based on previous costs for this method so may be more expensive taking inflation into account.

5.1.4 BPEO Assessment Discussion

For each of the above assessment criteria, the options were qualitatively and semi-quantitatively (for costs) assessed against feasibility/preference and awarded a ranking ranging from 1 to 4; 1 being the most acceptable and 4 being the least acceptable option. The assignment of rank was on the basis of professional judgement.

The individual assessment criteria rankings for each option were added up to give an overall hierarchy of preference. Table 5-5 provides a summary of the BPEO assessment.

Table 5-5: BPEO Summary

Criteria	Water Injection Dredging	Disposal in Intertidal Area
Environment	1	2
Strategic	1	1
Costs	2	3
TOTAL SCORE	**4**	**6**

Use of WID to dredge the harbour is an environmentally and cost efficient means of dredging. The sediments are within the realm of being suitable for sea-based disposal given their limited contaminant content.

In the event that WID equipment cannot access the harbour given size restrictions, the back-up plan would be to place excavated material on the intertidal area adjacent to the harbour wall. It is noted that this would need to be discussed and agreed with MD-LOT.

5.2 Conclusion

The Best Practicable Environmental Option for disposal of the Crail Harbour dredged material has been assessed as using the WID method assuming accessibility of available equipment.

As identified in the sediment chemical quality section, further assessment is deemed necessary to confirm the suitability of the sediment for disposal to the wider marine environment. The following section details this assessment.

6 FURTHER ASSESSMENT

As detailed in Section 5.2, on the basis of the exceedances of Action Level 1, further assessment to determine the suitability of the material for sea disposal is deemed a requirement.

The approach for this further assessment is outlined as follows:

- Provide an overview of the proposed dredge works and the identified disposal site including existing chemical monitoring data for the site where available; and
- Compare existing chemical data with other recognised sediment assessment criteria including those listed below. Summary tables are provided in Appendix C.

Background Assessment Concentration (BAC) – BACs were developed by the OSPAR Commission (OSPAR) for testing whether concentrations are near background levels. Mean concentrations significantly below the BAC are said to be near background. However, it should be noted that river catchments have their own unique geochemical fingerprints and are also governed by the geology within the catchment, so in theory one set of background level values is not applicable to all situations.

Effects Range Low (ERL) – ERLs were developed by the United States Environmental Protection Agency (USEPA) for assessing the ecological significance of sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms. Concentrations above the ERL will often cause adverse effects in some marine organisms.

Probable Effects Level (PEL) – PELs (Marine) have been adopted from the Canadian Environmental Quality Guidelines (http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/). If a concentration is recorded above the PEL this is the probable effect range within which adverse effects frequently occur. The Threshold Effect levels (TELs) have not been included in the summary table in Appendix C, as they typically fall below the RAL1.

The following section contains a review of potential risks to the list of receptors identified in “Water Framework Directive Assessment: estuarine and coastal waters” (https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters). The conclusions drawn from the available information will provide a recommendation on proposed disposal routes.

6.1 Water Injection Dredging

WID fluidises the seabed sediment into a near-bottom density current that remains close to the bed and is carried away by gravity, tides, and natural water flows out of the dredge area and into the marine waterbody, keeping it within the marine ecosystem, reducing turbidity and benthic habitat disturbance. Once sediment is carried out of the dredge area, usually on an ebb tide, gravity and hydrodynamics guide the dredged sediment away from the harbour where sediment will naturally settle out on the seabed as velocities decrease.

6.2 Dredge and Disposal Site

The dredge is to be undertaken within Crail Harbour, within the area shown on Drawing No. 783694-GIS005, in Appendix A.

6.3 Analytical Data Review

Existing analytical data for the proposed dredge site is provided in Summary Table A in Appendix C. This data has been summarised against RAL 1 & 2, the BAC, ERL and PEL. As detailed previously, the data has not been reviewed against the Canadian TEL as these numbers are typically lower than RAL1. A summary of the exceedances is detailed below.

6.3.1 Action Level 1

Exceedances of RAL1 can be summarised as follows:

- PAHs – all 4 samples recorded concentrations of one or more PAH species above RAL1; and
- THC – 3 of 4 samples recorded THC concentrations above RAL1.

6.3.2 BAC Review

Exceedances of the BAC can be summarised as follows:

- Copper – 1 of 4 samples recorded copper concentrations above the BAC;
- Mercury – 3 of 4 samples recorded mercury concentrations above the BAC; and
- PAHs – 4 of 4 samples recorded concentrations of one or more PAH species above the BAC.

6.3.3 ERL & PEL Review

Exceedances of the ERL can be summarised as follows:

- PAH – 2 of 4 samples recorded PAH (specifically benzo(ghi)perylene) concentrations above the ERL.

No exceedances of PEL were recorded in any of the samples analysed.

6.3.4 Action Level 2

No exceedances of RAL2 were recorded in any of the samples analysed.

6.4 Averages

Review of the averaged data for all the samples has been undertaken *i.e.* considering the material as a single volume for disposal. The review of average data against the available adopted assessment criteria can be summarised as follows:

- Averaged concentrations of several PAH species and THCs exceeded RAL1;
- All other parameters recorded averaged concentrations below RAL1 where they exist;
- Averaged concentrations exceeded the BAC for mercury and several PAH species;
- Averaged concentrations were recorded below the ERL where one is available;
- Averaged concentrations were recorded below the PEL where one is available; and
- Averaged concentrations were recorded below RAL2 where they exist.

6.5 Chemical Assessment Conclusions

None of the samples recorded exceedances above RAL1 for metals, however all samples recorded exceedances of at least one PAH species. Grab A, Grab B, and Grab D recorded exceedances of RAL1 for THC. No samples recorded contaminant levels in exceedance of RAL2. Averaged concentrations, which account for the dredged material as a single volume for disposal, also exceeded RAL1 for several PAH species and THCs. Averaged concentrations did not exceed the ERL, PEL or RAL2.

6.6 Water Framework Directive Assessment

As outlined in the Water Framework Directive Assessment: estuarine and coastal waters guidance (Environment Agency, 2017), there are several key receptors which can be impacted upon including the following:

- Hydromorphology;
- Biology – habitats;
- Biology – fish;
- Water quality; and
- Protected areas

Each of these points are considered in Table 6-1 below, in the context of disposal of dredged material at intertidal disposal area previously used adjacent to the harbour.

