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03	07/10/2019	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Survey Scientist	Ralph Brayne	Senior Coastal Processes Scientist
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06	30/01/2020	Katie Musgrave	Coastal Processes Survey Scientist	Andrew Bodle	Survey Scientist	Dean Foden	Hinkley Point Programme Lead

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TR502 HPC 2019 sediment sampling plan for dredge disposal. HPC cooling water intakes, outfalls, FRS, and jetty.

TR502 HPC 2019 sediment sampling plan for dredge disposal. HPC cooling water intakes, outfalls, FRS and jetty

Dean Foden and Katie Musgrave

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1 Introduction

During 2021 NNB GenCo plans to commission dredging as part of the development of Hinkley Point C (HPC) nuclear power station. Installation of the cooling water intake and outfall structures requires these locations to be dredged down to bedrock, with the dredged material being taken to a designated disposal site. Similarly, dredging and subsequent disposal is required at the site of a fish return and recovery system (FRS) outfall structure and to create a berthing pocket at the head of the HPC temporary jetty. The locations of these sites are shown in Figure 1. NNB GenCo will seek permission to dispose of this dredged material at authorised disposal sites within the Severn Estuary designated area as per the HPC Development Consent Order (S.I. 2013 No. 648). During 2018, capital dredge works of the cooling water intake and outfall areas were completed under Marine Management Licence (MMO) Marine Licence L/2013/00178/4 including disposal to LU110 under Natural Resources Wales (NRW) Marine Licence 12/45/ML.

The purpose of this document is to specify the sediment sampling that will be required to demonstrate whether the dredged sediments are suitable for dredging and subsequent disposal to sea. The planned window within which the sampling proposed within this report will take place is between March and September 2020. Based on the previously reported sediment sampling (BEEMS Technical Report TR444) carried out to satisfy Marine Licence 12/45/ML the number of sampling stations proposed in each dredge area (see Table 2) may be reduced, with regulatory approval.

The scope of this sampling campaign will be submitted to the regulating authority for approval prior to the disposal of any material. Dredged material will be disposed of at authorised sites within the Severn Estuary.

