ABERDEEN HARBOUR EXPANSION PROJECT

Construction Environmental Management Document

21 October 2019

AHEP-DRA-APP-0001 REV 7

DRAGADOS

Contents

Chapter 7

Dredging and Dredge Spoil Disposal Management and Monitoring Plan

Revision Log

A number of changes have been made to the document. Significant changes to sections/ paragraphs are highlighted throughout the document.

Revision Number	Date	Location of Revision	Revision Details
Rev 4	16/05/2018	Front of Document	Document updated to Revision 2 and date updated
		Throughout document	Reference to JDN removed. Reference now made to ‘dredging contractor’
		Throughout document	Figures updated to remove JDN drawings and add site specific figures where possible.
		Section 7.1.1	Text updated to remove JDN specific information
		Section 7.1.2	Table updated to remove individuals names
		Section 7.5	Heading of section updated however section text has not changed.
		Throughout document	Complete check for approval and adjustments/additions by VO
		Throughout document	Update based on CMS and VO Detailed Plans
		Appendices	All appendices updated
Rev 5	22/01/2019	Front of Document	Document updated to Revision 5 and date updated
		Section 7.1.2	Removed reference to Dredging Contractor Environmental Engineer and Surveyor in roles and responsibilities
		Section 7.2	Added reference to approved method statements found in Chapter 11 MMMP
		Section 7.3	Added reference to approved method statements found in Chapter 11 MMMP
		Section 7.3.3	Reworded section to include current works rather than future works, updated flowchart
		Section 7.3.4	Updated marine blasting communication protocol
		Section 7.3.5	Reference added to include land blasting method statements in Chapter 11 MMMP

		Section 7.5.2	Updated sediment sampling completed in 2018
		Section 7.6	Text edited to reflect current status with suspended sediment monitoring
		Section 7.6.1 / 7.6.2	Sections added from approved Dredge Plan 2018
		Section 7.6.6	Added in section for approved monitoring
		Section 7.7	Updated reporting commitments and added table
Rev 6	15/10/2019	Front of Document	Document updated to Revision 6 and date updated
		Throughout document	Figure numbers updated
		Throughout document	The word “disposal” has been changed to “deposit” when in reference to dredging activities.
		Section 7.2.1	Figure 7.1 updated Figure 7.2 updated
		Section 7.3.3	Maximum charge weight increased to 100kg to be consistent with EIAR
		Section 7.4.3	Added non-native species to environmental awareness training Updated environmental engineer reference to ECoW.
		Section 7.4.7	Moved information regarding anti biofouling from 7.4.8 to 7.4.7 where it is more appropriate.
		Section 7.5.2	Updated to include 2019 sediment sampling
		Section 7.5.3	PCBs removed from sediment sample test suite Updated procedures for the storage and submission of duplicate dredge sediment samples
		Section 7.5.4	Updated exceedance response procedure to coincide with updates to 7.5.3
		Section 7.6	Removed paragraph regarding request to remove suspended sediment monitoring
		Section 7.7	Reporting commitments updated
Rev 7	21/10/2019	Section 7.3.3	Figure 7.12 removed because it’s a duplicate of section 7.3.4

		Section 7.3.2	Updated the number of drilled holes
		Section 7.2.1	Table 7.2 updated

Contents

7 Dredging and Dredge Spoil Disposal Management Plan

7.1 Introduction

7.1.1 Outline

For the Aberdeen Harbour Expansion Project (AHEP), Dragados will work with the dredging contractors to undertake the dredging works including drill and blast operations. This plan outlines the approach for the environmental management and monitoring of the dredging and dredged material deposit activities.

The dredging contractor will establish, implement and maintain documented environmental objectives and targets, at relevant functions and levels within the organization. The objectives and targets will be measurable and consistent with the AHEP environmental policy, including the commitment to prevent pollution, to comply with applicable legal and other applicable requirements, and to improve continually.

In addition to the AHEP environmental policy, the dredging contractor will comply with the project objectives and targets.

During the execution of the project, the following aims will be taken into account:

- To mitigate the impact on the environment caused by construction activities;
- To minimise any disturbance to the human population and to the fauna and flora;
- To minimise waste production;
- To prevent any contamination of the land and marine environment through disposal of waste, spillages or leakages of chemicals; and
- To ensure the project is implemented in accordance with environmental permits and requirements.

The dredging contractor will execute the works in compliance with the requirements set out in the AHEP Environmental Statement (ES, 2015) and subsequent additional information, Marine Licenses (ML), Harbour Revision Order (HRO) and applicable laws.

7.1.2 Roles, Responsibilities and Cross-Referencing

Table 7.1 details the responsibility of selected staff with regards to construction dredging and blasting.

Table 7.1: Roles and Responsibilities Table

Job Title	Responsibilities
Dredging Contractor Project Manager	Responsible for all dredging and blasting activities, including HSE and complying with all relevant regulations. Managing the relevant parts of the CEMD. Task delegation.
Dredging Contractor Works Manager	Coordination of all works, including dredging operations, liaising with superintendent, engineers, captains and/ or crew.
Dragados Environmental Manager	Ensure the Dredging Contractor is following all applicable CEMD Plans and dredging according to the relevant Marine Licence.
Dragados Environmental Clerk of Works (ECoW)	Toolbox Talks, Audit the dredging contractor procedures

7.1.3 Cross-Referencing

The Dredging and Dredge Spoil Disposal Management Plan should be read in conjunction with the following CEMPs:

- Construction Method Statement;
- Waste Management Plan;
- Pollution Prevention Plan;
- Vessel Management Plan;
- Marine Mammal Mitigation Plan;
- Fish Species Protection Plan; and
- Nigg Bay Site of Special Scientific Interest (SSSI) Management Plan.

7.2 Dredging and Marine Drilling and Blasting

Detailed information on the approved construction methods for the complete development are available in:

- Construction Method Statement (CMS), Chapter 3 of the Construction Environmental Management Document (CEMD);
- Chapter 11 of the Marine Mammal Mitigation Plan

7.2.1 Work Method Statement and Planning

The material to be dredged can be split up in three main types of soil: gravelly sand, a layer of glacial till (a glacial deposit consisting in general of over-consolidated sediments as a mixture of hard clay, very dense silt, sands, gravels, cobbles and boulders) and zones with hard rock (granite and gneiss). Because of these different soil types, different types of dredging equipment are needed to complete this work.

The main part of the top sand layer and the underlying glacial till will be dredged by the Back Hoe Dredger (BHD). The BHD will load the dredged material straight into split hopper barges (SHB) with capacities of $800m^3$ and $2850m^3$. The barges will transport the dredged material to the designated deposit site and deposit its load by splitting the hopper. A Trailing Suction Hopper Dredger (TSHD) will also be used to remove the softer material. The Drilling and Blasting will start once the top layer of softer material is removed using the BHD/TSHD. The BHD will also be used to dredge the blasted rock for re-use.

Dredging will be undertaken 24 hours a day, 7 days a week; the blasting will only be undertaken during daylight hours. The Marine Licence allows the deposit of 2,190,000 m^3 at the deposit site (Table 7.2). Some of the material that will be dredged at the entrance channel will be re-used as fill for the caissons and the reclamation area behind the North Breakwater. Rock will be reused in the breakwaters and elsewhere in the construction process.

Table 7.2: Dredge area and volumes

Dredge Area	License Depth m	Area m^2	Approximate Dredge Volume m^3	Approximate Dredge Volume Wet Tonnes
Harbour Basin	-9	287,348	2,254,627	4,841,515
North Quay	-9.85	12,033	39,600	85,035
East Quay	-12.95	53,205	258,700	555,525
Entrance Channel	-10.5	93,425	95,900	205,932
South East Pier	-11.45	15,945	102,500	220,105
SBW Roundhead	-15.24	9,602	12,200	26,198
West quay	-12.55	Included within harbour basin		
Total		**471558**	**2,762,527**	**5,932,163***
* Total Includes dredged material to be reused in the construction of AHEP so maximum deposit at CR110 will not exceed 4,702,737 wet tonnes / 2,190,000m^3				

The area in which dredging works will be executed is shown Figure 7.1 and blasting in Figure 7.2. The licensed offshore Deposit Ground (CR110) is situated 2.2 nautical miles south east of the dredge area. It should be noted that Figure 7.2 has been updated to reflect a change in the blasting area due to updated geophysical information. The amount of blasting required and the amount of material to be removed has not changed (Table 7.2) from previous CEMD versions.

Dragados will follow the below communication protocol prior to blasting:

1.5 Hour prior to blasting

- Blast master informs PAM, MMO and environmental monitoring vessels so that equipment can be prepared

1 Hour prior to blasting

- Inform Aberdeen VTS (VHF Ch 12 – "1 Hr to blasting commencing Marine Blasting procedure")
- Inform other AHEP vessels (VHF Ch 13 – "1 Hr to blasting commencing Marine Blasting procedure")
- Inform Dragados UK so that land based exclusions can be readied and land based vibration monitoring equipment be checked
- Environmental vessel to start a 1km inspection of swimmers/pleasure craft/ marine mammal
- Initiate pre blast Passive Acoustic Monitoring (PAM) System – PAM operator to undertake monitoring within the 1km exclusion zone of the site of the proposed blast.
- Commence pre blast Marine Mammal Monitoring – MMO Observer to undertake monitoring within the 1km exclusion zone of the site of the proposed blast.
- Inform ATC Watch Manager (Air Traffic Navigation Service) 01224 727160
- Clean out Double Bubble Curtain

30 Minutes prior to blasting

- If any Marine Mammals enter the 1 km mitigation zone 30 minute prior to blasting, the Blast is postponed. Blast Master to inform all AHEP vessels. VHF 13 "Blast delayed until further notice"
- PAM/MMO watch continues until mammals depart the area at which point the 30 minute watch commences
- The Lead PAM then confirms to the Blast Master that blasting preparation can continue
- Blast Master instructs all AHEP vessels on VHF13 "30 minutes to blasting all required vessels to depart Nigg Bay"

15 Minutes prior to blasting – 1st Blasting Warning

- Inform Aberdeen VTS (Ch 12 – "15 Minutes to Marine Blasting, exclusion zone all clear")
- Inform other AHEP vessels (VHF Ch 13 – "15 Minutes to blasting, exclusion zone all clear")
- Drilling pontoon at safe distance – minimum of 50m
- Blast Master to check that exclusion zone clear of swimmers/pleasure craft/marine mammal/personnel/rafting birds

- Blast Master to check that exclusion zone clear of other vessels (minimum of 100m)
- Deploy the acoustic fish scare detonation
- Initiate Double Bubble Curtain and check fully operational

5 Minutes prior to blasting – 2nd Blasting Warning

- Inform Aberdeen VTS (Ch 12 – "5 minutes to Marine Blasting, exclusion zone clear and ready to fire")
- Inform other AHEP vessels (VHF Ch 13 – "5 minutes to Marine Blasting, exclusion zone clear and ready to fire")
- Confirmation from shot firer – ready to fire
- Blast Master to check that exclusion zone clear of swimmers/pleasure craft/marine mammals/personnel/rafting birds
- Blast Master to check that exclusion zone clear of other vessels (100m)
- Deploy the acoustic fish scare detonation if required
- Sound horn - 2 x 5 seconds