Table 6-1: Receptor Risk Assessment

Key Receptor[2]	Brief Summary of Potential Effects on Receptor	Further Consideration Required?	Comment
Hydromorphology (Source Area and Disposal Site)	Morphological conditions, for example depth variation, the seabed and intertidal zone structure tidal patterns, for example dominant currents, freshwater flow and wave exposure	No	The dredge area and the intertidal disposal area are located within the Fife Ness to Elie coastal water body (ID: 200054), which is classified as have a "Good" overall status and classification as "High" for hydromorphology (2024)[3]. The dredge area is not located within either the Firth of Forth SPA[4] or the Outer Firth of Forth and St Andrews Bay Complex SPA[5]. **WID** The dredge area and outer WID dispersal zone are located within the same coastal waterbody (Fife Ness to Elie – ID: 200054). The WID dispersal zone is likely to be within the designated SPA areas. No designated features that are protective of hydromorphology are present in the dredge or dispersal sites. Using this method, sediment is fluidised into a near-bottom density current that remains close to the bed and is carried away by gravity, tides, and natural water flows, and mobilised only within the local hydrodynamic regime. Significant effects are considered unlikely. The current classification of "high" will take into account the presence of the harbour which is subject to regular maintenance dredging, and a

[2] https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters
[3] https://informatics.sepa.org.uk/WaterClassificationHub/?page=Information_Sheet&WB=200054
[4] https://sitelink.nature.scot/site/8499
[5] https://sitelink.nature.scot/site/10478

Key Receptor[2]	Brief Summary of Potential Effects on Receptor	Further Consideration Required?	Comment
			change in classification as a result of these works is considered unlikely. Further discussion with regard to protected areas is given in Section 6.7.2. **Disposal Within Intertidal Area** The intertidal disposal area is located within the Fife Ness to Elie coastal water body (ID: 200054), which is classified as have a "Good" overall status and classification as "High" for hydromorphology (2024)[3]. The classification of this water body takes into account the presence of the disposal site, so no further assessment is considered to be required. Historically, the material has been excavated landside and dredged material placed out with the harbour wall on rocks (as detailed on the appended drawing CRAIL 2020 with the historic Deposit Site, Crail Harbour) to enable natural dispersal of material through wave action in subsequent tidal cycles all under marine licence. Impact on hydromorphology is considered to be limited given the anticipated relatively small footprint of placed material and is considered unlikely to have an effect on the status of the waterbody.
Biology - habitats	Included to assess potential impacts to sensitive/high value habitats.	Yes	The dredge area and intertidal disposal area are noted to have a classification for overall ecology of "Good"[3]. The Fife Ness to Elie (covering areas of the proposed works) coastal waterbody has a classification of "Good" for invertebrates and benthic invertebrates (IQI)[3]. The dredge area, WID dispersal zone and intertidal disposal area are located within designated protected areas for their bird populations. Further consideration is given to these below in Section 6.7.2.
Biology – fish	Consideration of fish both within the estuary and also potential effects on migratory fish in transit through the estuary	No	The Fife Ness to Elie (covering areas of the proposed works) coastal waterbody does not have a classification for fish and is located in the wider Forth estuary with no obvious constraints.

Key Receptor[2]	Brief Summary of Potential Effects on Receptor	Further Consideration Required?	Comment
			The small scale of the works proposed within an active harbour, so activities are ongoing on a daily basis. The works will not likely affect the migration of fish within the wider coastal waterbody as the width of the estuary at the point of dredge and deposit site will allow fish will have plenty of scope to avoid the works and continue their migration unhindered. No further assessment is considered necessary.
Water Quality	Consideration must be given to water quality when contaminants are present in exceedance of CEFAS RAL1.	Yes	The Fife Ness to Elie (covering areas of the proposed works) coastal waterbody has a water quality classification status of "Good" and a classification of "Pass" for Specific Pollutants. A number of sediment samples recorded results in exceedance of CEFAS RAL1. Potential effects are considered to be both localised and temporary. Further consideration of potential effects are discussed in Section 6.7.1 for completeness.
Protected Areas	If your activity is within 2km of any WFD protected area, include each identified area in your impact assessment. • Special Areas of Conservation (SAC); • Special Protection Areas (SPA); • Shellfish Waters; • Bathing Waters; and • Nutrient Sensitive Areas.	Yes	The dredge area is not located within the Firth of Forth SPA or the Outer Firth of Forth and St Andrews Bay Complex SPA. However, the WID dispersal zone and the offshore disposal site are located within the SPAs. Both the SPAs are classified for: breeding & non-breeding birds. The Crail (Roome Bay) designated bathing waters is located approx. 500 m northeast of the proposed dredge area. There are no shellfish harvesting waters within 2 km of either the dredge area, WID dispersal zone, or intertidal disposal area. Further discussion with regard to protected areas is given in Section 6.7.2.

6.7 Potential Risk to Receptors

The potential risks to water quality and habitats/protected areas at the dredge and intertidal disposal area are further considered as all other receptors have been screened out of the assessment.

6.7.1 Water Quality

The dredge, WID dispersal zone, and intertidal disposal area have a water quality classification status of "Good" and a classification of "Pass" for Specific Pollutants[3].

Although concentrations of some contaminants of concern were recorded above the RAL1 within the sediment for disposal, it is considered that these levels will not contribute to an overall degradation of water quality (both within the WID dispersal zone and the intertidal disposal area). While any effects which may occur are considered to be both localised and temporary, the potential for dilution in the open waters beyond the dredge site is considerable.

When the sediment results are reviewed as an average to assess all of the dredged sediment as a single unit for disposal, then then RAL1 is exceeded only for total hydrocarbons and marginally for three PAH species. Averaged concentrations exceeded the BAC for mercury and PAHs. The BAC is intended to be used to determine if concentrations are near to background concentrations, rather than qualify any potential environmental impact. It should also be noted that the BACs for PAH and some metals are generally lower than the Marine Directorate RAL1, therefore it is considered to be a very conservative assessment criterion. No sediment results were recorded in exceedance of RAL2. Averaged concentrations did not record any exceedances of the PEL, which is primarily protective of marine life.

In addition, PAHs and hydrocarbons are hydrophobic with low aqueous solubility and will naturally remain associated with organic sediment fractions, rather than become dissolved within the water column. On this basis, the risks associated with impact to water quality from chemical contaminants in sediment are considered to be low, with the associated dilution potential providing further mitigation.

The key risk to water quality is considered to be a localised increase in turbidity/suspended solids during the WID process, however, this is considered to be restricted to the area of fluidisation close to the harbour bed during the dredging activities.

Material placed within the intertidal zone would be redistributed over the course of the subsequent tidal cycles and may result in some localised increase in turbidity as it disperses.

The sediment material primarily comprises sand and silt and negligible quantities of gravel. Table 6-2 summarises the average physical sediment type from all three samples from the dredge area.

Table 6-2: Averaged PSA Data for Dredge Area

Gravel % (>2 mm)	Sand % (>63 µm<2 mm)	Silt % (<63 µm)
9.11	52.43	38.46

It is assumed that the intertidal disposal area will have been utilised to dispose of similar fine-grained sediments from other dredging projects undertaken previously in the Firth of Forth and the SEPA water quality classification has remained as "good" since 2014. As a result, it is considered unlikely that this dredging campaign will result in a change in the classification status of coastal water bodies at the dredge, WID dispersal zone, and intertidal disposal area.