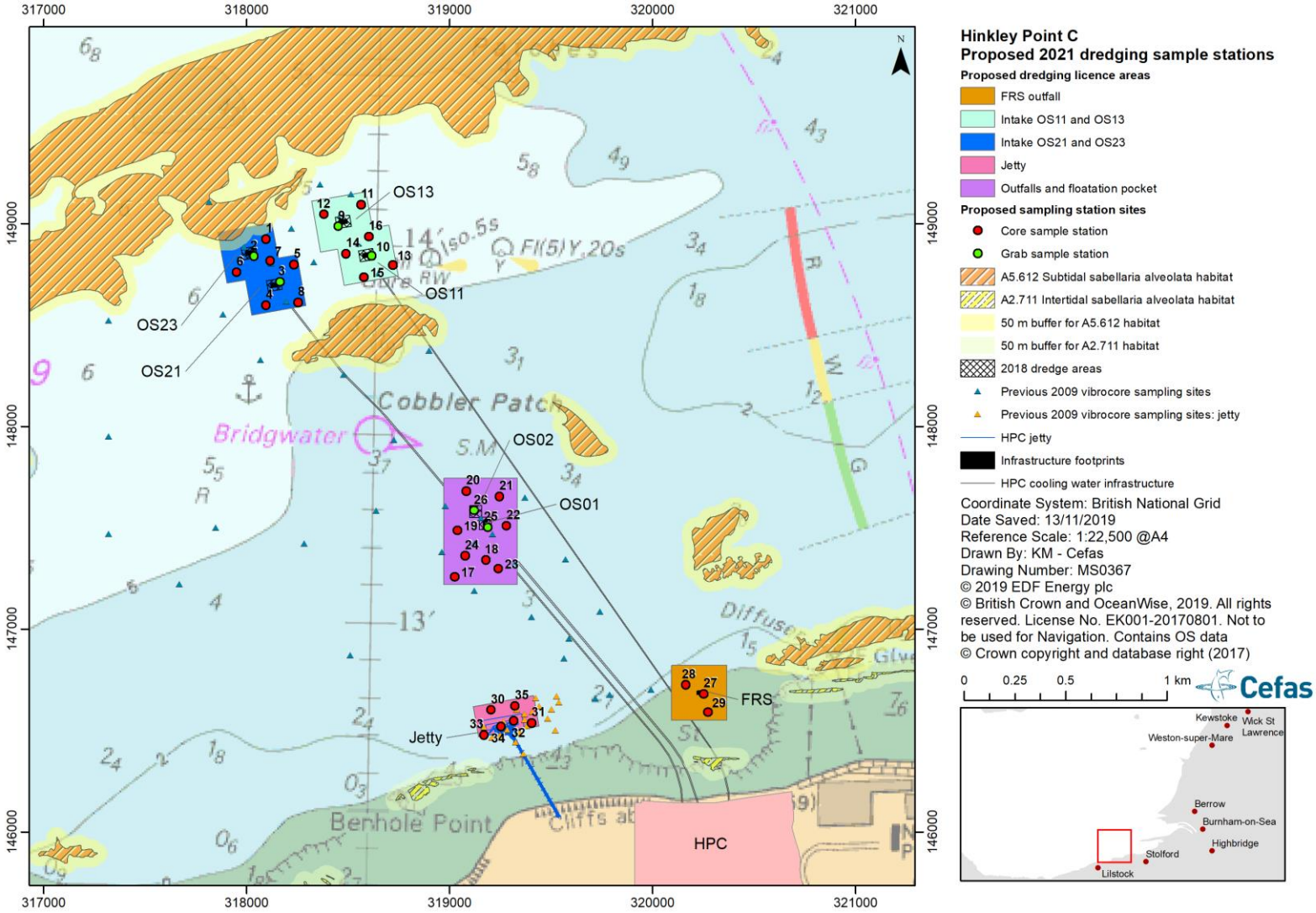

Figure 1. Proposed dredge licence area and indicative distribution of proposed sample station locations. Locations of previous 2009 vibrocore sampling locations (BEEMS Technical Report TR186) are also shown. Note that the area of the jetty berthing pocket dredge has yet to be finalised and the area shown is indicative. The number of sampling locations and the dredge volume for each area are shown in Table 2. *Sabellaria alveolata* habitat is derived from habitat mapping in BEEMS Technical Report TR184 and no sampling would take place within 50 m of these areas, as denoted by the buffer zones.

2 Sampling strategy

2.1 Number of sample stations

Sampling requirements to demonstrate that sediments are suitable for disposal to sea are based upon OSPAR guidelines (OSPAR, 2014) which specify the number of sampling stations required according to the volume of sediment to dredged. The sampling specified in the OSPAR guidelines is shown in Table 1.

Table 1. The number of sediment sampling stations required for different dredge volumes (from OSPAR, 2014)

Volume dredged (m^3)	Number of stations
Less than 25,000	3
25,000 - 100,000	4-6
100,000 - 500,000	7-15
500,000 - 2,000,000	16-30
Greater than 2,000,000	An extra 10 per million m^3

For the 2021 Hinkley Point dredge campaign, the dredge volumes proposed for each dredge location are shown in Table 2 together with the number of sampling stations required to comply with OSPAR guidance. The proposed works include a mixture of maintenance and capital dredging at the locations of the intakes and outfalls, the FRS and the jetty berthing pocket. The total number of sampling stations based on conservative application of OSPAR guidance is 35. To facilitate flexibility in the dredging plan, permission is sought for a contingency of up to 45 sampling stations in total to be sampled.

Table 2. The proposed volumes of sediment to be dredged from each location and the number of sampling stations required.