Third/Last Blasting Warning and post blast

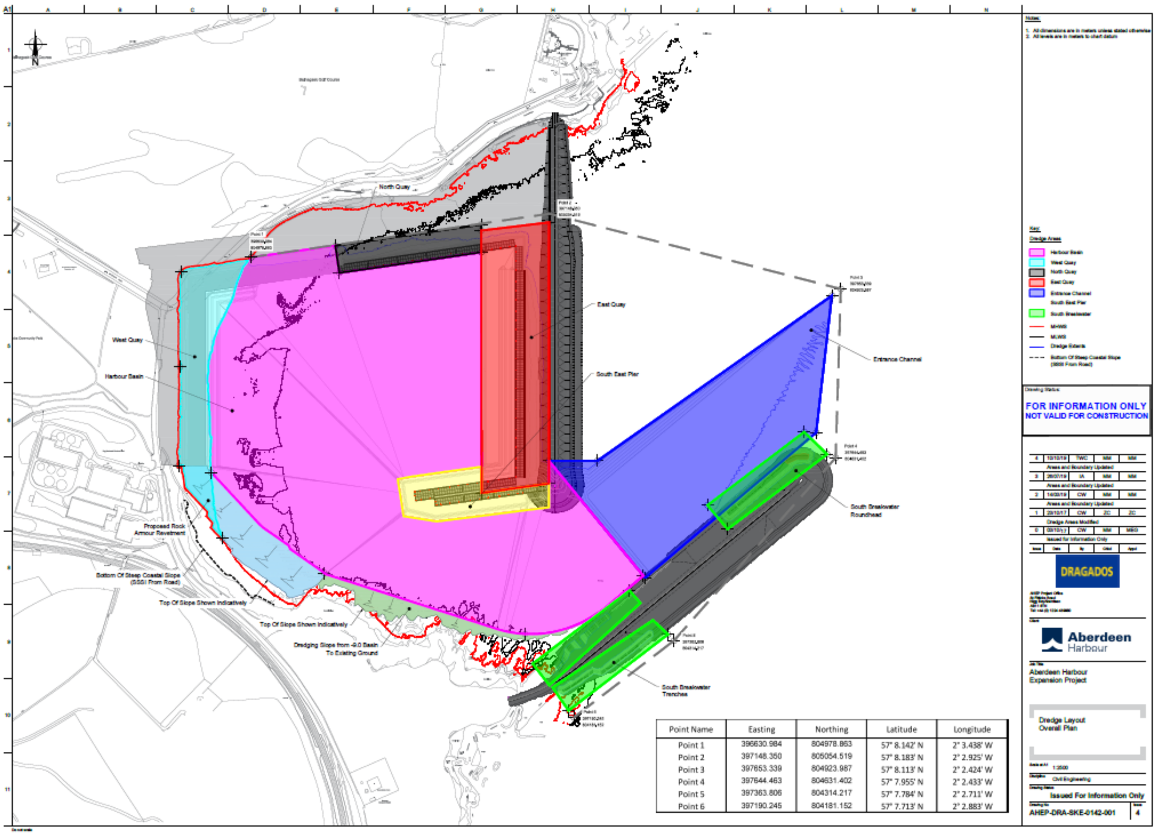

Figure 7.1: Dredge area

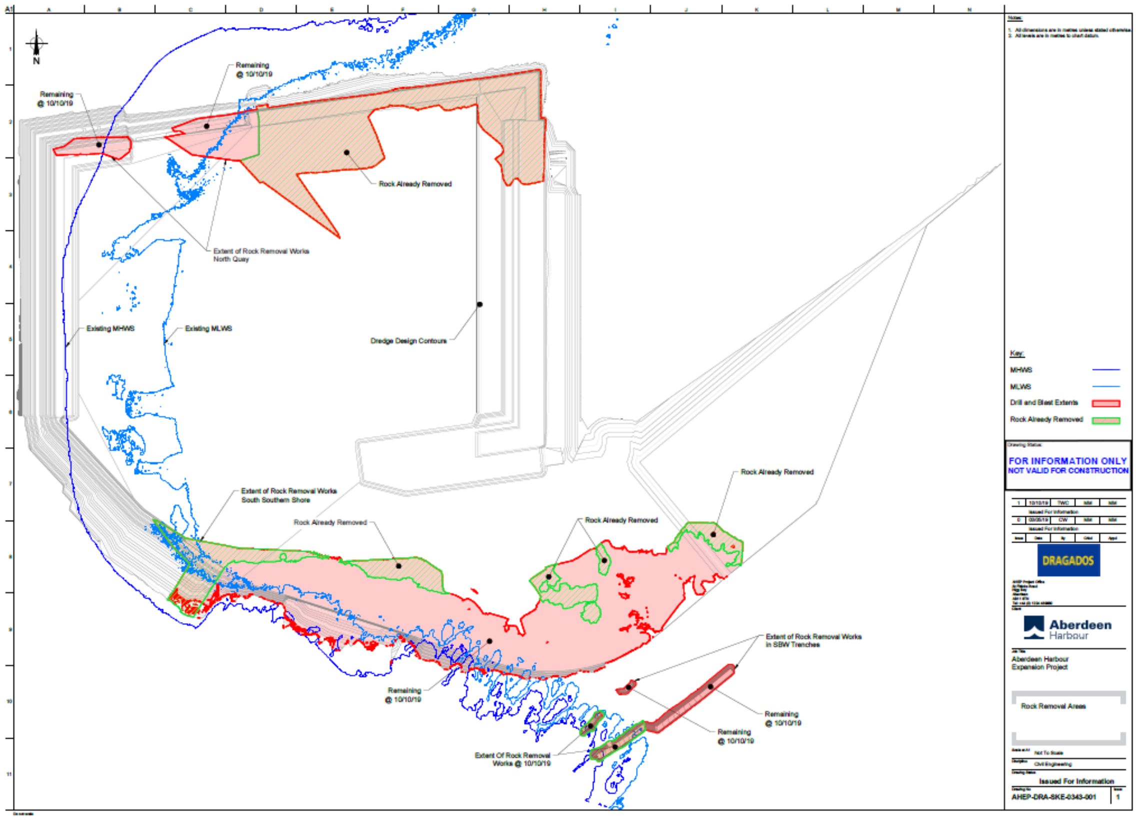

Figure 7.2: Areas where rockbreaking has taken place (green) and is due to take place (red).

Dragados will inform the licensing authorities the name of the vessels that will be mobilised for implementation of the works. A Notice to Mariners will also be released stating the nature and duration of the activities. This will follow processes detailed in the Vessel Management Plan.

Blasting activities have been registered in the Marine Noise Registry 7 days prior to start-up.

All works will be undertaken according to dredging best practices. The specific management measures that will be taken to minimise the impact on the environment are stated below.

7.2.2 Dredging Techniques

7.2.3 Trailing Suction Hopper Dredger (TSHD)

The TSHD is a sea-going, self-propelled vessel and its main working components and their respective function in the dredging process are briefly explained below.

A TSHD is in general deployed for the mining and hauling of granular materials and the dredging of soft to firm clays. An example of a TSHD is shown on Figure 7.3. A TSHD will store the dredged materials in its cargo hold, called the hopper.

Figure 7.3: Example of a TSHD (Van Oord Costa Verde)

Conventional hopper dredging activities can be divided in following consecutive activities: loading (dredging), sailing loaded, unloading and sailing back empty. A complete set of these four activities is called a dredging cycle.

7.2.4 TSHD Dredging

The dredging systems of a TSHD consist of one or two suction tubes, each driven by a powerful centrifugal pump, called the sand pump. During the dredging, and in a process which is quite similar to a hoover, the lower ends of the suction tubes are trailing along on the seabed, while the sand pumps provide the suction power to lift the materials from the seabed into the hopper.

The dredging cycle starts with the empty TSHD sailing to the dredging area guided by its in-house developed, highly accurate navigation systems. Once the TSHD approaches the dredging area, the sailing speed is reduced and the suction tubes will be hoisted over board and lowered to the seabed.

Figure 7.4: TSHD draghead (Van Oord Volvox Terranova)

At the lower end of the suction tube, a special draghead is attached which is designed for maximizing the dredging production during the loading phase (see Figure 7.4). The suction power is provided by the sand pump, which is normally installed in the pumproom in the engine rooms of the dredger. Alternatively, the suction power can be provided by an underwater pump mounted on the suction tube itself. This underwater pump enables high dredging productions at greater water depths.

During the dredging, while the draghead is on the seabed, the TSHD will maintain a low trailing speed. Such trailing speed is depending on the nature of the materials being dredged. The materials lifted from the seabed are pumped into the hopper (see Figure 7.5) as a soil/water mixture. Care is taken to minimise the water content in the mixture.

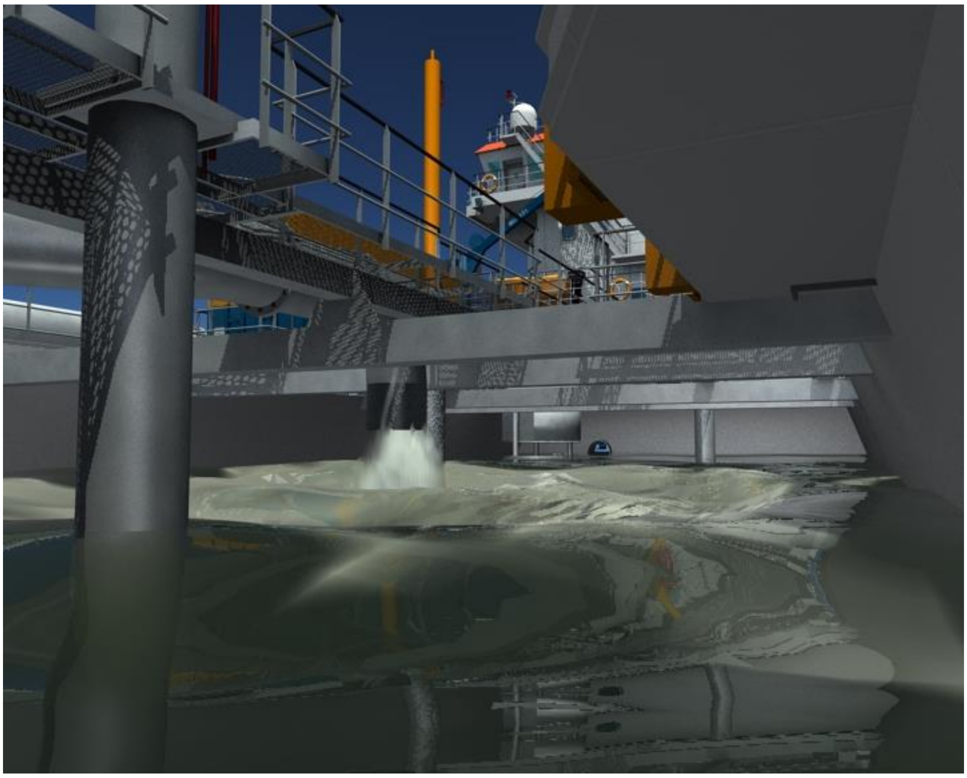

Figure 7.5: Hopper well (Van Oord Volvox Olympia)

Specialised operators control the highly computerised dredging process. Whilst the dredge master and the navigating officer will each be responsible for their own area of control, they will co-operate closely. The computerisation covers all possible parameters involved in the dredging including dredging productions, engine and pump loads, draghead positions and hopper levels, amongst others.

While the soils in the dredged soil/water mixture will settle in the hopper due to the gravity forces, the excess water is discharged via an adjustable overflow system. The overflow, which is built inside the hopper, consists of a height adjustable funnel mounted on top of a vertical cylinder which ends under the keel of the dredger. The excess water is discharged under the dredger, which is the lowest level possible, thus minimising the dispersion of fines into the surrounding waters.

7.2.5 TSHD Discharging / Deposit

As soon as the hopper is fully loaded, the suction tubes will be hoisted back on board and course will be set towards the deposit site/reuse area. During this transit the hopper dredger is sailing as a regular cargo vessel.

There are several ways to discharge the hopper load.

a) Bottom door deposit

The fastest way to unload the hopper is by discharging the load through the opened bottom doors of the hopper.

When the hopper dredge has arrived at the deposit site / stockpiling area, for re-use and the navigating officer is confident that the hopper dredge is on the area where the hopper load is to be unloaded, the command will be given to open the bottom doors to dispose the hopper load. Waterjets inside the hopper will ensure the hopper is completely empty and free of dredged material prior to closing the bottom doors.

A new dredging cycle can commence by sailing back to the dredging area.

b) Pumping ashore

Some TSHDs are equipped with pumping ashore facilities. This enables them to pump the hopper load ashore into a reclamation area, either directly via pumping at high pressure creating an arc of material (so-called Rainbowing; see Figure 7.6), or indirectly via a combination of a floating (or sinker) pipeline and shore pipelines (see Figure 7.7). To this end a coupling system will be prepared consisting of a flexible floating (or sinker) pipeline with at its seaside end a special bow connection piece. The other end is connected to the shore pipeline. The hopper dredger, upon arrival at the coupling area, will be connected via the bow connection on board to this floating pipeline. Now the jets in the hopper will fluidise the sand in the hopper. The sand pumps will pump this fluidised mixture of sand and water through the pipelines to the reclamation area.

Figure 7.6: Pumping ashore via rainbowing (Van Oord HAM317).

Figure 7.7: Pumping ashore via pipeline system (Van Oord Costa Dorada)

7.2.6 TSHD Control Over the Dredging Operations

Control over the dredging operations is provided using following systems:

- DGPS positioning system: all main vessels are equipped with a differential GPS which means that to augment the accuracy of the coordinates acquired from the

GPS satellites, a correction signal is received from a shore-based reference station. The position of this reference station is very accurately determined before it starts transmitting its corrective signal. The auxiliary craft are equipped with a GPS.

The position of the GPS receiving antenna that is mounted on board the TSHD is then used to compute the position of all the ship's major parts (essential in this exercise is the proper calibration of the ship's gyro compass).

- Survey computer: this system will take as inputs the DGPS-acquired position, the drag head position relative to the vessel tidal info and ship's heading. The outputs provided by this system are the position of the vessel and the drag head visualized on a screen with a bathymetric background, obstacles, buoys and of course the lines and limits of the project. A graphic representation of the survey data will be made so that the dredge master sees on his display how the drag head is positioned relative to the existing seabed and the profile that needs to be dredged. A plan view can also be generated with a colour chart showing the areas and quantities still to be dredged.
- Survey feedback: at regular intervals newly acquired survey data will be fed into the survey computer so that the dredge master is always presented with the most actual seabed 'view'. The quality and speed of this feedback is of great importance for not only the efficiency of the dredging process but of course also the overall result, i.e. working within the specified tolerances.

7.2.7 Backhoe Dredger (BHD)

The backhoe dredger (BHD) is a common type of dredger, and can be either self-propelled or reliant on tugs. The main component is a hydraulic excavator, performing the dredging operation, mounted on a pontoon (see Figure 7.8).

7.2.8 BHD Dredging

The BHD will either be self-propelled or towed into an approximate operating location by tugs, the BHD will subsequently be anchored by lowering the three heavy-duty spuds. The BHD will move into the exact starting position by using the walking spud/spudcarrier and the bucket. In general, the areas will be dredged in parallel lanes. The lane separation and bench-height will be decided during the dredging operation and are dependent on the nature and stability of the material, the siltation rate and the dredging capacity.

The dredging layout will take into consideration impacts from shipping activities, currents and wind and wave actions. Parts of the operation can if necessary be adapted to facilitate the dredging and other related activities. The start and end position as well as the bearing for each dredging line will be calculated in advance for the dredger to follow.

The most frequent width of one dredging lane will be 20 - 25 m. The dredger will dig steps of approximately 5m length. When one step is completed the dredger will release the front spuds from the sea bottom and raise them approximately 2m over the sea bottom. The walking spud/spudcarrier will shift the dredger 5m backward in the dredging lane and then start the new digging step. Depending on the equipment that is used, the dimensions may differ.

Figure 7.8: Backhoe dredger alongside a Split Hopper Barge (Goliath, Van Oord)

7.2.9 BHD Discharging / Deposit

The BHD can load a variety of barge vessels. The dredged material is transported to the area of deposit and unloaded via bottom doors or by discharging via excavators whilst alongside a quay wall (see Section 7.1.1).

7.2.10 BHD Control Over the Dredging Operations

For horizontal positioning the dredger will use Differential GPS systems in combination with gyrocompasses.

For controlling the bucket position, the dredger is fitted with IHC digviewer systems or similar. These systems will measure:

- The angles for the boom, stick & bucket;
- The pontoon draught;
- The pontoon tilt; and
- Bearing

The operator can follow the excavation operation on two video screens, one for horizontal bucket position and the other for vertical bucket position. The system will enable the dredge operator to follow the exact movements and the depth of the bucket, and facilitates digging in a controlled manner to the designed limits.