6.7.2 Habitats/Protected Areas

Marine Special Protection Areas (SPAs)
The following section gives further discussion on each of the designated protected areas that have been identified within 2 km of the dredge area, WID dispersal zone, and intertidal disposal area.

The dredge area is not located within the Firth of Forth SPA or the Outer Firth of Forth and St Andrews Bay Complex SPA, however the WID dispersal zone and the intertidal disposal area are likely to be within identified SPAs.

Identified designated areas for inclusion within the assessment are shown in Drawing No. 778694-GIS007 in Appendix A).

Both the Firth of Forth SPA and The Outer Firth of Forth and St Andrews Bay Complex SPA are classified for Breeding & non-breeding birds[4,5].

The Conservation and Management Advice documents for the SPAs (NatureScot, June 2022) gives specific advice for capital and maintenance dredging, and is reproduced below:

> *"No additional management for existing maintenance dredging (ports and harbours).*
>
> *Reduce or limit pressures (disturbance, damage of supporting habitat) associated with new capital dredging projects and associated maintenance dredging through appropriate mitigation such as:*
>
> - *spatial limitations to avoid damaging supporting habitat within foraging dive ranges of protected features and/or;*
> - *seasonal restrictions."*

Given that marine activities are already undertaken in Crail Harbour, it is considered that that the dredging works will not result in significant disturbance for protected species and habitats, beyond what is already experienced during normal harbour operations.

Bathing Waters
The Crail (Roome Bay) Bathing Water (ID: UKS7616011) is located approximately 500 m to the northeast of the dredge area. The bathing water was most recently classified as "Excellent" for 2025[6].

It is concluded above that the key risk to water quality as a result of the dredging and disposal activities is a temporary increase in suspended solids at the dredge area, WID dispersal zone, and intertidal disposal area.

Even if dredging and disposal works are undertaken during the bathing water season (June to September), the temporary and localised impacts on water quality experienced at the dredge and intertidal disposal area (*i.e.* increase in suspended solids/turbidity) are unlikely to impact the status of the bathing water at Crail.

Furthermore, the monitoring and classification of bathing water quality by SEPA pertains primarily to microbiological parameters (E. Coli and intestinal enterococci). The nature of marine sediments is such that the dredging and disposal activity is not considered likely to have an impact on microbiological results and bathing water quality classification.

[6] https://bathingwaters.sepa.org.uk/locations-and-results/results/?location=4548

7 CONCLUSIONS AND RECOMMENDATIONS

Fife Council appointed EnviroCentre Ltd to complete a Best Practicable Environmental Option (BPEO) assessment to inform proposed maintenance dredging at Crail Harbour. The assessment has been informed using sediment quality results from sampling undertaken in February 2024.

The proposed dredge depth will not exceed 1.0m and is intended to improve navigability in the berth and approaches. A maximum quantity of 1,500 m^3 is proposed to be dredged across the area shown in Drawing No. 783694-GIS005 in Appendix A. It is understood that the previous licence (reference: 07251/20/0) expired on 23rd June 2021. Fife Council is seeking to renew the licence for maintenance dredging works proposed in August 2026.

Review of available information has highlighted that although some contaminants of concern exceed RAL1 in sediment samples, assessment of key receptors identified from the Water Framework Directive assessment for estuarine and coastal waters concluded that there is a low risk of the sediments impacting upon the overall hydro-morphological, ecological or chemical status.

The WID method is low impact and should be achievable given the access restrictions of the harbour. Should the harbour not be accessible for available equipment, it is proposed that the historic option of placement of dredged material on the rocks for tidal dispersal be considered in conjunction with discussions with MD-LOT.