Dredge purpose	Location	Dredge volume (m^3)			Number of sampling stations	
		Capital	Maintenance	Total	Stations in capital zones	Stations in maintenance zones
Intakes	OS11	24,757	36,743	122,501	6	2
	OS13	24,757	36,244			
	OS21	24,757	36,897	123,613	6	2
	OS23	24,757	37,202			
Outfalls and flotation pocket	OS01 and OS02	118,657	72,914	280,228	8	2
	Flotation pocket	88,657				
FRS	FRS	20,000	-	20,000	3	-
Jetty berthing pocket*	Jetty	53,657	-	53,657	6	-
Subtotal:		**380,000**	**220,000**	**600,000**	**29**	**6**
Additional contingency sampling stations**:					10	
Total:						**45**

* The extent and exact volume of the jetty dredge has yet to be finalised. **Ten additional stations are included as contingency in the case of amendments to dredging plans. These additional stations would either be core sampled or grab sampled, determined based upon whether the station was located within capital (core) or maintenance (grab) dredging zones, and subjected to the same subsampling and analysis as for all other sample stations.

Proposed sample station locations are shown in Figure 1, whilst indicative station co-ordinates are tabulated and presented in Table 6 (Appendix A). Sample stations will be evenly spaced within each dredge area to provide representative coverage of both capital and maintenance dredging zones. Precise locations may vary according to ground conditions encountered and the presence of *Sabellaria alveolata* habitat; an even distribution of sample points throughout the dredging zones would be maintained where possible. It is likely that core sampling would be undertaken from a jack up barge and the vessel would not jack up within the *Sabellaria alveolata* habitat area or within the 50 m buffer zone surrounding it (Figure 1). Final sampling methodology, including confirmed sample station locations, will be confirmed prior to works commencing.

At each sampling station within maintenance dredging zones (black hashed areas in Figure 1), surface grab samples should be obtained by 0.1 m^2 Day grab, Hamon grab, or similar. Sampled material should be subsampled, and the subsamples should be tested for chemical and radiological contamination and subjected to particle size analysis (PSA) according to Table 3. In the case of the 2021 dredge depth being greater than the 2018 dredge depth, sampling stations would be sampled according to the capital dredge methodology.

At each sampling station within capital dredging zones, sediment cores should be obtained by vibrocoring or similar method. The cores should extend to the maximum dredge depth, or until expert geotechnical examination reveals that undisturbed geological material has been reached, or the sample consists almost

exclusively of sand, gravel or rock. The maximum core length would be 9 m. The cores should be subsampled, and the subsamples should be tested for chemical and radiological contamination and subjected to particle size analysis (PSA). Subsamples should be taken from the sediment surface and then at depth intervals from the sediment core. The depths of subsamples to be taken, the required analyses and the required subsample volumes are shown in Table 3 and the analyses are described in section 3 and 4. It is assumed that two samples will be taken at each core sample station to ensure sufficient material is available to collect a full set of replicate subsamples, and to allow contingency in case required subsample volumes vary according to the requirements of the laboratory selected for the analysis.

In the event insufficient material is collected during a sample removal attempt (if a partial sample was recovered, for example), or where unsuitable ground conditions were encountered, collection of a further sample may be required. This would be undertaken at the same station to minimise the area of seabed influenced by sampling activities. If additional attempts were made, this would be recorded, specifying location, number of attempts, and justification of why additional attempts were required.

Table 3: The subsampling and analysis strategy for sediment cores and estimated subsample volumes. Subsample volume refers to the material required for one subsample set: a second replicate subsample set would also be collected.

Subsample depth (m)	Analysis required			Estimated subsample volume (ml)			
	Radiological	Chemical	PSA	Radiological	Chemical	PSA	Total
Sediment surface (or grab samples)	✓	✓	✓	500 - 1000	375	375*	875 - 1750
0.25	✓	X	X	500 - 1000	-	-	500 - 1000
0.5	✓	X	X	500-1000	-	-	500 - 1000
1.0	✓	✓	✓	500-1000	375	375*	875 - 1750
2.0	✓	✓	✓	500-1000	375	375*	875 - 1750
Etc at 1.0 m intervals to the bottom of the core or until undisturbed geological material or almost exclusively sand, gravel or rock are found.	✓	✓	✓	500-1000	375	375*	875 - 1750

*PSA can use chemical sub-sample material, unless coarse gravelly material is sampled, in which case, an additional separate sample should be collected.