In this system the required dredging levels and slope angles can be pre-set in the computer so the operator can see the digging lines as well as the bucket position, in relation to the pre-set limits, on his video screens.

7.2.11 Cutter Suction Dredging (CSD)

A CSD may be deployed at AHEP if necessary. It is a stationary dredging vessel and its main working components and their respective function in the dredging process are briefly explained below. A CSD is in general deployed for the re-handling of sand and the dredging of stiffer clays and hard strata.

The cutter head is the rotating cutting tool mounted at the end of the cutter ladder that creates a mixture of material and water that can then be discharged hydraulically.

The cutter head consists of a set of blades that form a half-sphere shape. The number of blades and hence also the opening between them varies with the type of material that needs to be dredged. If required cutter heads can be changed in a fairly short time to cope with changing soil characteristics.

The rotating cutter head will first cut out the materials to be dredged, in order to get them in a suitable state for removal by hydraulic means. The loosened material then enters the suction mouth, passes through the suction pipe and the pump (or pumps) and into the delivery line. The CSD is operated by swinging about the central work spud using moorings leading from the lower end of the ladder to anchors. By pulling on alternate sides the dredge clears an arc of cut, and then moves forward by pushing against the work spud using the spud carriage.

The side anchors are lifted and moved forward when the dredge has progressed far enough and the force on the anchors is not sufficient anymore. The anchors are shifted using the dredge’s own anchor booms system or with an auxiliary anchor handling vessel.

The dredge material is disposed of as per TSHD.

7.2.12 Water Level Control

Water level information for all dredging will be provided by a radio-linked tide gauge. The tide gauge will be placed in the water close to the dredging area. The dredger will be equipped with a radio-linked receiver to monitor the tide level during the dredging operation. The “digviewer system” will receive the actual tide level several times per minute and the dredging depth is automatically updated.

7.2.13 Logging

The supervisor or the main operator on each shift will keep a log for noting events of significance for the dredging operation, such as operation hours, breakdowns, repairs, production rates, weather conditions, dredging area, dredging depth etc.

The area which has been dredged during the last shift will be marked on the specially designed dredging lay out drawings.

On board the dredging and barge vessels, a report will be completed for each load, specifying date, shift, load number, departure time from dredge area, the unloading berth and the unloading place.

7.2.14 Communication

All floating equipment will be equipped with VHF radio and mobile telephone.

7.3 Drilling and Blasting Techniques

For AHEP there will be drilling and blasting activities undertaken in the marine (i.e. from vessels/pontoons) and terrestrial environments. It should be noted that, whilst some of the land based drilling is below Mean High Water Springs (MHWS) the land based drilling is either on ‘made-up’ ground such as a working platform or existing land (i.e. the southern shore of Nigg Bay).

7.3.1 Marine Drilling

Marine drilling will be carried out using hydraulic drilling towers fitted with top hammer rotation units and down the hole hammers. The drill towers run on rails fitted to the deck of the pontoon giving them full coverage over one side of the pontoon (longitudinal) (see Figure 7.9).

The top hammer rotation units will be used to drive the casing and rotate the drill string. The drill strings will be fitted with down-the-hole hammers to maximise drilling power and the rate of penetration. The down-the-hole drill hammers will be powered pneumatically.

Figure 7.9: Typical drill tower (left) and drilling & blasting pontoon (right)

A typical work procedure entails that the holes are drilled in a sequence (see Figure 7.10) and such that the holes adjacent to the longitudinal free face are drilled first, thus allowing the shot to be safely fired even if the full pattern has not been completed. Stemming will be used for confining the explosive energy within the blast holes to more effectively fragment the rock.

Once a blast hole has been drilled, it will be charged with explosives and initiated with detonators. Drilling and charging will continue until the required numbers of holes of the pattern are completed.

After completion of drilled and loaded holes, the charges are connected to the blasting lines and the usual blasting warning procedure will take place. The shot firer will connect the firing line to the first hole blasted and check all the connections. The barge and other marine equipment will move clear of the area. Premature ground movement is prevented so the risk of cut-off and/or misfire is significantly reduced.

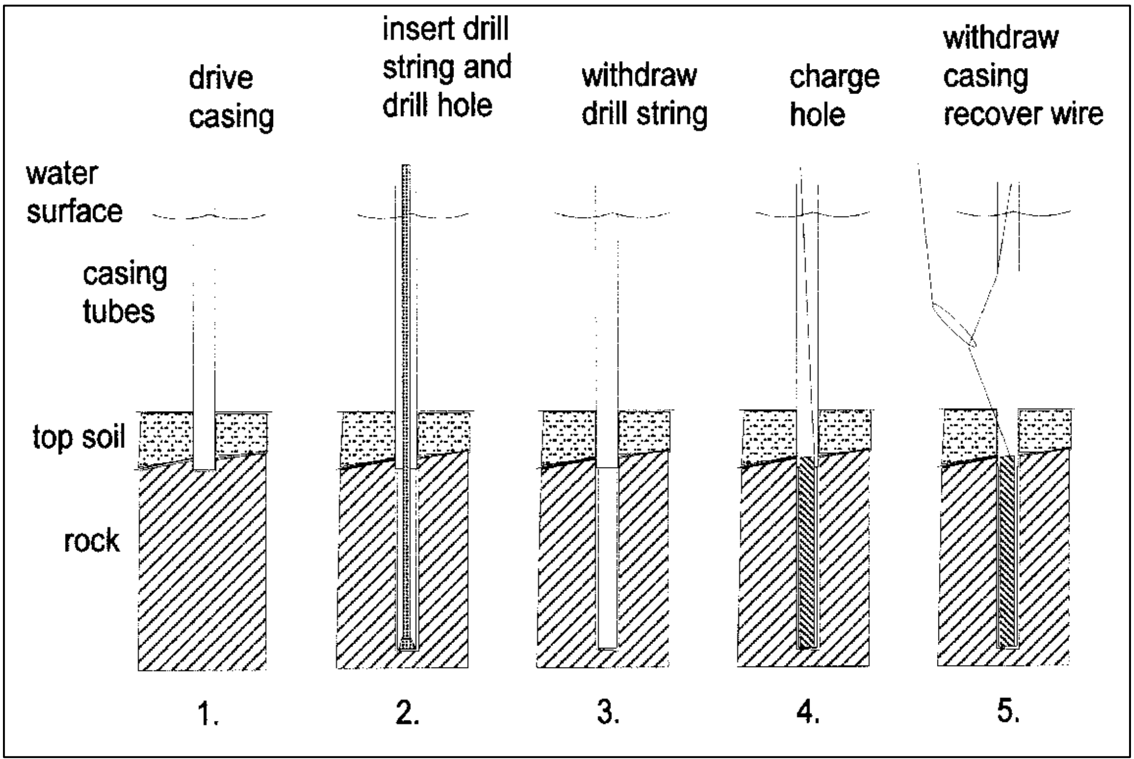

Figure 7.10: Drilling and charging sequence.

7.3.2 Working Principles Drilling

A drill tower will be positioned on site, either from a marine platform or directly onto land where applicable. For drilling, a heavy duty Top-hammer Rock Drill Sandvik Tamrock HL 1540 is used. 60 mm drill rods are used to drill holes in diameter ranging from 115 to 126 mm.

The drill tower is mounted to a frame which is holding the tower sideways from the platform over the water. From one spud position a total area of approximately 30x4m can be drilled. This usually means in practice two parallel rows of holes on a grid of 4 x 4 m (16 holes per spud position).

A typical field for blasting can be approximately 217 based on the blast programme in 2018

7.3.3 Marine Blasting

Once the required number of holes have been drilled and charged, the blasting procedure is undertaken to ensure that the danger zone and exclusion zones have been cleared so that the blast can be detonated safely. A blasting procedure, outlined in 7.3.4 has been prepared, to ensure the following:

- That exclusion zones for vessels, divers and marine mammals are inspected and cleared; and
- That relevant port users and other parties are informed.

Although the blasting procedure commences at 1 hour prior to blasting, charging may be completed after this time, provided that sufficient time is left to complete the connection of the initiation system and move the barge to a safe distance 15 minutes prior to blasting. The area around the firing will be restricted to the shotfirer and personnel working under his control required for the connection and blasting procedure. The marine assistance vessel is also used by a designated person who checks the lines and tubes after the blasting.

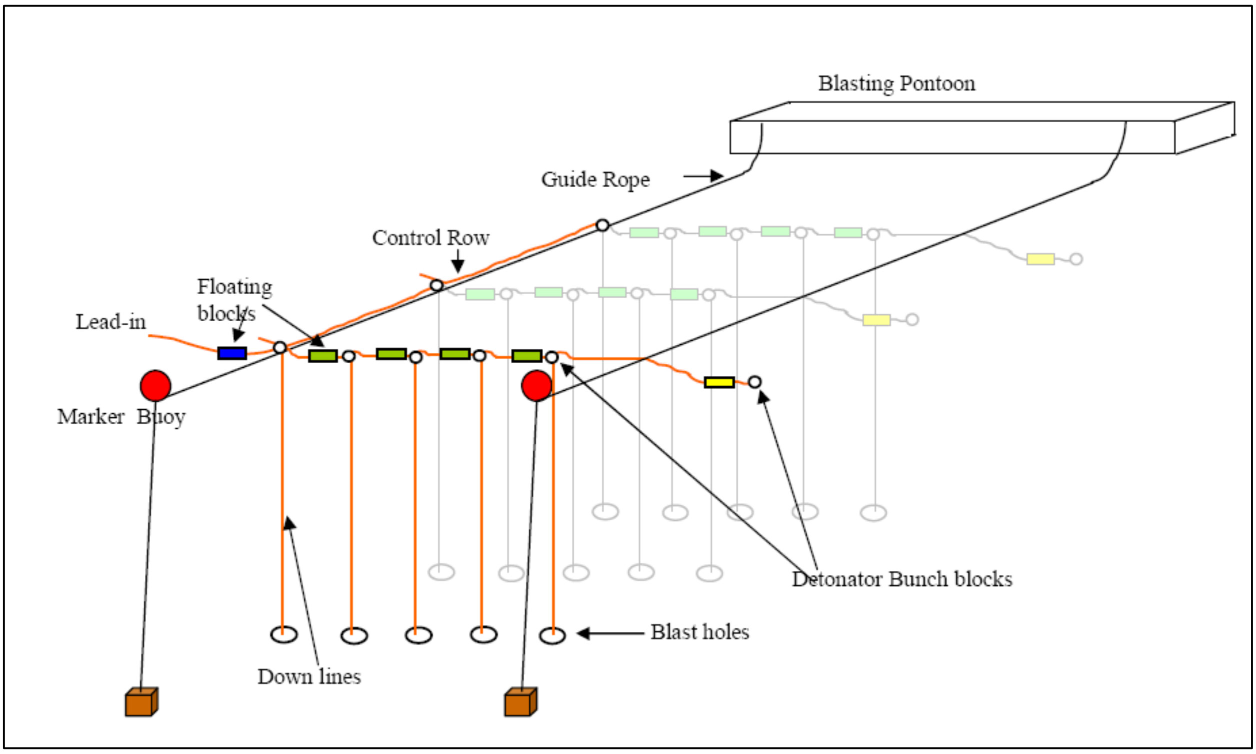

Figure 7.11: Typical layout of detonators of a marine blasting field.

Blasts are undertaken up to twice a day, depending on the number of loaded holes, but will only be carried out during day light. In the event that a full blast hole pattern is not completed during daylight, then only the smaller number of completed holes will be fired.

The minimum amount of blasting will be undertaken using the smallest practicable charge. Dragados are seeking to increase the charge weight in consultation with MS-LOT, SNH and WDC. Dragados have proposed to MS-LOT that an incremental increase of the charge weight should be undertaken with a precautionary approach and that charge weight will not exceed the 80kg that was assessed by Fugro in the Environmental Impact Assessment Report. The mitigations described in CEMD MMMP Section 11.7 provide checks and balances to ensure that marine mammals are not exposed to noise levels above the 183 dB re 1μPa (peak) equivalent to 170 re 1μPa (rms) at 400 m from the blast location or outside the double bubble curtain, whichever is the greater distance as assessed in the ES.

The coordinates of each area blasted will be properly recorded so that dredging of the broken rock can take place.

These blasting operations are being undertaken in an environmentally sensitive location so it is important that activities are undertaken in such a way that the vibration created by blasting activities is eliminated or controlled. The measures to minimise the impact of blasting are described in Chapter 11 of the CEMD: Marine Mammal Mitigation Plan. Cross reference should be made to Chapter 8: Fish Species Protection Plan.

A blasting and marine mammal protocol is included in CEMD Chapter 11, MMMP.