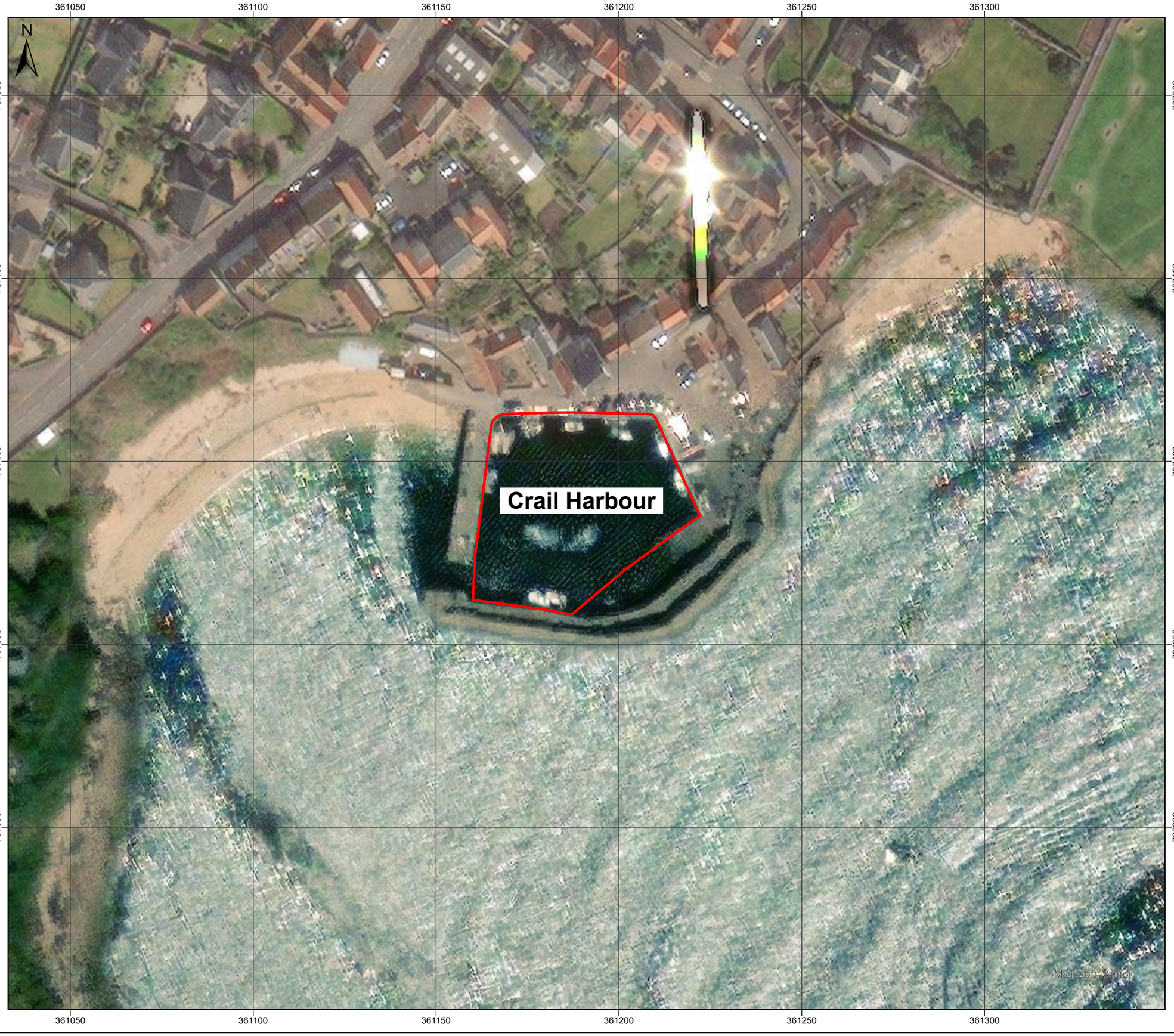
REFERENCES

Marine Directorate (2017). Pre-Dredge Sampling Guidance Version 2: Scottish Government.

Marine Directorate (2015). Guidance for Marine Licence Applicants Version 2: Scottish Government.

APPENDICES

A DRAWINGS



Legend

Dredge Area

Do not scale this map

Client
Fife Council

Project
Fife Council Harbours

Title
Dredge Area Plan
Crail Harbour

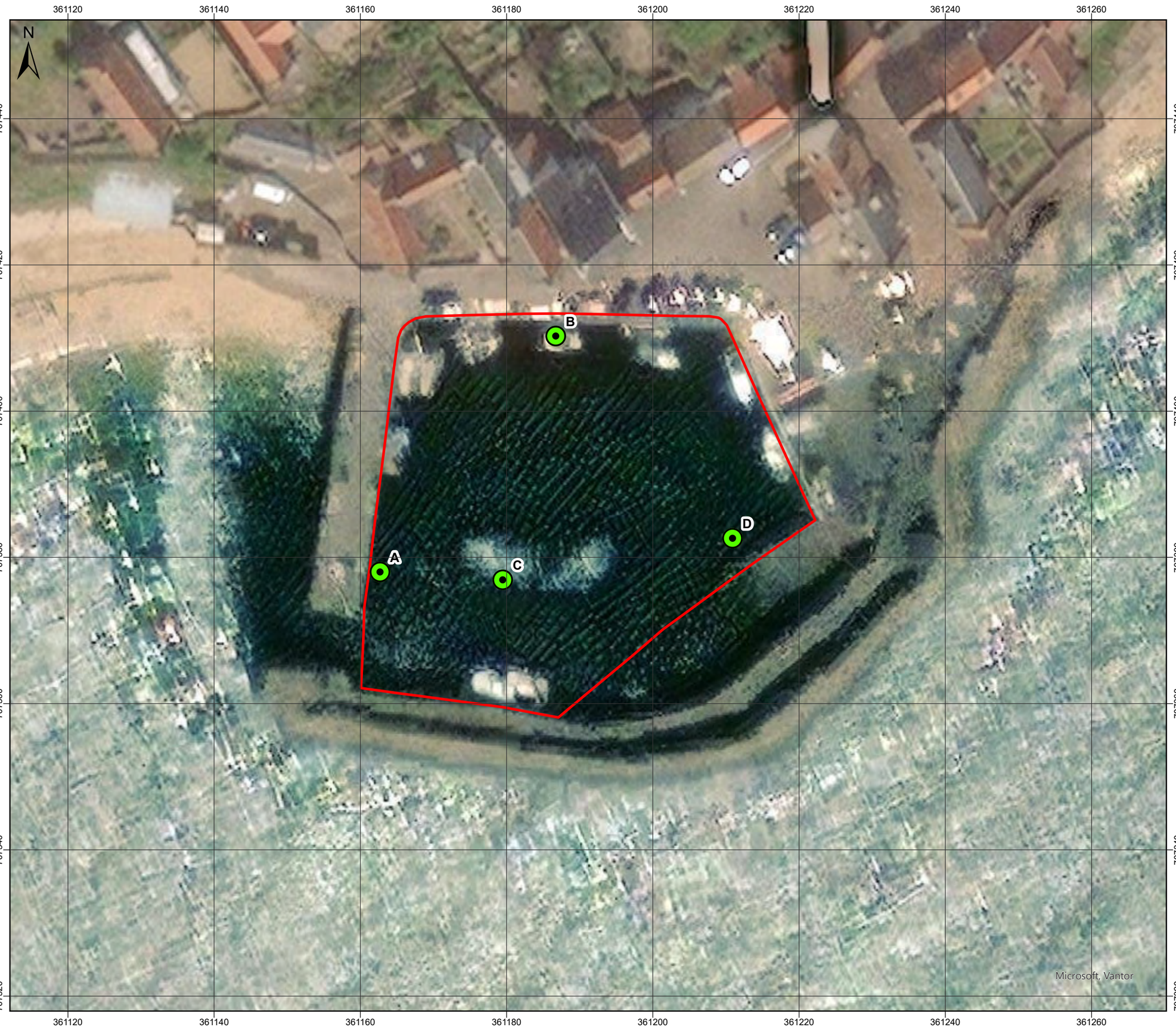
Status
FINAL

Drawing No.	Revision	Date
783694-GIS005	-	23 Mar 2026
Drawn	**Checked**	**Approved**
MMF	FR	CCAS

Scale 1:1,000 @A3 — 0 5 10 20 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre
part of CuraTerrae
8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA.
T: 0141 341 5040 E: info@envirocentre.co.uk
W: www.envirocentre.co.uk