2.2 Sampling volumes

The volumes of material which would be removed from the seabed according to different sampling techniques are detailed in Table 4. The maximum volume of material for the full sampling campaign would be approximately 9.43 m^3, assuming six grab samples and 39 core stations, assuming that two samples are collected at each core sample station, that all 10 contingency stations are required (and core sampling is required for all 10 of these stations), and that all cores are sampled to 9 m depth. A factor of 50% has also been included in the maximum volume to account for minor variations to requirements, for example, if unsuitable ground conditions were encountered, if analysis laboratories required more material than was estimated in Table 3 therefore requiring multiple cores, or if unsuccessful sampling attempts yielded partial samples and repeat sampling was required.

Only surface sampling or core sampling would be undertaken at each sampling station (according to whether it was a capital or maintenance dredging zone). Once collected, the material sampled using these techniques would be subsampled according to methods described in Section 3.

Table 4: Sediment sampling volumes (Note: this details the total volume of material removed from the seabed and differs from the volume of material that will be subsampled for analysis).

	0.1 m^2 surface grab sample (for maintenance dredge areas)	**9 m deep core sample (ø 0.106 m) (for capital dredge areas)**
Sediment volume per sample attempt (m^3)	0.015	0.0794
Number of stations using this sampling method	6	39*
Number of samples taken per station	1	2
Total sample volume per station (m^3)	0.09	6.19

* this volume estimate assumes that the ten contingency stations would be core sampled twice, as a worst-case scenario in terms of total volume to be removed from the seabed. Additional contingency stations may be either grab or core sampled, according to whether they were located within maintenance or capital dredge areas, respectively, but are assumed to be core sampled here for the purposes of providing a worst-case volume estimate.

3 Subsampling methodology

Cores should be subsampled by scientifically trained staff according to the methodology below in order to prevent contamination of the samples.

3.1 Radiological samples

For each subsample, between 500 and 1000 ml of sediment should be placed in a plastic container (or containers) using a clean plastic scoop. Clearly labelled sample containers should be filled, and any excess water discarded to leave a small air gap at the top of the container. The top should be screwed on firmly and the container wiped clean before being placed in a clean plastic bag and sealed with tape.

Two sub-samples should be taken at each depth at each station as a full set of replicate subsamples will be collected. Two cores per station may be required to provide a sufficient volume of material.

Samples should be clearly labelled and carefully packed to minimise risk of damage during transport. Samples should be stored either at room temperature (out of direct sunlight) or refrigerated but not frozen and sent to the analysing laboratory as soon as possible (e.g. by overnight courier). A specific period within which samples must be received by the laboratory is not defined, however fast transport is preferable as it reduces the possibility of algal growth, which may take up radionuclides following sample collection.

3.2 Chemical and PSA samples

For each subsample, one contaminant-free 500 ml glass jar should be ¾ filled with sediment using a clean stainless-steel scoop, in accordance with MMO Chemical Determinants Guidance (MMO, 2018). Contaminant-free foil should be placed over the top of the jar and the lid replaced firmly.

If the sample contains coarse gravelly material, a second jar should be subsampled according to the same methodology. A conservative approach to determining whether a second jar is required should be employed, based on visual inspection of the core by an experienced geotechnical technician.

Two sub-samples should be taken at each depth at each station, as a full set of replicate subsamples will be collected. If the subsample consists of coarse gravelly material, a total of four sub-samples would be required.

The jars and containers should be clearly labelled and carefully packed to minimise the risk of breakage. The samples should be frozen and then sent to the analysing laboratory as soon as practical in insulated cool boxes with frozen ice-packs.

4 Sample analysis

The acquired samples will be analysed for radionuclides and chemical contaminants as recommended in OSPAR (2014). All analyses will be performed at an MMO validated laboratory and are described below.