7.3.4 Marine blasting communication protocol

Dragados will follow the below communication protocol prior to blasting:

1.5 Hour prior to blasting

- Blast master informs PAM, MMO and environmental monitoring vessels so that equipment can be prepared

1 Hour prior to blasting

- Inform Aberdeen VTS (VHF Ch 12 – "1 Hr to blasting commencing Marine Blasting procedure")
- Inform other AHEP vessels (VHF Ch 13 – "1 Hr to blasting commencing Marine Blasting procedure")
- Inform Dragados UK so that land based exclusions can be readied and land based vibration monitoring equipment be checked
- Environmental vessel to start a 1km inspection of swimmers/pleasure craft/ marine mammal
- Initiate pre blast Passive Acoustic Monitoring (PAM) System – PAM operator to undertake monitoring within the 1km exclusion zone of the site of the proposed blast.
- Commence pre blast Marine Mammal Monitoring – MMO Observer to undertake monitoring within the 1km exclusion zone of the site of the proposed blast.
- Inform ATC Watch Manager (Air Traffic Navigation Service) 01224 727160
- Clean out Double Bubble Curtain

30 Minutes prior to blasting

- If any Marine Mammals enter the 1 km mitigation zone 30 minute prior to blasting, the Blast is postponed. Blast Master to inform all AHEP vessels. VHF 13 "Blast delayed until further notice"
- PAM/MMO watch continues until mammals depart the area at which point the 30 minute watch commences
- The Lead PAM then confirms to the Blast Master that blasting preparation can continue
- Blast Master instructs all AHEP vessels on VHF13 "30 minutes to blasting all required vessels to depart Nigg Bay"

15 Minutes prior to blasting – 1st Blasting Warning

- Inform Aberdeen VTS (Ch 12 – "15 Minutes to Marine Blasting, exclusion zone all clear")
- Inform other AHEP vessels (VHF Ch 13 – "15 Minutes to blasting, exclusion zone all clear")
- Drilling pontoon at safe distance – minimum of 50m
- Blast Master to check that exclusion zone clear of swimmers/pleasure craft/marine mammal/personnel/rafting birds
- Blast Master to check that exclusion zone clear of other vessels (minimum of 100m)
- Deploy the acoustic fish scare detonation
- Initiate Double Bubble Curtain and check fully operational

5 Minutes prior to blasting – 2nd Blasting Warning

- Inform Aberdeen VTS (Ch 12 – "5 minutes to Marine Blasting, exclusion zone clear and ready to fire")
- Inform other AHEP vessels (VHF Ch 13 – "5 minutes to Marine Blasting, exclusion zone clear and ready to fire")
- Confirmation from shot firer – ready to fire
- Blast Master to check that exclusion zone clear of swimmers/pleasure craft/marine mammals/personnel/rafting birds
- Blast Master to check that exclusion zone clear of other vessels (100m)
- Deploy the acoustic fish scare detonation if required
- Sound horn - 2 x 5 seconds

Third/Last Blasting Warning and post blast

- Blast Master conducts final checks that exclusion zone clear of swimmers/pleasure craft/personnel
- Blast Master conducts final check that exclusion zone clear of other vessels (minimum of 100m)
- Sound horn - 4 x 2 seconds, initializing blast on fourth signal
- Shot firer – Sound horn - One long blast if all clear
- All clear given to Aberdeen VTS (VHF 12) and other AHEP vessels (VHF 13) "Blasting complete - all clear - return to normal activities"
- AHEP vessels return to Nigg Bay in accordance with normal marine communication procedures
- Blast area will be checked for fish kills, and carcasses recovered if safe to do so. If dead salmon are found Marine Scotland and Dee District Salmon Fishery Board will be informed

7.3.5 Terrestrial Drilling and Blasting Techniques

The terrestrial drilling and blasting is similar to the marine blasting. Procedures and protocols are described in the Section above, within the CMS Section 5.3 and in the CEMD Chapter 11 MMMP.

For areas around the southern slopes of Nigg Bay, South breakwater trenches, and at the north open quay, it will be possible to undertake blasting from land, although this area is still below mean high water springs and hence part of activities managed through the Marine Licence(s).

Earthwork access platforms will be constructed which will also be used as access / haul roads and lay down areas. Holes will be drilled through the platform into the rock layers below and then explosives set into these holes. Once blasting is completed the fractured rock will be excavated and used to either create the next stage of the rock platform and ultimately in construction of the harbour such as placement in the southern breakwater or elsewhere. All blasting will be below the constructed platform and as such will not require containment.

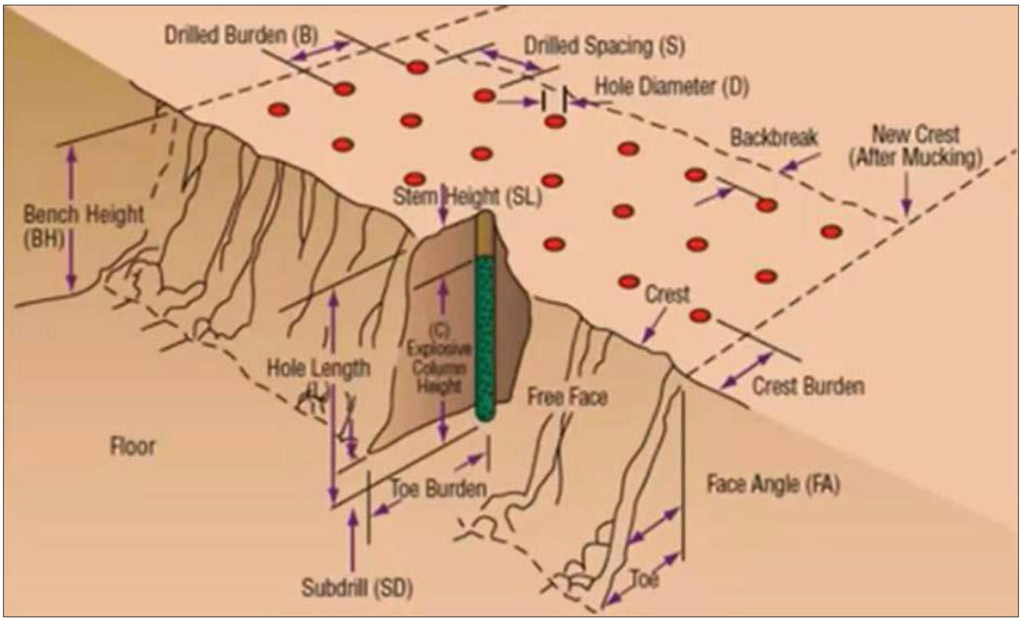

Figure 7.12: Typical layout of a terrestrial drill field

7.4 Environmental Management

7.4.1 Project Team Environmental Responsibilities

The dredging and/or blasting contractors Project Managers (PM) are responsible for all dredging and blasting activities, including HSE and will be the main interface with Dragados for all matters. The PM is responsible for the following environmental management aspects:

- Making sure that the project activities comply reasonably with regulations and requirements and that all employees understand the environmental requirements.
- Ensuring the availability of an effective Environmental Management System (EMS) and the implementation of this System and ensuring that appropriate technical and financial resources are made available to support the EMS.
- Verifying whether the different tasks are performed by qualified and competent personnel.

7.4.2 Environmental Coordination / Progress Meetings

Regular structured meetings will be undertaken to ensure that effective communications occur between Dragados EM, the dredging and/or blasting contractor PM and their representative.

7.4.3 Environmental Awareness Training

The dredging and/or blasting contractors will establish an Environmental training programme schedule which will cover all topics of the environmental management relevant to the project:

- Environmental responsibilities of all those on site;
- Contractor’s environmental policy;
- Significant environmental issues (e.g. marine mammals, reporting of dead fish);
- Areas of the site including site boundaries;
- Waste types, segregation method and location of waste disposal containers;
- Identification and reporting of non-native species
- Location of washing areas, refuelling stations and maintenance of vehicles, plant and equipment;
- Incident management and spill clean-up process;
- Emergency response plans; and
- Reporting process for environmental incidents, etc.

This programme will be initiated by the HSE department with input from the ECoW and will be included in the site induction for all staff arriving on site.

The dredging and/or blasting contractor will recognise that raising awareness of environmental risks to employees is an important preventive measure to avoid environmental incident or non-conformity.

In addition, specialist training will be given to individuals with specific roles and responsibilities. Specialised training will include but not be limited to:

- Handling of chemicals, fuel, organic solvents, toxic materials and hazardous wastes;
- COSHH Risk assessment;
- Accident and Incident investigation;
- Emergency preparedness and response;
- Firefighting;
- Spill control and response;
- First aid and CPR training; and
- Marine Mammal Observation

The dredging and/or blasting contractor will hold toolbox meetings at a regular and ad hoc basis after an accident, incident or a near miss should they arise. The meetings will be held by supervisory staff (HSE staff will assist) regarding subjects relevant to the work.

Toolbox meetings will take place in the team's work area, provided that the environment is suitable (e.g. safe location, absence of noise, disturbances, other teams or work nearby). The meetings will take place during working hours, at the (appropriate) time chosen by the supervision.

Records (signed attendance sheets) will be kept of each toolbox meeting including registration of the subjects discussed and attendants.

7.4.4 Waste Management and Hazardous Waste

The dredging and blasting contractors will work within the overarching Waste Management Plan, which can be found in Chapter 18 of the CEMD, with reference to the dredging contractor specific Waste Management Plan.

7.4.5 Sewage Management

International requirements for the prevention of pollution from sewage are contained in Annex IV of the International Maritime Organization's Pollution Convention, Regulations for the Prevention of Pollution by Sewage from Ships.

As applicable, all dredging and blasting contractor vessels will hold an International Sewage Pollution Prevention Certificate (ISPPC) and have an IMO/MARPOL MEPC.2 (VI) annex IV type approved waste water treatment installation (black and grey waste water) on board and will therefore not dispose untreated waste water during the project.

The dredging and blasting contractors will work within the overarching Vessel Management Plan, which can be found in Chapter 17 of the CEMD, with reference to the dredging contractor specific Vessel Management Plan.

7.4.6 Oil Spill Management

The dredging and blasting contractors will work within the Vessel Management Plan, which can be found in Chapter 17 of the CEMD, and the Pollution Prevention Plan, which can be found in Chapter 15 of the CEMD, both including oil spill contingency planning, with reference to the dredging contractor specific Oil Spill Contingency Plan.

7.4.7 Biosecurity Management

Reference is made to the Marine Non-Native and Biosecurity Management Plan, which can be found in Chapter 12 of the CEMD.

In line with international guidance on bio-fouling, and in order to reduce the potential for introduction or spread of Non-Native Species (NNS) submerged vessel surfaces will have been treated with antifoul coatings which will be maintained in accordance with manufacturers' guidelines. For further information on marine NNS, see CEMD Chapter 12 Marine Non-Native Species and Biosecurity Management Plan.

In regard to harmful anti-fouling paints, the dredging and blasting contractors will follow the IMO convention on the control of harmful anti-fouling systems on ships.

7.4.8 Ballast Water Management

The dredging and blasting contractors will work within the Vessel Management Plan and Marine Non-Native Species and Biosecurity Management Plan, Chapters 17 and 12 of the CEMD respectively, with reference to dredging contractor Vessel Management Plan. All dredging and blasting contractor vessels will comply with International Maritime Organization guidelines and have a Ballast Water Management Plan as well as a Statement of compliance for International Ballast Water Management.

7.4.9 Ambient Noise and Air Quality Management

Vessels and other equipment that the dredging and blasting contractors will assign for the project are designed to operate in accordance with appropriate industry and equipment standards, including specifications for sound levels and air pollution.

The dredging and blasting contractors will have the required control and maintenance measures in place on their vessels and for the equipment concerning occupational noise and air quality (see CEMD Chapter 13 Noise and Vibration Management Plan). Vessel traffic will be restricted to the working hours where practicable (see CEMD Chapter 17 Vessel Management Plan).

Concerning air quality, reference is made to the MARPOL 73/78, Annex VI 'Regulations for prevention of air pollution', Regulation 16 'Shipboard incineration'. The rules set limits on sulphur oxide (SOx) and nitrogen oxide (NOx) emissions from ship exhausts and prohibit deliberate emissions of ozone depleting substances.

7.4.10 Underwater Sound Management

The environmental consequences of drilling and blasting are dependent on the sensitivity of receptors, the proximity of receptors to the underwater noise source and the nature of both the direct (seabed disturbance and habitat alienation) and indirect (sedimentation and reduced water quality) potential effects. To reduce the propagation of underwater noise a double air bubble curtain will be installed between the blasting area and the open sea and Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM) deployed. Testing of the double bubble curtain has been undertaken to ensure the effectiveness of the curtain in sound attenuation. All mitigation measures and testing are described in Chapter 11 of the CEMD: Marine Mammal Mitigation Plan. Cross reference should be made to Chapter 8: Fish Species Protection Plan.

7.5 Dredging Material Monitoring Plan

7.5.1 General

The ES and additional surveys by Aberdeen Harbour Board have shown that given the low levels of contaminants in the sediment, no significant release of pollutants into the water column is anticipated to occur as a result of the dredging and deposit activities. The residual effect of the operations is believed to be negligible. This is due to the relatively localised nature of contaminants within the sediment and the substantial dilution that will occur during the dredging process. This is discussed in more detail in Section 7.5.2.

7.5.2 Marine Contamination Assessment Summary

An extensive programme of sampling and testing of marine deposits has been undertaken between 2013 and 2018. The 2016 surveys sampled 34 locations with sub-samples from each core analysed at 0.5-1m intervals, providing a comprehensive 258 samples for analysis. Sediment sampling was undertaken during the 2018 dredging activities, 31 samples were taken in the north and east quay areas, a further 27 samples were collected during 2019 dredging activities (not including the monthly deposit site samples).

The pre-dredging sampling results indicate levels of heavy metals above AL1 at several locations spread across the bay, although many of them had values only slightly above AL1 for only 1 or 2 heavy metals. Only 6 locations showed levels of several heavy metals higher than AL1 but still well below AL2. PAH levels above AL1 were only found in the upper sand layer, therefore when dredging the underlying glacial till it is not expected to have levels of PAH above AL1. For TBT and PCBs, no concentrations above AL1 were found at all in any of the sampled locations or depths. During the 2018 dredging operations heavy metals (predominately Cadmium, Chromium, Copper and Nickel) and PAH were identified above AL 1, no concentrations above AL 2 were identified in any of the sediment samples. Similar results were noted in 2019 as heavy metals (predominantly Chromium, Copper and Nickel) and PAH were identified above AL1 though again no AL2 exceedances were noted.

Following discussion and agreement with Marine Scotland, a further marine sediment assessment was undertaken on contamination test data from the 2013[1] and 2016[2] Ground Investigation surveys. The test data was compared to published Effects Range Medium (ERM) and Effects Range Low (ERL) sediment toxicity datasets (Goreham-Test 1998[3], Long et al 1998[4]) to assess the potential risk of actual biological effects being realised from contaminants within the sediments, namely heavy metals and individual polyaromatic hydrocarbons (PAH's).

The ERL/ERM method of assessment is adopted by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) in England for the monitoring of dredged material deposit sites in England.