Legend

- Dredge Area
- Sediment Sample Locations

Do not scale this map

Client
Fife Council

Project
Fife Council Harbours

Title
2024 Sediment Sample Locations Plan
Crail Harbour

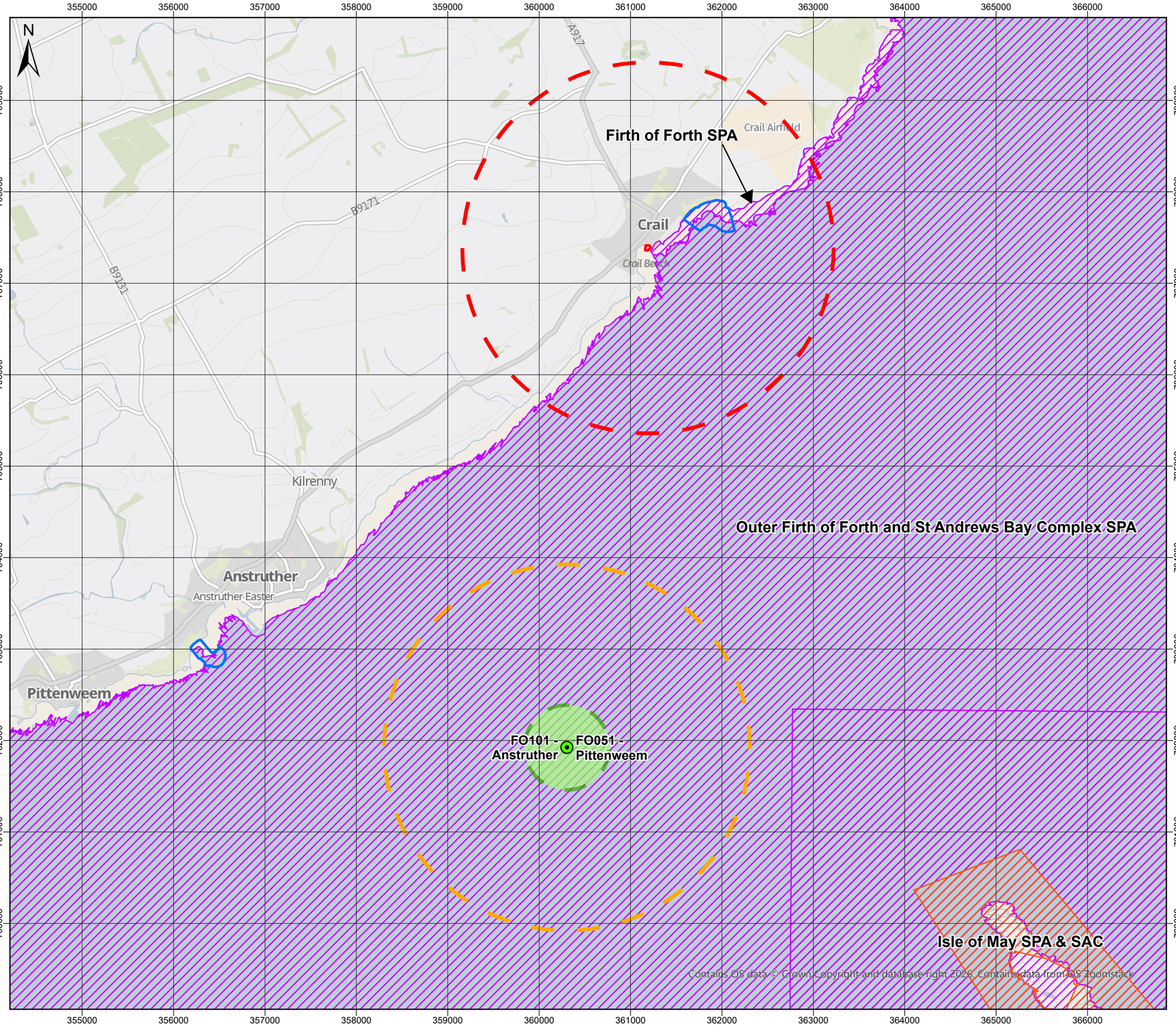
Status
FINAL

Drawing No.	Revision	Date
783694-GIS006	-	23 Mar 2026
Drawn	**Checked**	**Approved**
MMF	FR	CCAS

Scale 1:500 @A3 — 0 4.5 9 18 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre
part of CuraTerrae
8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA.
T: 0141 341 5040 E: info@envirocentre.co.uk
W: www.envirocentre.co.uk



Legend

- Dredge Area
- Dredge Site 2km Buffer
- Disposal Sites' 2km Buffer
- Bathing Waters
- Special Areas of Conservation (SAC)
- Special Protection Areas (SPA)
- 0.25 Nautical Mile Buffer Zone
- Pittenweem & Anstruther Disposal Sites

Do not scale this map

Client
Fife Council

Project
Fife Council Harbours

Title
Protected Areas Plan
Crail Harbour
Page 1 of 2

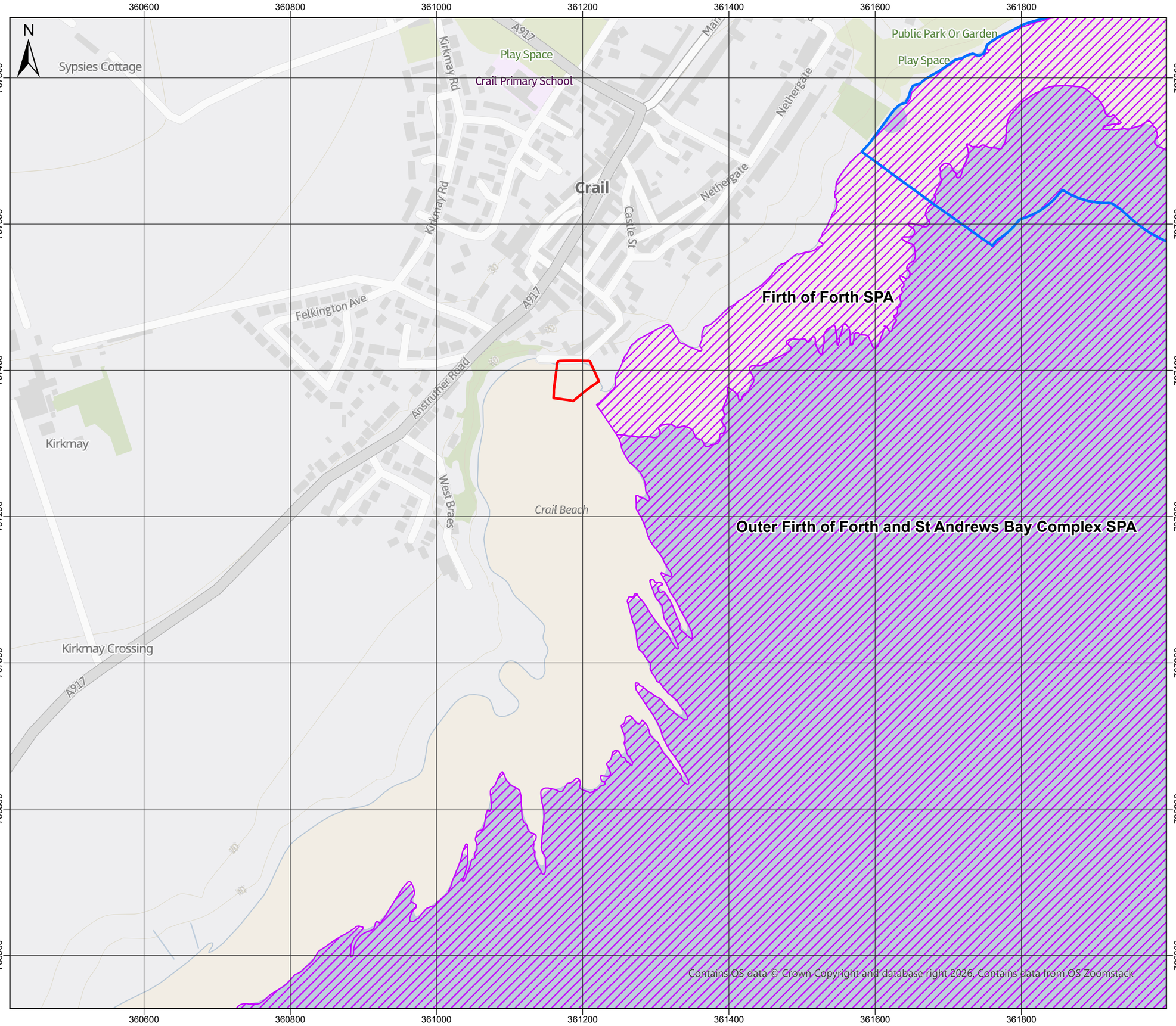
Status
FINAL

Drawing No.	Revision	Date
783694-GIS007	-	24 Mar 2026
Drawn	**Checked**	**Approved**
MMF	FR	CCAS