4.1 Radiological analyses

Radionuclide analysis will be conducted by ɣ counting samples on a high purity Ge detector to detect any activity within the energy range 60 keV to 2 MeV, including the detection of ^{60}Co, ^{137}Cs, ^{226}Ra (via ^{214}Pb), ^{232}Th (via ^{228}Ac), ^{238}U (via ^{234}Th), and ^{241}Am. Assessment will be undertaken in line with the guidance for the dose assessment methodology for dredge operators and the public as detailed in IAEA (2003) and (2015) and in accordance with the current UK accepted methodology, described in RL05/06 (McCubbin & Vivan, 2006). Results will be compared against internationally accepted limits recommended by the IAEA (2003; 2004).

In addition, for one core at one outfall location and one core from one intake location, subsamples will be taken from all depths and Alpha spectroscopy will be used to determine the plutonium (Pu-239+240) and americium (Am-241) isotopes within these subsamples, in line with ISO 18589. This analysis will be undertaken on cores which are also used for the gamma spectroscopy, to enable direct comparison of results from each analysis.

4.2 Chemical analyses

Samples will be analysed to determine the concentrations of metals, organotins, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) and the results compared with Cefas Action Levels (MMO, 2015).

PAHs
Analysis for PAHs listed in Table 5 will be achieved using gas chromatography-mass spectrometry (GC-MS). Additionally, a total hydrocarbon (THC) measurement will be performed using UV fluorescence spectrophotometry calibrated with a Forties oil standard.

Metals (partial digestion)
The metals listed in Table 5 will be analysed using microwave digestion with nitric acid and subsequent analysis by inductively coupled plasma mass spectroscopy (ICP-MS) and inductively coupled plasma optical emission spectroscopy (ICP-OES).

Organotins
The organotins listed in Table 5 will be extracted from the sediment sample, converted into their hydrides using sodium borohydride and analysed by gas chromatography – flame photometric detection (GC-FPD).

PCBs
For the analysis of the PCBs listed in Table 5, the sediment samples will be dried and sieved to a less than 2 mm fraction. The dried sediment will be extracted by soxhlet, and the extracts cleaned and analysed by gas chromatography with electron capture detection (GC-ECD).

The limits of detection and quantification of the analyses to be conducted are shown in Table 5.

Table 5: Analytical method detection limits for metals, organotins and PAHs and limits of quantification for PCBs.

Determinant	Limit of detection (dry weight basis)
Metals (Partial Digestion)	
Arsenic (As)	0.01 mg/kg
Cadmium (Cd)	0.01 mg/kg
Chromium (Cr)	0.01 mg/kg
Copper (Cu)	0.01 mg/kg
Lead (Pb)	0.01 mg/kg
Mercury (Hg)	0.006 mg/kg
Nickel (Ni)	0.01 mg/kg
Zinc (Zn)	0.20 mg/kg
Organotins	
Tribultyl tin (TBT)	2 µg/kg
Dibutyl tin (DBT)	2 µg/kg
Polyaromatic Hydrocarbons (PAHs):	
Acenaphthene	0.1 µg/kg
Acenaphthylene	0.1 µg/kg
Anthracene	0.1 µg/kg
Benzo[a]anthracene	0.1 µg/kg
Benzo[a]pyrene	0.1 µg/kg
Benzo[b]fluoranthene	0.1 µg/kg
Benzo[e]pyrene	0.1 µg/kg
Benzo[ghi]perylene	0.1 µg/kg
Benzo[k]fluoranthene	0.1 µg/kg
C1-Naphthalenes	0.1 µg/kg
C1-Phenanthrenes	0.1 µg/kg
C2-Naphthalenes	0.1 µg/kg
C3-Naphthalenes	0.1 µg/kg