The ERL/ERM assessment[5][6] concluded that for both heavy metals and PAH's that:

- Isolated elevations of concentrations of contaminants above the ERM were recorded; however, the extent of material that exceeds the ERM is relatively localised in the vertical and horizontal planes with the vast majority of samples recorded at levels closer to or below the ERL. Adverse biological effects are rarely observed at concentrations below the ERL with the ERM representing concentrations towards the middle of the effects ranges.
- The dredging and deposit process will lead to considerable mixing of the dredged materials during all stages. This will result in substantial dilution of the limited volume of material containing elevated concentrations of contaminants above the ERM with the much greater proportion of material that is below the ERL. Based on the assessment undertaken, it is considered that the risk posed to biological communities or the marine environment from the levels of contaminants within the materials to be dredged is negligible.

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[1] Soil Engineering: Ground Investigation Report for Bay of Nigg Harbour Development, Aberdeen Vol 1-3. 9th January 2014

[2] Fugro Geoservices Ltd: Aberdeen Harbour Expansion – Nigg Bay – Ground Investigation.

[3] Gorham-Test, C. (1998). Regional Environmental Monitoring and Assessment Program: Galveston Bay 1993. US EPA report no EPA/906/R-98/002. 51 pp.

[4] Long, E.R., Field, L.J. & MacDonald, D.D. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environmental Toxicology and Chemistry, 17(4): 714 – 727.

[5] Aberdeen Harbour Board: Aberdeen Harbour Expansion Project - Additional Environmental Information Report. 2016.

[6] Aberdeen Harbour Board: Aberdeen Harbour Expansion Project – Clarifications Document: Marine Scotland Science. 29th June 2016.

The assessment also highlights the Aberdeen Harbour maintenance dredging activity and the comparison of heavy metal test data from the dredged material (over a period of several years) to test data from the offshore deposit site CR110. The results identify that despite historic maintenance dredged materials from Aberdeen Harbour containing elevated heavy metals between AL1 and AL2 that the concentrations of these contaminants at the deposit site have remained below AL1. This suggests that there is no evidence of accumulation of heavy metals at the deposit site above the AL1 threshold. The maintenance dredging activity whilst a smaller operation than the proposed capital dredging from AHEP, is an activity that has been taking place for many years under licence using the same deposit techniques that are proposed for AHEP.

7.5.3 Dredged Sediment Monitoring

During dredging operations, sampling is undertaken within the dredge hoppers to verify that mixing material is taking place. In particular, there is a requirement to take samples from where material above AL1 have been found in past sampling campaigns.

To ensure samples are taken from the correct area, Dragados have pinpointed the location and depth at which samples will be taken at approximately 110 points across Nigg Bay. These are provided in Appendix A1. This information has been provided to the dredging contractor with clear instructions to take sufficient material from the hopper for sediment sampling, the first time dredging occurs at this location & dredge depth.

Based on the results of the pre-dredging sampling campaign, the samples will be analysed for Heavy metals (Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Zinc), Tributyltin (TBT)and Polycyclic Aromatic Hydrocarbons (PAHs) and the results compared to the Marine Scotland Action Levels.

In May 2019 MS-LOT confirmed they were content for PCB testing to cease based on levels being low in previous samples..

Samples are stored in a dark, cool environment for transport to the laboratory. At Nigg Bay a freezer is available to freeze samples as required. The samples are delivered to the laboratory within 48 hours after sampling. Details of the location where the material was dredged and where the material is deposited are logged. Reports on the analysis of the given parameters are provided to Dragados within 28 days. Reports are then forwarded onto MS-LOT on a quarterly basis provided results are below Action level 2 (or Action Level 1 where no Action Level 2 exists).

In the event that results are above Action Level 2 (or Action Level 1 where no Action Level 2 exists) duplicate samples are to be collected and delivered to Marine Scotland, following on from testing for the presence of asbestos, the associated results reports will also be submitted. Tested samples that have parameters close to an action level will be kept frozen in storage unless instructed otherwise by MS-LOT.

Contaminant	**Revised AL1 mg/kg dry weight (ppm)**	**Revised AL2 mg/kg dry weight (ppm)**
Arsenic (As)	20	70
Cadmium (Cd)	0.4	4
Chromium (Cr)	50	370
Copper (Cu)	30	300
Mercury (Hg)	0.25	1.5
Nickel (Ni)	30	150
Lead (Pb)	50	400
Zinc (Zn)	130	600
Tributyltin	0.1	0.5
Polychlorinated Biphenyls	0.02	0.18
Polyaromatic Hydrocarbons		
Acenaphthene	0.1	
Acenaphthylene	0.1	
Anthracene	0.1	
Fluorene	0.1	
Naphthalene	0.1	
Phenanthrene	0.1	
Benzo[a]anthracene	0.1	
Benzo[b]fluoranthene	0.1	
Benzo[k]fluoranthene	0.1	
Benzo[g]perylene	0.1	
Benzo[a]pyrene	0.1	
Benzo[g,h,i]perylene	0.1	
Dibenzo[a,h]anthracene	0.01	
Chrysene	0.1	
Fluoranthene	0.1	
Pyrene	0.1	
Indeno(1,2,3cd)pyrene	0.1	
Total hydrocarbons	100	
Booster Biocide and		
Brominated Flame Retardents *		

Table 7.2: Marine Scotland Action Levels

In accordance with the requirements of Marine Scotland's *Pre-deposit Sampling Guidance Version 1 2017*, the laboratory performing the analyses will be ISO17025 accredited for marine sediment analysis and take part in intercomparison exercises such as QUASIMEME. The laboratory will meet the limit of detection (LOD) sensitivity requirements set out in the CSEMP Green Book.

7.5.4 Sediment Sampling Adaptive Management – Material above AL1

The following adaptive management measures will be undertaken in the event that contamination above Action Level 2 (or Action Level 1 where no Action Level 2 exists) is encountered during the hopper monitoring testing.

1. Inform MS-LOT of exceedance of monitored sample by email within 48hrs of receipt of elevated result. Notification will include specific details on the dredge

sample location, depth, date and time. Notification will also be made to MS-LOT regarding the deposit location of material where the exceedance occurred.

2. Duplicate samples are to be delivered to Marine Scotland, following on from testing for the presence of asbestos.
3. The exceedance will be assessed in line with the contamination assessment[6] performed by AHB and will assess whether the exceedance would lead to any increased level of risk to the marine environment compared to the baseline contamination assessment, this would be in line with the ERM/ERL assessment.
4. In the unlikely event of identifying material greater than AL2 within the hopper samples, adaptive measures 1-2 will be undertaken. Dragados would then take grab samples from the relevant area of the deposit ground for subsequent analysis to enable the potential impact on the deposit site to be appropriately assessed
5. Following conclusion of an assessment, proposals for mitigating environmental risk will be presented, Dredging activities will cease within any area/depth identified to have elevated levels of contaminants, until the issue is resolved. Changes to processes would be forwarded to and discussed with MS-LOT for agreement.

7.5.5 Deposit Site Sediment Sampling

During licensed dredging and deposit activities monthly sediment sampling of the deposit site is undertaken. Four samples are collected at the deposit site and analysed at an accredited laboratory. The samples are collected with a Van Veen or similar day grab at 4 fixed points within the deposit site. This will allow a comparison of results through time. The deposited material will be spread over a large part of the site, which will be covered by four sampling points:

- Point D1: 57°07’07” N – 02°00’15” W
- Point D2: 57°07’07” N – 01°59’45” W
- Point D3: 57°06’52” N – 02°00’15” W
- Point D4: 57°06’52” N – 01°59’45” W

Figure 7.13: Sediment sample locations at deposit area (green dots)

Based on the results of the pre-dredging sampling the samples will be analysed for Heavy metals (Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead and Zinc), Tributyltin (TBT)and Polycyclic Aromatic Hydrocarbons (PAHs). Sampling of the deposit site during the 2018 dredging activities have identified trace metals, predominately Caduim, Copper, Zinc and Nickel and traces of PAHs. Sampling of the deposit site during the 2019 dredging activities identified traces of PAHs.

7.5.6 Bathymetric Surveys

Bathymetric surveys at the dredging and deposit site will be conducted during the dredging works in order to assess the changes in the seabed following the dredging and deposit activities. All surveys are carried out along pre-determined lines, both parallel and at right angles to the route or slope. Where reasonably practicable, levels will be obtained up to the visible high water line on shore, so to obtain an overlap with the topographical data.

Line spacing and extension of survey lines are specified by Dragados or the dredging Contractor, In case of a multi-beam survey the complete area will be covered. A copy of the surveys will be forwarded to MS-LOT for information. The surveys will be provided in a .DWG and .PDF format.

The purpose of the surveys is to keep track of the dredging and deposit process and to check that deposit activities are carried out according to regulations and that the dredged material is being disposed evenly in the deposit area.

7.5.6.1 Adaptive Management

In case the surveys show an uneven distribution, a change can be made to the deposit strategy by adjusting the grid progress and aim at another – but still even – distribution of dredged material at the deposit site.

Based on the ES and additional information provided by Aberdeen Harbour Board, no exceedances of acceptable limits of contaminants are foreseen. In the event of recorded exceedances within hopper monitoring samples, the adaptive management activities outlined in section7.5.4 will be instigated.

7.5.7 Re-use of Dredged Material

Dragados plan to reuse dredge material where possible and are committed to re-use of rock excavated during blasting and dredging operations. The exact re-use will depend on the quality and quantity of material but is likely to involve use in caissons or behind the quays and within the footprint of the breakwaters.

7.6 Suspended Sediment / Turbidity Monitoring Plan

The suspended sediment levels as presented in the ES show average background SSCs in Nigg Bay ranging from 24 mg/l in the outer bay area to 144 mg/l in the inner bay area. Maximum SSCs of up to 529 mg/l and 899 mg/l have been recorded in the outer bay and inner bay areas during high energy wave events.

According to the model in the ES, the turbidity plume generated by the dredging works reaches the entrance of Aberdeen Harbour and the outer coastal area. The peak increases in SSC north of Girdle Ness are predicted to be no higher than 100 mg/l to 200 mg/l above background levels, and generally around 10-50 mg/l in front of the mouth of the River Dee, which is well within natural background variation. Therefore, the ES states that the expected increases in SSC as a result of dredging in the areas surrounding Nigg Bay will be within natural range.

In regard to the deposit activities, the model in the ES shows that high SSCs following a deposit event reduce rapidly with distance from the deposit site. Total SSC values fall to 92 mg/l and 99 mg/l approximately 500 m north and south respectively of the deposit area.

Therefore, no significant longer duration, high turbidity events above these background values are expected.

The turbidity in the water is monitored on a regular basis and compared with values as estimated in the ES. The methodology for this monitoring is described below in section 7.6.3.

7.6.1 Suspended Sediment Monitoring – 2017 Dredging Season

Prior to dredging commencing on September 5th, 2017, Fugro undertook baseline water quality measurements from September 1st to September 4th, 2017. Suspended sediment levels were sampled at eight locations around Nigg Bay and the wider area as pictured in Figure .