Scale 1:40,000 @A3
0 380 760 1,520 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre
part of CuraTerrae
8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA.
T: 0141 341 5040 E: info@envirocentre.co.uk
W: www.envirocentre.co.uk



Legend

- Dredge Area
- Bathing Waters
- Special Protection Areas (SPA)

Do not scale this map

Client
Fife Council

Project
Fife Council Harbours

Title
Protected Areas Plan
Crail Harbour
Page 2 of 2

Status
FINAL

Drawing No.	Revision	Date
783694-GIS007	-	24 Mar 2026
Drawn	**Checked**	**Approved**
MMF	FR	CCAS

Scale 1:5,000 @A3 — 0 45 90 180 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre
part of CuraTerrae
8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA.
T: 0141 341 5040 E: info@envirocentre.co.uk
W: www.envirocentre.co.uk

DRAWING NUMBER CRAIL 2020

CRAIL HARBOUR

DREDGE AREA A

Sampling Point D
56.257535 N
-2.6283958 W

Dredge Area
56.257575 N
-2.6283638 W

Dredge Area
56.257578 N
-2.6276939 W

Disposal point over
harbour wall
56.257660 N
-2.6270266 W

Sampling Point C
56.257537 N
-2.6276686 W

Dredge Area
56.257346 N
-2.6275100 W

Sampling Point A
56.257205 N
-2.6284984 W

Dredge Area
56.257158 N
-2.6285040 W

Dredge Area
56.257130 N
-2.6280878 W

Sampling Point B
56.257242 N
-2.6278575 W

SHOREGATE
KING STREET COBBLES
SLIPWAY COBBLES
TARMAC
IRREGULAR STONE
GRAVEL
BRICKS LINE
LIFE BUOY
DISPLAY BOARD
MOORING STONE
JUCT BOX
BENCH
OH LAMP
CONCRETE
GARDEN AREA
SUPPORT
EDGING
STONE STEPS
METAL PLATE
WOODEN SUPPORTS
BRICK STOVE
CHIMNEY
HOIST

PRELIMINARY		TENDER		CONTRACT		RECORD		DATE	APRIL 2020	SCALE As Shown @ A3	DRAWING NUMBER CRAIL 2020
DESIGNED		DRAWN		CHECKED		APPROVED					

Fife Council

Assets, Transportation and Environment

Head of Service - Ken Gourlay

HARBOURS, FLOOD, COAST

Crail Harbour Dredging Marine Licence (January 2020)

B SEDIMENT SAMPLE LOGS

envirocentre 8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA	**Project Name**	Fife Harbours Crail and Pittenweem	**Location ID**
	Project No.	778896	**Grab A**
	Client	Fife Council	

GRAB SAMPLE LOG

Date	06/02/24	**Latitude**	56° 15.43805’
Dredge Area	Crail Harbour	**Longitude**	-2° 37.70817’
Method	0.045m^2 Van Veen Grab Sampler	**Sampled/logged by**	FR/MK

Remarks: Soft dark-greyish brown, sandy silt with very frequent shell-derived fine gravel

Biota: Frequent vegetation, seaweed, and rootlets

Odours: Moderate H_2S odour

Anthropogenic Inputs: None

Notes: Re-sited to the north due to seaweed in grab after many attempts

envirocentre 8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA	**Project Name**	Fife Harbours Crail and Pittenweem	**Location ID**
	Project No.	778896	**Grab B**
	Client	Fife Council	

GRAB SAMPLE LOG

Date	06/02/24	**Latitude**	56° 15.45556’
Dredge Area	Crail Harbour	**Longitude**	-2° 37.68518’
Method	0.045m^2 Van Veen Grab Sampler	**Sampled/logged by**	FR/MK

Remarks: Soft dark greyish-brown sandy silt. Sand is fine.

Biota: Occasional Seaweed/vegetation

Odours: Moderate H_2S odour

Anthropogenic Inputs: None

Notes: -

envirocentre 8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA	**Project Name**	Fife Harbours Crail and Pittenweem	**Location ID**
	Project No.	778896	**Grab C**
	Client	Fife Council	

GRAB SAMPLE LOG

Date	06/02/24	**Latitude**	56° 15.43755’
Dredge Area	Crail Harbour	**Longitude**	-2° 37.69191’
Method	0.045m^2 Van Veen Grab Sampler	**Sampled/logged by**	FR/MK

Remarks: Soft dark grey/black sandy silt with rare shell-derived gravel.

Biota: Occasional seaweed/vegetation

Odours: Strong H_2S odour

Anthropogenic Inputs: None

Notes: -

envirocentre 8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA	**Project Name**	Fife Harbours Crail and Pittenweem	**Location ID**
	Project No.	778896	**Grab D**
	Client	Fife Council	

GRAB SAMPLE LOG

Date	06/02/24	**Latitude**	56° 15.44077’
Dredge Area	Crail Harbour	**Longitude**	-2° 37.66152’
Method	0.045m^2 Van Veen Grab Sampler	**Sampled/logged by**	FR/MK

Remarks: Soft dark grey silt

Biota: Frequent seaweed and other vegetation

Odours: Slight H_2S odour

Anthropogenic Inputs: None

Notes: -

C SUMMARY TABLES

Summary Table A

Sampling Results Incorporated with BPEO Assessment (mg/kg)