Chrysene	0.1 µg/kg
Fluoranthene	0.1 µg/kg
Fluorene	0.1 µg/kg
Indeno[123-cd]P	0.1 µg/kg
Naphthalene	0.1 µg/kg
Perylene	0.1 µg/kg
Phenanthrene	0.1 µg/kg
Pyrene	0.1 µg/kg
Dibenz(a,h)anthracene	0.1 µg/kg
Total Hydrocarbon Content (THC)	0.1 mg/kg
25 Polychlorinated Biphenyls (PCBs) congeners (as per IUPAC nomenclature):	
CB 18, CB 28[a], CB 31, CB 44, CB 47, CB 49, CB 52, CB 66, CB101[a], CB 105, CB 110, CB 118[a], CB 128, CB 138[a], CB141, CB149, CB 151, CB 153[a], CB 156, CB 158, CB 170, CB 180[a], CB 183, CB 187, CB 194	**Limit of quantification** Per congener = 0.2 µg/kg Sum of ICES7 = 1.4 µg/kg Sum of 25 congeners = 5.0 µg/kg Key = [a] ICES7 congener

4.3 Particle size analyses

Particle size analysis (PSA) will be carried out in accordance with NE Atlantic Marine Biological Analytical Quality Control Scheme (NMBAQC) best practice guidance (Mason, 2011).

If frozen, samples will be defrosted prior to analysis and a representative subsample taken. Laser diffraction will be carried out on the <2 mm sediment using a Beckman Coulter LS13320 laser sizer (or similar). The remainder of the subsample will be wet sieved using a 1 mm sieve. The >1 mm sediment fraction will be oven dried and then dry sieved at half phi intervals. The <1 mm sediment fraction will be oven dried and the weight recorded. The sieve and laser data will be merged to produce a full Particle Size Distribution (PSD) at half phi intervals.

5 Reporting

Following analysis of the sediment samples, the results of the analyses undertaken will be reported to the appropriate regulatory body together with an assessment of whether the analysis results indicate that the sampled sediments are suitable for disposal to sea. The results and assessment will be submitted to the appropriate regulatory body for approval prior to dredging works commencing.

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Appendix A Indicative sample station locations

Table 6: Indicative sample station locations from Figure 1. Actual sampling stations may vary and would be confirmed prior to works being undertaken.

Sample station ID	Easting (m)	Northing (m)	Dredge licence area
1	318095	148923	Intakes 21 & 23
2	318039	148819	Intakes 21 & 23
3	318165	148712	Intakes 21 & 23
4	318095	148596	Intakes 21 & 23
5	318232	148797	Intakes 21 & 23
6	317950	148760	Intakes 21 & 23
7	318117	148817	Intakes 21 & 23
8	318254	148610	Intakes 21 & 23
9	318452	148985	Intakes 11 & 13
10	318616	148840	Intakes 11 & 13
11	318565	149093	Intakes 11 & 13
12	318382	149044	Intakes 11 & 13
13	318720	148795	Intakes 11 & 13
14	318490	148851	Intakes 11 & 13
15	319040	147486	Intakes 11 & 13
16	319083	147681	Intakes 11 & 13
17	319026	147257	Outfalls and floatation pocket
18	319179	147341	Outfalls and floatation pocket
19	319040	147486	Outfalls and floatation pocket
20	319083	147681	Outfalls and floatation pocket
21	319246	147655	Outfalls and floatation pocket
22	319281	147510	Outfalls and floatation pocket
23	319241	147298	Outfalls and floatation pocket
24	319077	147362	Outfalls and floatation pocket
25	319190	147502	Outfalls and floatation pocket
26	319120	147585	Outfalls and floatation pocket
27	320252	146681	FRR
28	320165	146726	FRR

Sample station ID	Easting (m)	Northing (m)	Dredge licence area
29	320272	146591	FRR
30	319204	146602	Jetty berthing pocket
31	319405	146538	Jetty berthing pocket
32	319318	146548	Jetty berthing pocket
33	319170	146479	Jetty berthing pocket
34	319254	146521	Jetty berthing pocket
35	319322	146621	Jetty berthing pocket

Locations of the ten additional contingency stations have not been included in Table 6, as the requirement for the additional contingency stations had not been confirmed; they are included to ensure a worst case volume is assessed. The six jetty berthing pocket stations (stations 30 to 35) may vary as the jetty dredge area had not been finalised at the time of writing.

Final sampling station locations and additional contingency stations (if required) will be provided in a detailed method statement once dredging plans and any further sampling requirements are confirmed, prior to carrying out the works.