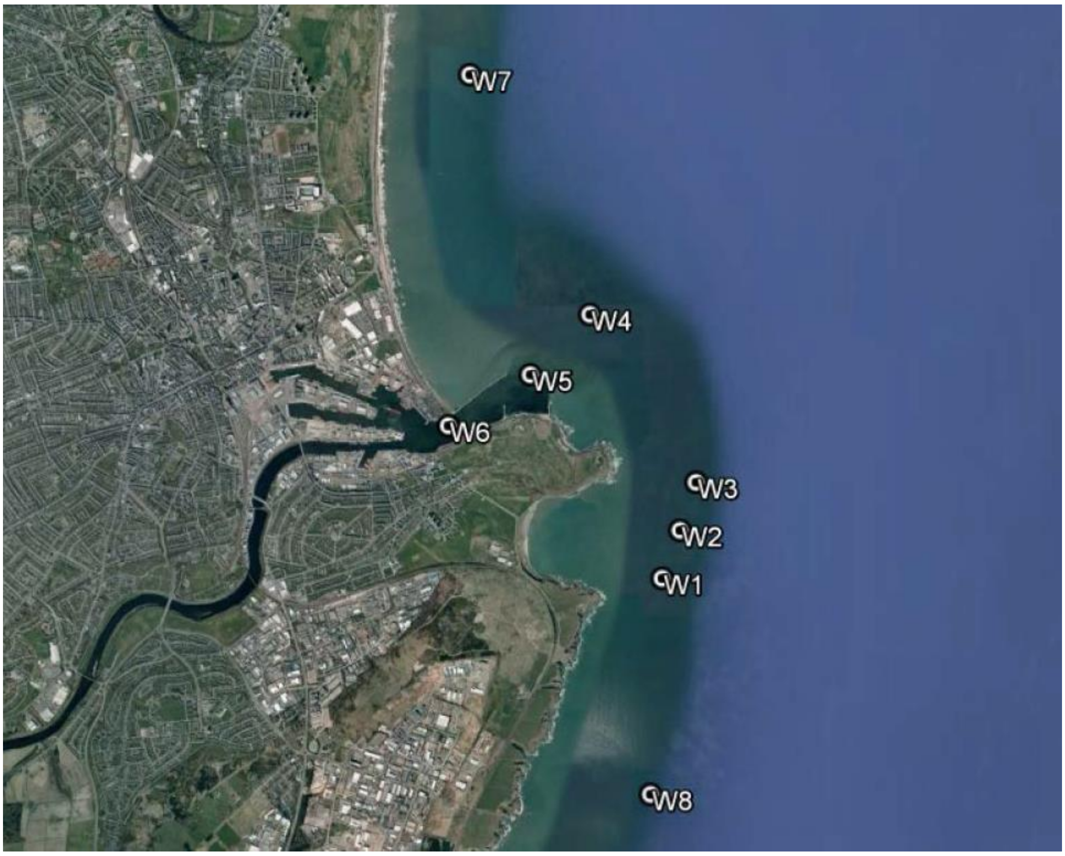


Figure 7.15: Water quality measurement locations

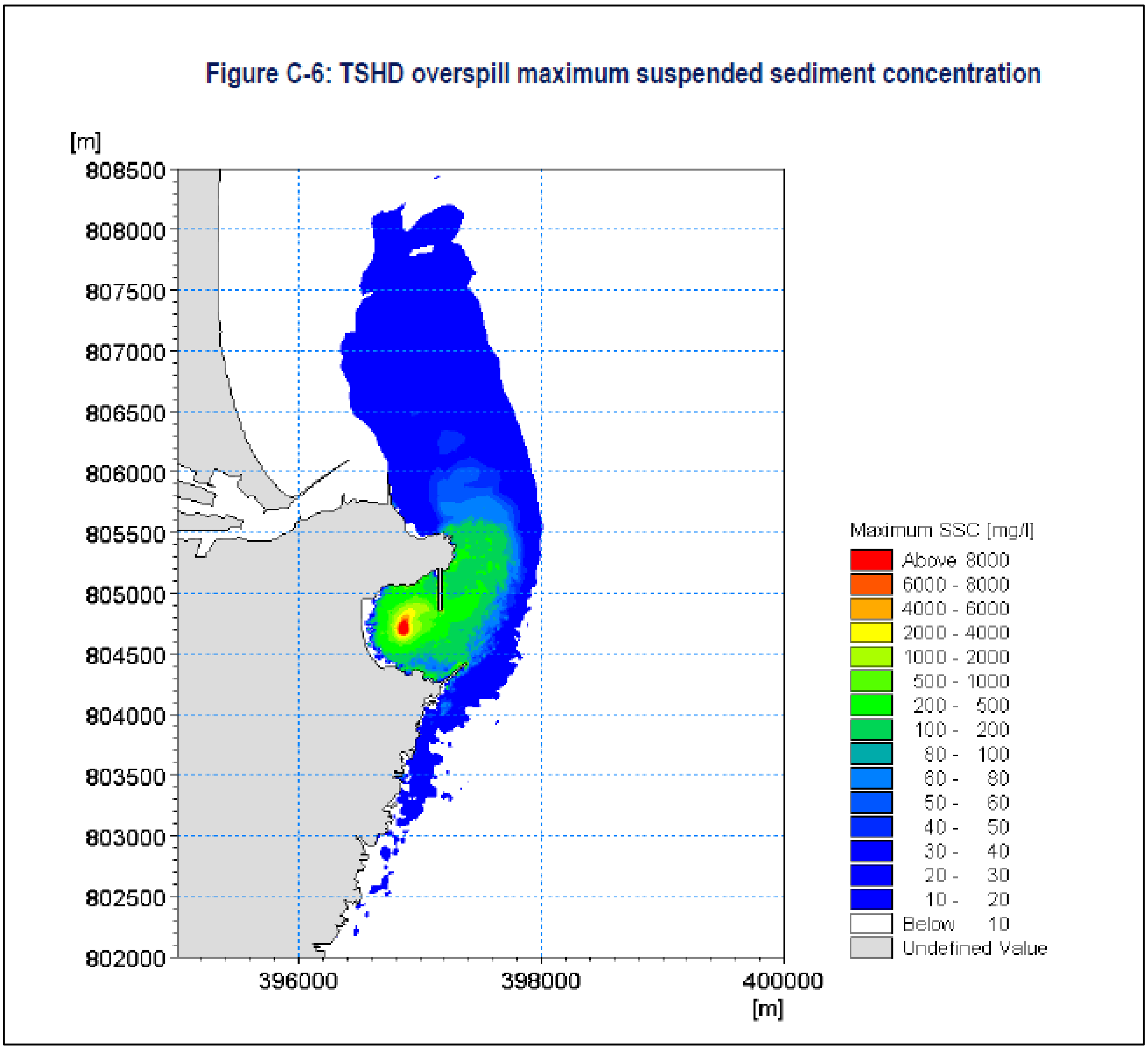
The baseline water samples were taken at three depths, 2m below surface, 2m above seabed and at a midpoint in the water column. During dredge operations, the suspended sediment concentration were calculated using an average turbidity value from 10 minutes of profiling data at each location.

Dredging operations ceased on September 16th 2017 with no further dredging in 2017. During the dredging campaign, no increase of above 50mg/l was recorded in suspended sediment concentrations, when comparing the baseline measurements at W8 to W1, 2, 3. Measurements at W5 & 6 were difficult to achieve given the boat traffic coming in and out of the river and found to add little value to the wider recordings given the impact of changing sediment levels in the River Dee It is not proposed that sampling at these locations are continued into 2018 and beyond.

For the remaining dredging activities, Dragados have appointed contractor to install and maintain a continuous monitoring system at the locations shown in Figure 7.18. The outer buoy is positioned to provide a background level and the inner buoy is positioned to measure the amount of suspended sediment generated by AHEP activities. Buoy locations were chosen using information from the AHEP EIA Appendix 7-D[7].

7.6.2 Dredging Monitoring - Buoy Deployment Location

Appendix 7-D of the AHEP Environmental Statement describes the sediment plume modelling for the proposed dredging operations (Intertek Report Ref. - P1974_R3873_Rev2.docx, Issued 27 October 2015). The intention of the suspended sediment monitoring proposed by Dragados is to ensure that suspended sediment levels generated by the AHEP dredging operations do not exceed those predicted in the AHEP ES.



[7] Aberdeen Harbour Expansion Project (November 2015). Volume 3: Technical Appendices, Appendix 7-D Sediment Plume Modelling.

Figure 7.16: TSHD overspill maximum suspended sediment concentration (From AHEP ES Plume Modelling)

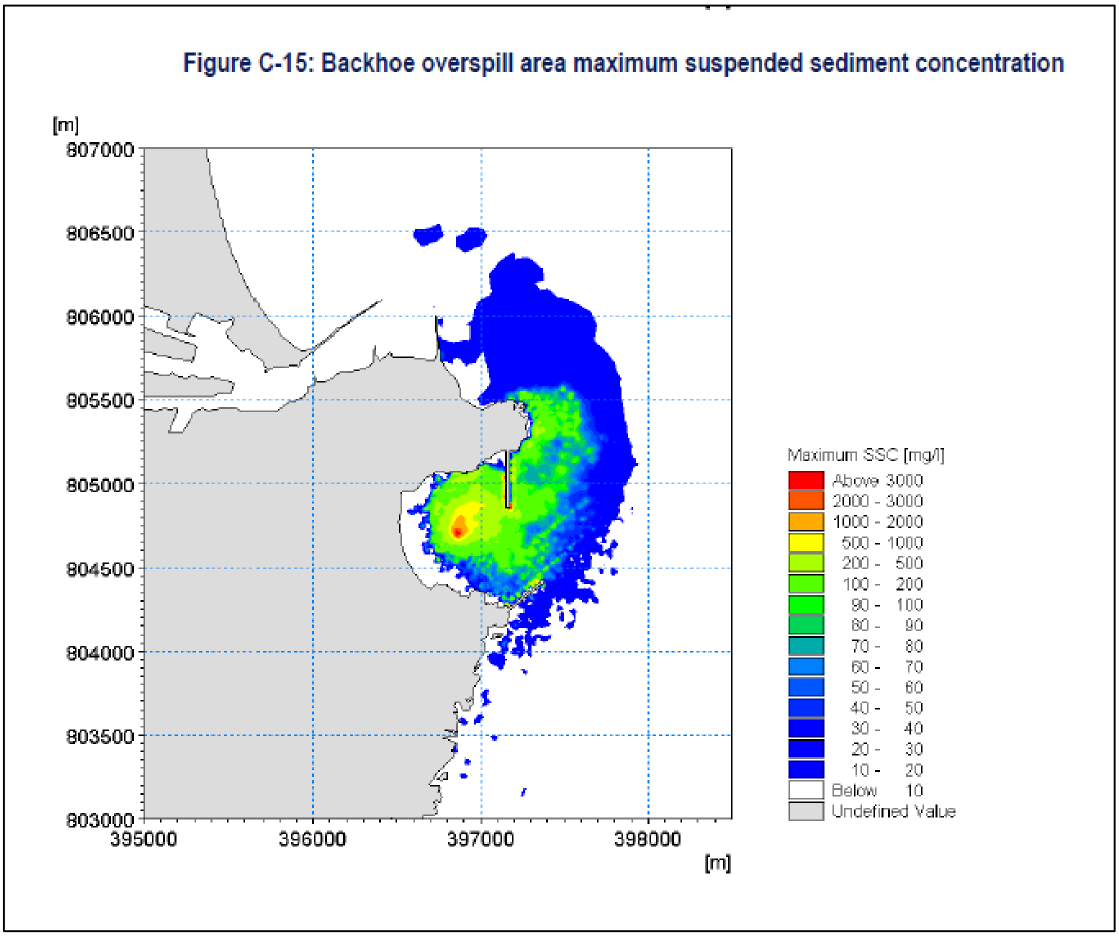


Figure 7.17: Backhoe overspill area maximum suspended sediment concentrations (From AHEP ES Appendix 7-D)

The locations for buoys have taken into account the location of construction activities ongoing at AHEP and other scientific equipment being placed on the seabed (C-Pods, Waverider etc.). A location, to the north of the site, outside the sediment plume has been selected for the baseline suspended sediment buoy and a location to the north, within the predicted sediment plume, has been selected to record suspended sediment levels within the dredge plume (See **Error! Reference source not found.**). These locations are 750m apart. According to the plume model, the maximum suspended sediment concentration at the monitoring buoy location should be less than 200mg/l above the levels of suspended sediment at the baseline buoy.

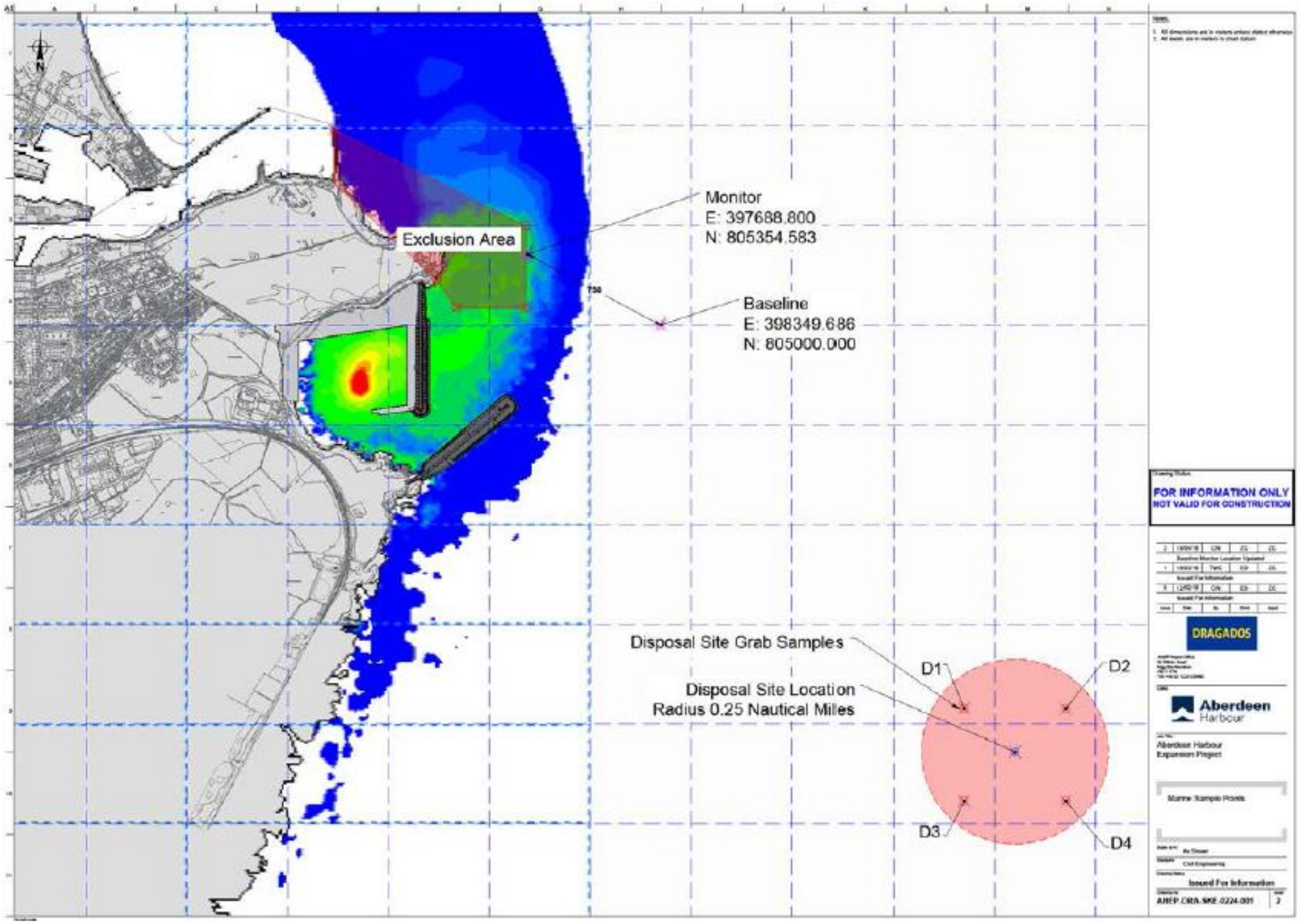


Figure 7.18: Locations of the 2 continuous monitoring buoys, namely Base Line Point (Location X) and Point 2 (Location Y)

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7.6.3 Suspended sediment Monitoring Methodology

The suspended sediment monitoring kit deployed at AHEP will consist of a buoy/marker, weight and turbidity sensor deployed at two locations.

The monitoring equipment will measure the optical quantity, turbidity measured in Formazin turbidity units (FTU), whereas the model provides the physical quantity, the suspended sediment concentration measured in mg/l. As there is no universal relationship between FTU and SSC, turbidity measurements and water samples are collected concurrently to establish a site-specific relationship known as a correlation graph. Water samples within the dredge plume will be taken and analysed in an accredited laboratory for turbidity and suspended sediment concentrations in order to develop this correlation. In-situ turbidity measurements will also be conducted. This correlation graph will then be used to enable real-time monitoring during the dredging activities.

Before the equipment is deployed at AHEP, all instruments will have been tested and calibrated for each specific parameter and purpose. Calibration of the instruments and depth indicators will be performed according to the manufacturer's specification and recorded. Equipment will be cleaned / serviced as per manufacturer's instructions.