All units in mg/kg

						Crail Harbour										
Source	AL1	AL2	BAC CSEMP	ERL CSEMP	PEL Canada	GRAB A	GRAB B	GRAB C	GRAB D	Max	AVERAGE	No. Exceed RAL 1	No. Exceed RAL 2	No.Exceed BAC?	No. Exceed ERL	No. Exceed PEL?
Arsenic	20	70	25		41.6	6.6	6.8	6.6	6.6	6.8	6.65	0	0	0	N/A	0
Cadmium	0.4	4	0.31	1.2	4.2	0.11	0.2	0.16	0.27	0.27	0.19	0	0	0	0	0
Chromium	50	370	81	81	160	21.2	27.8	23.3	29.8	29.8	25.53	0	0	0	0	0
Copper	30	300	27	34	108	11.1	17.2	15.9	28	28	18.05	0	0	1	0	0
Mercury	0.25	1.5	0.07	0.15	0.7	0.04	0.12	0.07	0.07	0.12	0.08	0	0	3	0	0
Nickel	30	150	36	-	-	16.5	20.1	18.5	21.5	21.5	19.15	0	0	0	N/A	N/A
Lead	50	400	38	47	112	12	19.2	16.5	21.7	21.7	17.35	0	0	0	0	0
Zinc	130	600	122	150	271	36.7	61.1	48.2	73	73	54.75	0	0	0	0	0
Napthalene	0.1		0.08	0.16	0.391	0.0647	0.0558	0.0426	0.0304	0.0647	0.05	0	N/A	0	0	0
Acenaphthylene	0.1		-	-	0.128	0.005	0.005	0.005	0.005	0.005	0.01	0	N/A	N/A	N/A	0
Acenaphthene	0.1		-	-	0.0889	0.005	0.005	0.0106	0.005	0.0106	0.01	0	N/A	N/A	N/A	0
Fluorene	0.1		-	-	0.144	0.0311	0.0346	0.0328	0.0203	0.0346	0.03	0	N/A	N/A	N/A	0
Phenanthrene	0.1		0.032	0.24	0.544	0.108	0.122	0.14	0.0764	0.14	0.11	3	N/A	4	0	0
Anthracene	0.1		0.05	0.085	0.245	0.04	0.0344	0.0252	0.0209	0.04	0.03	0	N/A	0	0	0
Fluoranthene	0.1		0.039	0.6	1.494	0.131	0.148	0.0871	0.103	0.148	0.12	3	N/A	4	0	0
Pyrene	0.1		0.024	0.665	1.398	0.123	0.148	0.0876	0.0997	0.148	0.11	2	N/A	4	0	0
Benzo(a)anthracene	0.1		0.016	0.261	0.693	0.0664	0.0792	0.0421	0.0511	0.0792	0.06	0	N/A	4	0	0
Chrysene	0.1		0.02	0.384	0.846	0.0745	0.0895	0.0469	0.0582	0.0895	0.07	0	N/A	4	0	0
THC	0.1		-	-	-	0.0753	0.105	0.0485	0.0544	0.105	0.07	1	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	0.1		-	-	-	0.0919	0.126	0.0469	0.0627	0.126	0.08	1	N/A	N/A	N/A	N/A
Benzo(a)pyrene	0.1		0.03	0.384	0.763	0.074	0.096	0.0428	0.0603	0.096	0.07	0	N/A	4	0	0
Indeno(1,2,3cd)pyrene	0.1		0.103	0.24	-	0.06	0.0764	0.034	0.0471	0.0764	0.05	0	N/A	0	0	N/A
Benzo(ghi)perylene	0.1		0.08	0.085	-	0.0904	0.102	0.0433	0.0497	0.102	0.07	1	N/A	2	2	N/A
Dibenzo(a,h)anthracene	0.01		-	-	0.135	0.005	0.0151	0.005	0.005	0.0151	0.01	1	N/A	N/A	N/A	0
THC	100		-	-	-	147	244	82.4	101	244	143.6	3	N/A	N/A	N/A	N/A
PCBs	0.02	0.18	-	-	0.189	0.00062	0.00285	0.00065	0.00076	0.00285	0.0012	0	0	N/A	N/A	0
TBT	0.1	0.5	-	-	-	0.005	0.005	0.005	0.005	0.005	0.0050	0	0	N/A	N/A	N/A

Note: Underlined Values are <LOD. Values highlighted red are equal to or greater than AL1.

PEL Data Source: http://ceqg-rcqe.ccme.ca/en/index.html#void

Summary Table B

Crail Harbour Average Concentrations

All units in mg/kg

Source	AL1	AL2	BAC	<ERL	PEL	Dredge Average	Exceed AL1?	Exceed AL2?	Exceed BAC?	Exceed ERL ?	Exceed PEL?
			CSEMP	CSEMP	Canada						
Arsenic	20	70	25	-	41.6	6.7	No	No	No	N/A	No
Cadmium	0.4	4	0.31	1.2	4.2	0.2	No	No	No	No	No
Chromium	50	370	81	81	160	25.5	No	No	No	No	No
Copper	30	300	27	34	108	18.1	No	No	No	No	No
Mercury	0.25	1.5	0.07	0.15	0.7	0.1	No	No	**Yes**	No	No
	30	150	36	-	-	19.2	No	No	No	N/A	N/A
Lead	50	400	38	47	112	17.4	No	No	No	No	No
Zinc	130	600	122	150	271	54.8	No	No	No	No	No
					-						
Napthalene	0.1	-	0.08	0.16	0.319	0.0	No	N/A	No	No	No
Acenaphthylene	0.1	-	-	-	0.128	0.0	No	N/A	N/A	N/A	No
Acenaphthene	0.1	-	-	-	0.0889	0.0	No	N/A	N/A	N/A	No
Fluorene	0.1	-	-	-	0.144	0.0	No	N/A	N/A	N/A	No
Phenanthrene	0.1	-	0.032	0.24	0.544	0.1	**Yes**	N/A	**Yes**	No	No
Anthracene	0.1	-	0.05	0.085	0.245	0.0	No	N/A	No	No	No
Fluoranthene	0.1	-	0.039	0.6	1.494	0.1	**Yes**	N/A	**Yes**	No	No
Pyrene	0.1	-	0.024	0.665	1.398	0.1	**Yes**	N/A	**Yes**	No	No
Benzo(a)anthracene	0.1	-	0.016	0.261	0.693	0.1	No	N/A	**Yes**	No	No
Chrysene	0.1	-	0.02	0.384	0.846	0.1	No	N/A	**Yes**	No	No
Benzo(b)fluoranthene	0.1	-	-	-	-	0.1	No	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	0.1	-	-	-	-	0.1	No	N/A	N/A	N/A	N/A
Benzo(a)pyrene	0.1	-	0.03	0.384	0.763	0.1	No	N/A	**Yes**	No	No
Indeno(1,2,3cd)pyrene	0.1	-	0.103	0.24	-	0.1	No	N/A	No	No	N/A
Benzo(ghi)perylene	0.1	-	0.08	0.085	-	0.1	No	N/A	No	No	N/A
Dibenzo(a,h)anthracene	0.01	-	-	-	0.135	0.0	No	N/A	N/A	N/A	No
THC	100	-	-	-	-	143.6	**Yes**	N/A	N/A	N/A	N/A
PCBs	0.02	0.18	-	-	0.189	0.001	No	No	N/A	N/A	No
TBT	0.1	0.5	-	-	-	0.005	No	No	N/A	N/A	N/A

D LABORATORY CERTIFICATES

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR02208

Issue Version: 1

Customer: EnviroCentre Ltd, 8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA

Customer Reference: 778896 Crail Harbour

Date Sampled: 06-Feb-24

Date Samples Received: 09-Feb-24

Test Report Date: 14-Mar-24

Condition of samples: Cold Satisfactory

Opinions and Interpretations expressed herein are outside the scope of our UKAS accreditaion
The results reported relate only to the sample tested
The results apply to the sample as received

JMColbourne

Authorised by: Jane Colbourne

Position: Customer Service Specialist

UKAS TESTING 1252

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

			Units	%	%	%	%	%	N/A
			Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SUB_02*
			Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A
			Accreditation	UKAS	UKAS	N	N	N	UKAS
Client Reference:		**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Asbestos**
Grab A		MAR02208.001	Sediment	57.9	42.1	23.61	59.17	17.22	NAIIS
Grab B		MAR02208.002	Sediment	57.5	42.5	1.61	42.34	56.05	NAIIS
Grab C		MAR02208.003	Sediment	48.5	51.5	8.96	63.16	27.88	NAIIS
Grab D		MAR02208.004	Sediment	45.7	54.3	2.26	45.06	52.69	NAIIS
			Reference Material (% Recovery)	N/A	N/A	N/A	N/A	N/A	N/A
			QC Blank	N/A	N/A	N/A	N/A	N/A	N/A

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	% M/M
		Method No	WSLM59*
		Limit of Detection	0.02
		Accreditation	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**TOC**
Grab A	MAR02208.001	Sediment	1.18
Grab B	MAR02208.002	Sediment	2.70
Grab C	MAR02208.003	Sediment	2.90
Grab D	MAR02208.004	Sediment	2.99
		Reference Material (% Recovery)	103
		QC Blank	<0.02

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
Grab A	MAR02208.001	Sediment	6.6	0.11	21.2	11.1	0.04	16.5	12.0	36.7
Grab B	MAR02208.002	Sediment	6.8	0.20	27.8	17.2	0.12	20.1	19.2	61.1
Grab C	MAR02208.003	Sediment	6.6	0.16	23.3	15.9	0.07	18.5	16.5	48.2
Grab D	MAR02208.004	Sediment	6.6	0.27	29.8	28.0	0.07	21.5	21.7	73.0
Certified Reference Material SETOC 768 (% Recovery)			95	98	101	102	111	99	98	99
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
Grab A	MAR02208.001	Sediment	<5	<5
Grab B	MAR02208.002	Sediment	<5	<5
Grab C	MAR02208.003	Sediment	<5	<5
Grab D	MAR02208.004	Sediment	<5	<5
Certified Reference Material BCR-646 (% Recovery)			79	69
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
Grab A	MAR02208.001	Sediment	<5	<5	40.0	66.4	74.0	75.3
Grab B	MAR02208.002	Sediment	<5	<5	34.4	79.2	96.0	105
Grab C	MAR02208.003	Sediment	10.6	<5	25.2	42.1	42.8	48.5
Grab D	MAR02208.004	Sediment	<5	<5	20.9	51.1	60.3	54.4
Certified Reference Material Quasimeme QPH118MS (% Recovery)			82	93	91	96	97	92
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

*See report notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	N*	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF***	**CHRYSENE ***	**DBENZAH**	**FLUORANT**	**FLUORENE**
Grab A	MAR02208.001	Sediment	90.4	91.9	74.5	<5	131	31.1
Grab B	MAR02208.002	Sediment	102	126	89.5	15.1	148	34.6
Grab C	MAR02208.003	Sediment	43.3	46.9	46.9	<5	87.1	32.8
Grab D	MAR02208.004	Sediment	49.7	62.7	58.2	<5	103	20.3
Certified Reference Material Quasimeme QPH118MS (% Recovery)			83	45	116	94	104	74
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

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*See report notes

Certificate of Analysis

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Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
Grab A	MAR02208.001	Sediment	60.0	64.7	108	123	147000
Grab B	MAR02208.002	Sediment	76.4	55.8	122	148	244000
Grab C	MAR02208.003	Sediment	34.0	42.6	140	87.6	82400
Grab D	MAR02208.004	Sediment	47.1	30.4	76.4	100	101000
Certified Reference Material Quasimeme QPH118MS (% Recovery)			90	78	99	108	98~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

*See report notes

Certificate of Analysis

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Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
Grab A	MAR02208.001	Sediment	0.08	<0.08	<0.08	<0.08	0.11	0.11	0.08
Grab B	MAR02208.002	Sediment	0.39	0.43	0.41	0.52	0.56	0.35	0.19
Grab C	MAR02208.003	Sediment	0.11	<0.08	<0.08	<0.08	<0.08	0.14	<0.08
Grab D	MAR02208.004	Sediment	0.09	<0.08	<0.08	0.09	0.18	0.16	<0.08
Certified Reference Material Quasimeme QOR155MS (% Recovery)			101	101	89	98	94	100	101
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR02208
Issue Version 1
Customer Reference 778896 Crail Harbour

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR02208.001-004	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMSS*	MAR02208.001-004	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SUB_01*	MAR02208.001-004	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR02208.001-004	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR02208.001-004	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR02208.001-004	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR02208.001-004	The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. The remaining data gives the Laboratory confidence that the test has performed satisfactorily and that the validity of the data may not have been significantly affected.However in line with our QMS policy we have removed accreditation, where applicable, from the affected analytes (FLUORENE) . These circumstances should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR02208.001-004	Benzo[k]fluoranthene is known to coelute with Benzo[j]fluoranthene and these peaks can not be resolved. It is believed Benzo[j]fluoranthene is present in these samples therefore it is suggested that the Benzo[k]fluoranthene results should be taken as a Benzo[k]fluoranthene (inc. Benzo[j]fluoranthene). Benzo[j]fluoranthene is not UKAS accredited. This should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR02208.001-004	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Sample Contaminated through Damaged Packaging	N/A	N/A
D3	Sample Contaminated through Sampling	N/A	N/A
D4	Inappropriate Container/Packaging	N/A	N/A
D5	Damaged in Transit	N/A	N/A
D6	Insufficient Quantity of Sample	N/A	N/A
D7	Inappropriate Headspace	N/A	N/A
D8	Retained at Incorrect Temperature	N/A	N/A
D9	Lack of Date & Time of Sampling	N/A	N/A
D10	Insufficient Sample Details	N/A	N/A
D11	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR02208
Issue Version	1
Customer Reference	778896 Crail Harbour

Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried and seived to <63µm	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		