The buoys will measure turbidity and transmit the results via GPRS / GSM networks to an internet server every 30 minutes. The levels will be converted from Turbidity to Suspended Sediments. In order to manage peaks and changes due to natural variability, a running average over 12 hours will be taken to work out the elevation above background level. Using the information provided in the AHEP ES (Appendix 7-D), during dredging operations, the Suspended Sediment levels at the inner or monitoring buoy should not exceed 200mg/l above the background level recorded at the baseline or outer buoy.

The results will be displayed near real-time using an online monitoring system. This system allows automatic alerts to project personnel (via SMS or email) if a threshold is breached or if a buoy stops transmitting. If levels are breached, adaptive management measures will be put in place (Section7.6.5).

7.6.4 Hand Held Suspended Sediment Monitoring

Alongside the continuous monitoring, Dragados also have in place a system to undertake handheld monitoring. This will be as a contingency for when continuous monitoring is not available at the dredging site due to a fault with the equipment and also for measuring turbidity at the deposit site on a monthly basis.

Handheld monitoring will be undertaken using the same procedure as that deployed during the 2017 dredging season. A baseline survey will be conducted to establish reference conditions on site by taking samples at the six sites. These baseline condition surveys will establish the correlation curve to be used. Once dredging commences, the suspended sediment monitoring will be undertaken twice daily during dredging operations. A baseline will be established at W7 or W8 and measurements at W1, 2, 3 and 4 compared against the baseline suspended sediment levels. As these monitoring points are within different parts of the plume model to where the continuous monitors will be, an exceedance of 50mg/l will trigger further action.

If exceedances are found the adaptive management described in Section 7.6.5 will be implemented and Marine Scotland informed.

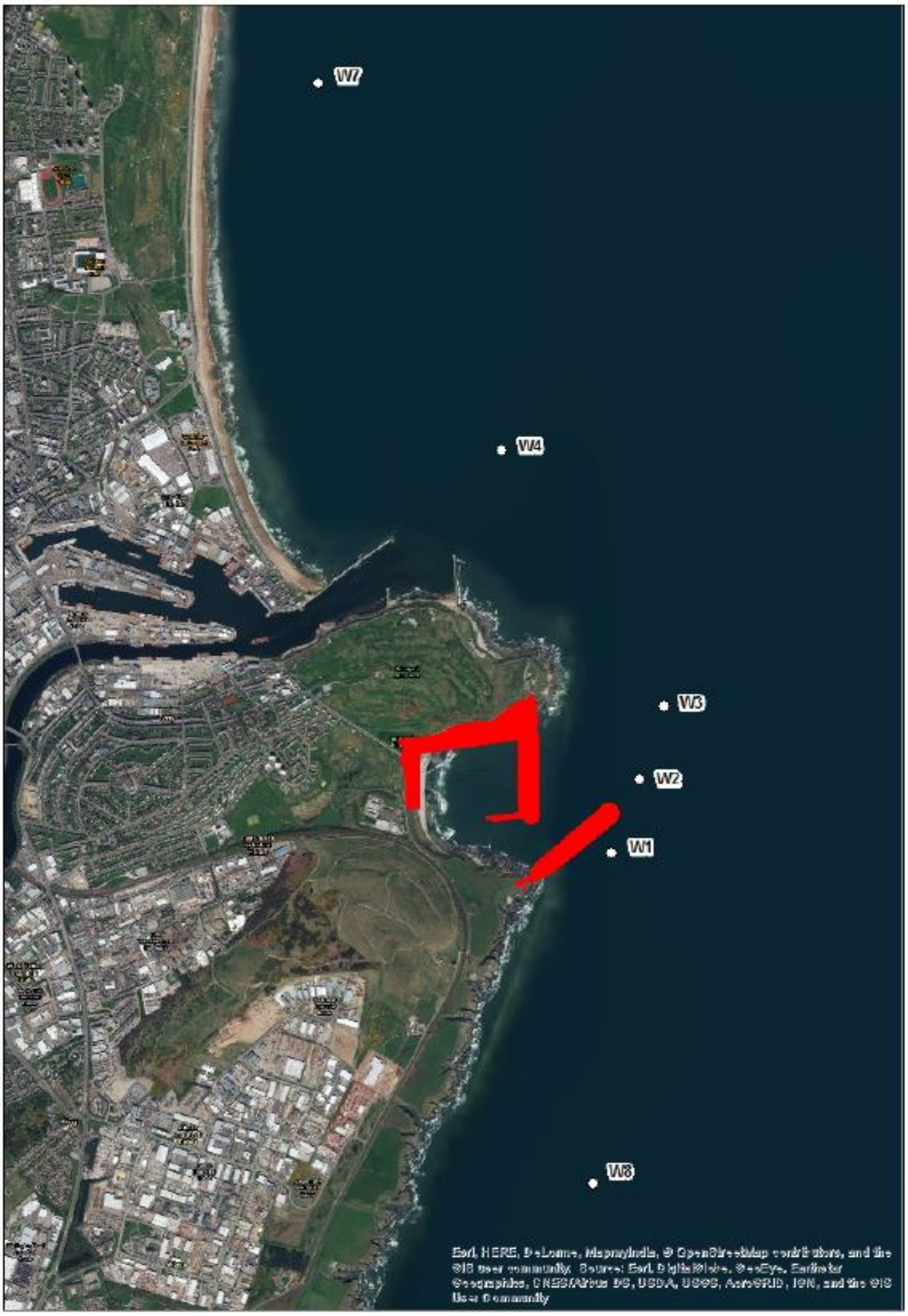


Figure 7.9: Handheld monitoring sampling points

7.6.5 Adaptive Management

Should suspended sediment levels exceed those predicted by the sediment plume modelling an alert will be issued to the Dragados responsible person (EM, ECoW, Marine Manager etc. depending who is on duty) and adaptive management and reporting procedures implemented.

Initially, the Dragados responsible person will review the level of exceedance reported and using the flowcharts provided in Appendix A3, and in conjunction with the dredging contractor, decide upon the mitigation measures to be implemented from the bullet point list provided below.

At the dredging site, the levels of suspended sediment can be controlled by:

- Adjusting the overflow position of the TSHD and/or SHB's;
- Minimise the de-watering process
- Stop dewatering completely
- Reduce dredging production
- Dredge at a different location

If suspended sediment levels cannot be reduced using the above, or other mitigation, dredging will be temporarily stopped and other solutions explored such as the use of bubble screens, silt screens or only dredging during certain phases of the tide to reduce the release and/or dispersion of suspended sediment.

If suspended sediment concentrations are exceeded, these will be reported to MS-LOT Major Projects initially by a phone call to a member of the MS-LOT Major Projects Team on: 0300 2445046 (within standard working hours) and by a follow up email (within 1 hour of the exceedance being detected) to ms.marinelicensing@gov.scot detailing the exceedance and the measures that are being implemented to control suspended sediment levels.

SEPA will also be notified by telephone on SEPA pollution hotline number 0800807060, local SEPA office reception number 01224 266600 if there are potentially any implications for bathing water quality (for instance, a substantial sediment plume which may impact upon the bathing water quality at Aberdeen Pleasure Beach). MS-LOT Major Projects Team will also be asked for advice as to whether SEPA should be contacted, depending on the nature of the suspended sediment level exceedance

7.7 Reporting commitments

Regular reports will be provided to MS-LOT in which all data from the following sections are summarised as and when required. The report will include all necessary data to give a complete overview of the results and actions of the relevant reporting period.

7.7.1 Suspended Sediment

A report on the suspended sediment concentrations will be produced and submitted to MS-LOT on a quarterly basis except in cases where an exceedance is noted (see 7.6.5). This report will include:

- Sampling methodology
- Any difficulties encountered during sampling and changes proposed as a result

- Suspended Sediment Concentrations at both Baseline and Monitoring Buoys and at the four locations at the deposit site
- Any instances of exceedances (baseline versus monitoring buoy)
- Adaptive Management / Actions taken when exceedances have occurred
- Results of adaptive measures taken

7.7.2 Sediment Sampling

- A report on the sediment sampling results for Nigg bay and the deposit site will be produced and submitted to MS-LOT on a quarterly basis except in cases where sediment sample results are above Action Level 2 (or Action Level 1 where no Action Level 2 exists). This report will include: Location and depth of samples taken
- Material sampled
- Log of when samples sent to laboratory, asbestos testing complete, duplicate samples sent to MS-LOT (when required) and results received
- Details of analyses undertaken and results
- Any further actions undertaken/required

7.7.3 Blasting:

During blasting activities a report will be produced and issued to MS-LOT on a monthly basis containing the following:

- Cycle details including date and time of drilling and blasting.
- Quantity of holes drilled and rock blasted
- Quantity of explosives used

Section	**TYPE OF REPORT**	**REPORT DESCRIPTION**	**FREQUENCY**	Responsible	Report to
7.2.1	**List of Vessels**	Dragados will inform the licensing authorities the name of the vessels that will be mobilised for implementation of the works. A Notice to Mariners will also be released stating the nature and duration of the activities. This will follow processes detailed in the Vessel Management Plan.	Prior to start of marine works	DUK	MS-LOT

7.5.3	**Sediment sample submission**	In the event that results are above Action Level 2 (or Action Level 1 where no Action Level 2 exists) duplicate samples are collected and delivered to Marine Scotland, following on from testing for the presence of asbestos. MS-LOT recommends that DUK retain any tested samples that have tested parameters close to an action level.	As & When	DUK	MS-LOT
7.5.3 7.7	**Sediment sampling results report**	Dragados will prepare a report of sediment sampling results and submit it to MS-LOT. Samples will be collected from locations provided in appendix A1. Monthly sampling of the deposit site will also take place during dredge and deposit activities.	Quarterly when results are below Action level 2 (or Action Level 1 where no Action Level 2 exists).	DUK	MS-LOT
7.5.4	**Sediment sampling (Notification)**	Inform MS-LOT of exceedance of monitored sample by email within 48hrs of receipt of elevated result. Notification will include specific details on the dredge sample location, depth, date and time. Notification will also be made to MS-LOT regarding the deposit location of material where the exceedance occurred.	As & When	DUK	MS-LOT
7.5.6	**Bathymetric Surveys (Notification)**	A copy of the surveys will be forwarded to MS-LOT for information. The surveys will be provided in a .DWG and .PDF format	As & When	DUK	MS-LOT
7.6.5	**Suspended sediment (Notification)**	If suspended sediment concentrations are exceeded, these will be reported to MS-LOT Major Projects initially by a phone call to a member of the MS-LOT Major Projects Team on: 0300 2445046 (within standard working hours) and by a follow up email (within 1 hour of the exceedance being detected) to ms.marinelicensing@gov.scotms.majorprojects@gov.scot detailing the exceedance and the measures that are being implemented to control suspended sediment levels. SEPA will also be notified by telephone on SEPA pollution hotline number 0800807060, local SEPA office reception number 01224 266600 if there are potentially any implications for bathing water quality (for instance, a substantial sediment plume which may impact upon the bathing water quality at Aberdeen Pleasure Beach). MS-LOT Major Projects Team will also be asked for advice as to whether SEPA should be contacted, depending on the nature of the suspended sediment level exceedance.	As & When	DUK	MS-LOT SEPA
7.7	**Drilling and blasting report**	Dragados will prepare a report all drilling and blasting activities and associated monitoring and submit to Marine Scotland Licensing Operations Team (MS-LOT)	Monthly	DUK	MS-LOT
7.7	**Suspended sediment report**	A report on the suspended sediment concentrations will be produced and submitted to MS-LOT	Quarterly, except when an exceedance is noted	DUK	MS-LOT

Table 7.4: Chapter 7 Dredging and Dredge Spoil Disposal Management and Monitoring Plan reporting requirements

Appendix A

Dredging and Dredge Spoil Disposal Management Appendices

A1 Sediment Sample Locations

Sediment Profile Area BH Number	BH Northing (Approximate locations)	BH Easting (Approximate locations)	VO Dredge Areas	Contaminant action level 2016 Sample Areas	Sample Depth -CD	No of Samples
RC2016-1	804900	396700	9,11, 10a,30	Between AL1 & 2	2,4,6	3
RC2016-5	804800	396700	16	Between AL1 & 2	5,7,8	3
RC2016-14	804600	396700	16	Between AL1 & 2	3,5,7	3
RC2016-17	804500	396700	19	Between AL1 & 2	3,5,7	3
RC2016-2	804900	396800	9, 10a,30	Between AL1 & 2	6	1
VC2016-6	804800	396800	16	Between AL1 & 2	4	1
VC2016-11	804700	396800	16	Between AL1 & 2	5	1
VC2016-3	804900	396900	3,31,32	Between AL1 & 2	4, 6,8	3
VC2016-7	804800	396900	2,16	Between AL1 & 2	4,6,8	3
VC2016-12	804700	396900	16	Between AL1 & 2	6,8	2
VC2016-19	804500	396900	16,18	Between AL1 & 2	5,8	2
VC2016-13	804700	397000	1c 35	Between AL1 & 2	8	1
RC2016-31	804600	397000	1b,35,	Between AL1 & 2	8	1
VC2016-20	804500	397000	1a,17	Between AL1 & 2	6	1
VC2016-19	804500	396900	18	Between AL1 & 2	6	1
VC2016-20	804500	397000	17,1a	Between AL1 & 2	6	1
VC2016-22	804500	397200	13,15	Between AL1 & 2	8	1
VC2016-33	804500	397362	15	Between AL1 & 2	12,14	2
RC2016-14	804600	396700	16	Between AL1 & 2	3	1
RC2016-16	804600	396900	16	Between AL1 & 2	4,6,8	3
RC2016-31	804600	397000	1b	Between AL1 & 2	6,8	2
North Quay	Various Points	Various Points	5a	New Areas	6,8	2

Sediment Profile Area BH Number	BH Northing (Approximate locations)	BH Easting (Approximate locations)	VO Dredge Areas	Contaminant action level 2016 Sample Areas	Sample Depth -CD	No of Samples
North Quay	Various Points	Various Points	6a	New Areas	6,8	2
North Quay	Various Points	Various Points	7a	New Areas	6,10	2
North Quay	Various Points	Various Points	10a	New Areas	4,8	2
North Quay	Various Points	Various Points	12a	New Areas	2,8	2
West Quay	Various Points	Various Points	20	New Areas	2,6,8	3
West Quay	Various Points	Various Points	21	New Areas	2,6,8	3
West Quay	Various Points	Various Points	22	New Areas	2,6,8	3
West Quay	Various Points	Various Points	23	New Areas	2,6,8	3
West Quay	Various Points	Various Points	24	New Areas	2,6,8	3
West Quay	Various Points	Various Points	29	New Areas	2,6,8	3
East Quay	Various Points	Various Points	8	New Areas	6,8, 10	3
East Quay	Various Points	Various Points	25	New Areas	8,10,12	3
East Quay	Various Points	Various Points	26	New Areas	8,10,12	3
East Quay	Various Points	Various Points	27	New Areas	8,10,12	3
Deposit Site CR110	802 859.69	400099.54	4 Grab Samples Per Month			28
					Total	**107**

A2 NTU-TSS Correlation

Background

Total Suspended Solids (TSS) is a parameter that has to be determined in a laboratory as the water sample has to be filtered in order to determine the dry weight of suspended solids per unit volume of water, and reported in milligrams of solids per litre (mg/L). Turbidity is an optical water quality parameter that can be monitored instantaneously by measuring the optical backscatter with a turbidity sensor. The turbidity sensor measures turbidity levels in NTU.

Turbidity is easy to measure quickly, but there is no universal relationship between turbidity and TSS. However, turbidity can be used to indicate suspended solids concentration on a site-specific basis, if certain techniques are used. This relationship will be established by taking a large number water samples over a large variety of turbidity values. The primary reason for wanting to use turbidity measurements instead of suspended solids is that turbidity measurements are quick. Nephelometric turbidity readings can be done in a matter of minutes. On the other hand, taking a sample, transporting it to the laboratory, filtering it, drying it, weighing it, and calculating the TSS value can take from 6 to 24 hours. In the meantime, the TSS of the discharge or water body of interest will have changed.

The relationship between turbidity and TSS depends on the particle size, particle colour and particle shape as well as other parameters. TSS depends on the total weight of particles in suspension, and is a direct function of number, size, and specific gravity of the particles, while turbidity is a direct function of the number, surface area, and refractive index of the particles, but is an inverse function of their size (for constant TSS).

The conversion of turbidity to TSS is done by means of a conversion formula that is the result of a statistical analysis of data points that have both a TSS value and a turbidity value. The points are shown as a point cloud. In general, it is assumed that there is a linear relation between turbidity and TSS. Statistical tests may be used to check this assumption. After a linear regression (using least squares, maximum likelihood or a similar method), a graph can be drawn through the point cloud, representing the result of the regression. To be able to carry out a linear regression, a number of requirements have to be met. As described above, the mean of the response variable (TSS) is assumed to be a linear combination of the mean of the predictor value (turbidity) and the regression coefficients.

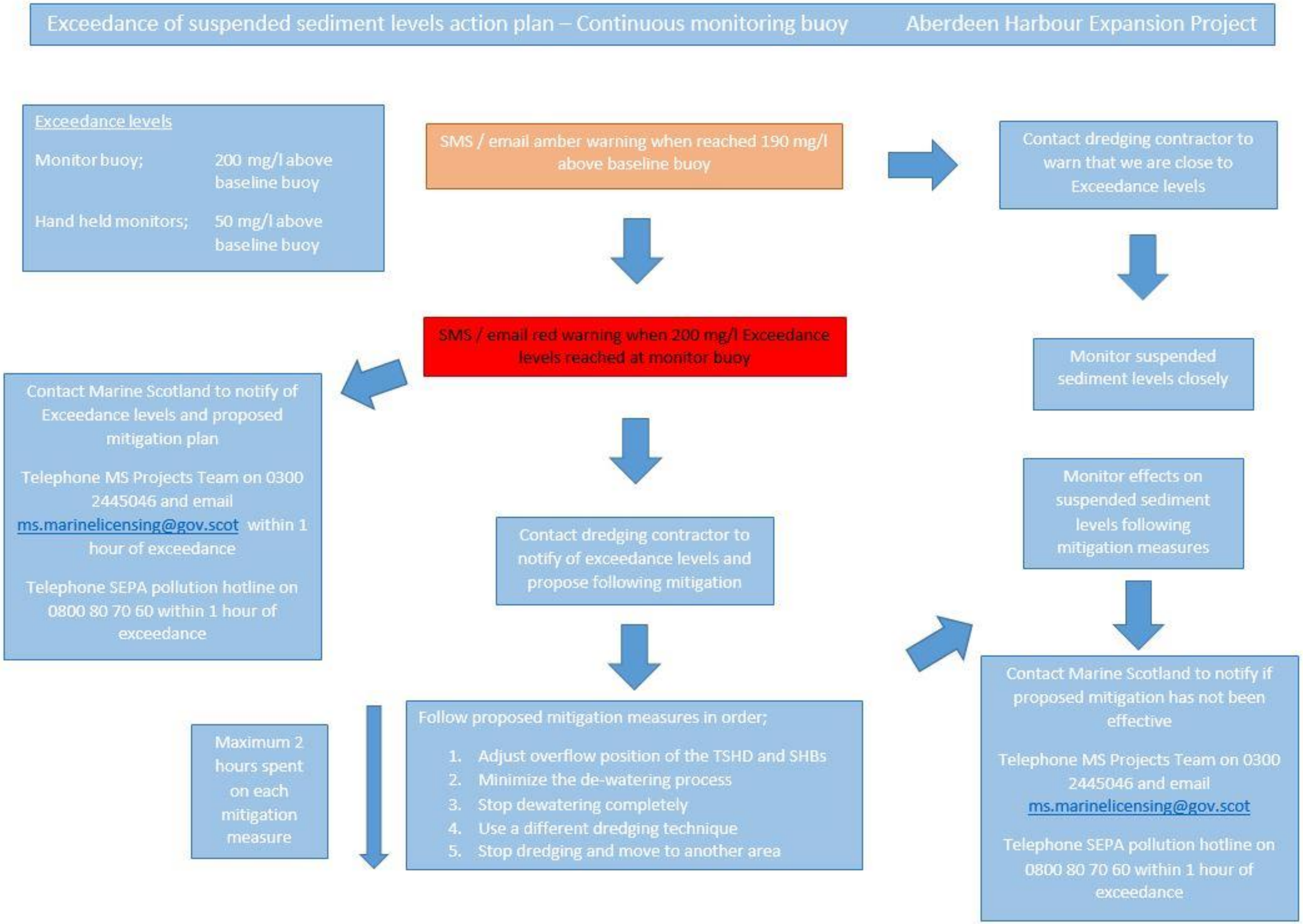
A2.1 Site-specific Correlation

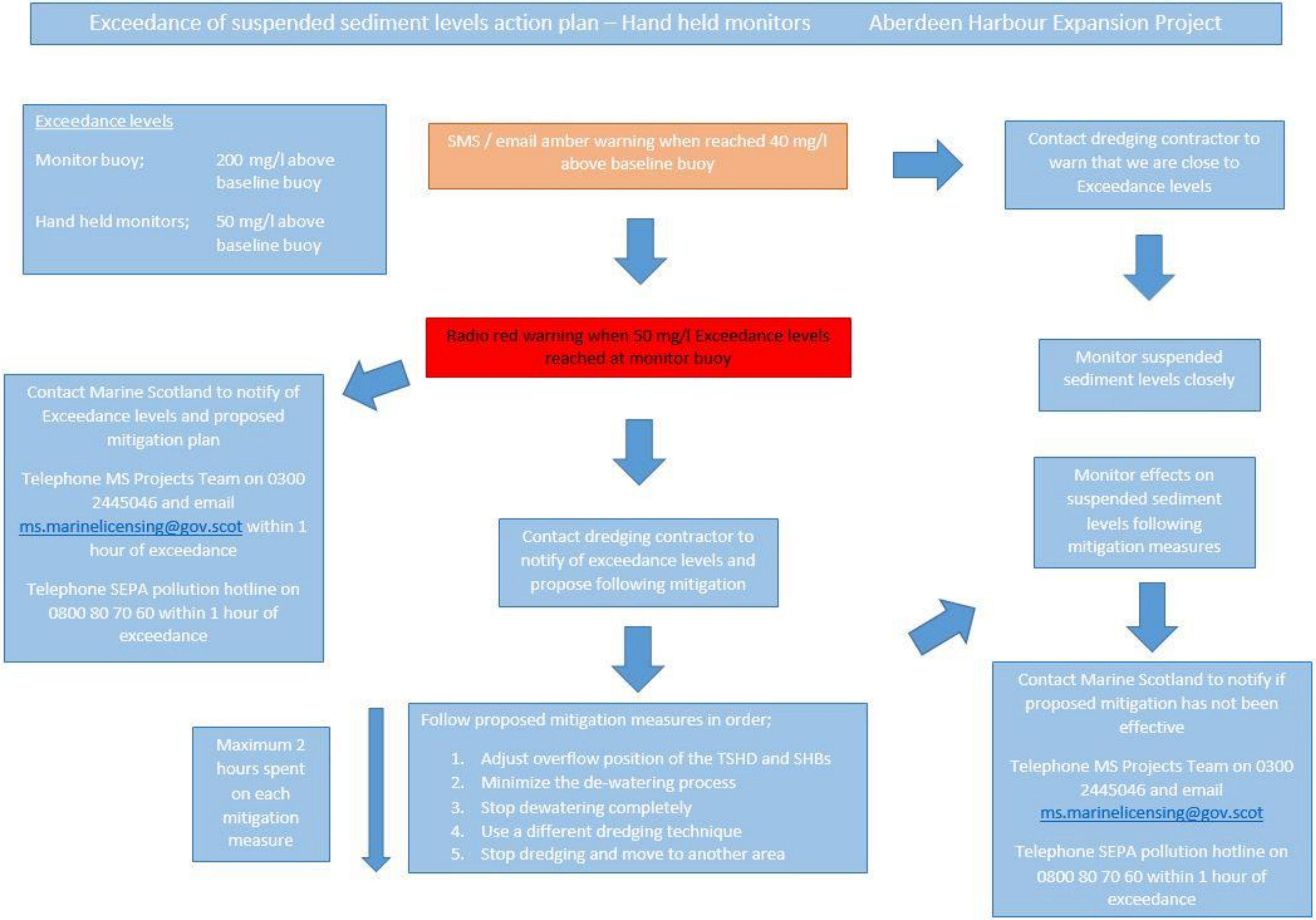
Seawater samples will be collected from different locations by the use of a water sampler. The samples should be taken from a suspended sediment source that is representative for the conditions that will be monitored during the continuous turbidity monitoring. The number of samples taken should not be too small and should be well-distributed between the range of applicability (assumed to be 0 – 100 NTU).

Water samples will be taken with a Niskin bottle, while at the same time conducting turbidity measurement. The samples have to be taken from the same location as the turbidity sensor. To be able to sample TSS and measure turbidity from the 'same' sample, it is necessary to sample from a part of the water body that is homogeneously mixed. Visual checks have to be carried out to make sure that the gradients in concentration are not so large that they might influence the results.

The samples will be transferred to pre-cleaned bottles and stored in cooling boxes and kept as cool as reasonably practicable. The samples are then taken to laboratory for analysis. QA/QC procedures are according to laboratory standards. The laboratory will test laboratory duplicates for 10% of the samples.

A3 Suspended Sediment Exceedance Procedures


Exceedance of suspended sediment levels action plan – Continuous monitoring buoy
Aberdeen Harbour Expansion Project
Exceedance levels
Monitor buoy; 200 mg/l above baseline buoy
Hand held monitors; 50 mg/l above baseline buoy
SMS / email amber warning when reached 190 mg/l above baseline buoy
Contact dredging contractor to warn that we are close to Exceedance levels
Monitor suspended sediment levels closely
SMS / email red warning when 200 mg/l Exceedance levels reached at monitor buoy
Contact Marine Scotland to notify of Exceedance levels and proposed mitigation plan
Telephone MS Projects Team on 0300 2445046 and email ms.marinelicensing@gov.scot within 1 hour of exceedance
Telephone SEPA pollution hotline on 0800 80 70 60 within 1 hour of exceedance
Contact dredging contractor to notify of exceedance levels and propose following mitigation
Monitor effects on suspended sediment levels following mitigation measures
Maximum 2 hours spent on each mitigation measure
Follow proposed mitigation measures in order;
1. Adjust overflow position of the TSHD and SHBs
2. Minimize the de-watering process
3. Stop dewatering completely
4. Use a different dredging technique
5. Stop dredging and move to another area
Contact Marine Scotland to notify if proposed mitigation has not been effective
Telephone MS Projects Team on 0300 2445046 and email ms.marinelicensing@gov.scot
Telephone SEPA pollution hotline on 0800 80 70 60 within 1 hour of exceedance


Exceedance of suspended sediment levels action plan – Hand held monitors
Aberdeen Harbour Expansion Project
Exceedance levels
Monitor buoy; 200 mg/l above baseline buoy
Hand held monitors; 50 mg/l above baseline buoy
SMS / email amber warning when reached 40 mg/l above baseline buoy
Contact dredging contractor to warn that we are close to Exceedance levels
Monitor suspended sediment levels closely
Radio red warning when 50 mg/l Exceedance levels reached at monitor buoy
Contact Marine Scotland to notify of Exceedance levels and proposed mitigation plan
Telephone MS Projects Team on 0300 2445046 and email ms.marinelicensing@gov.scot within 1 hour of exceedance
Telephone SEPA pollution hotline on 0800 80 70 60 within 1 hour of exceedance
Monitor effects on suspended sediment levels following mitigation measures
Contact dredging contractor to notify of exceedance levels and propose following mitigation
Contact Marine Scotland to notify if proposed mitigation has not been effective
Telephone MS Projects Team on 0300 2445046 and email ms.marinelicensing@gov.scot
Telephone SEPA pollution hotline on 0800 80 70 60 within 1 hour of exceedance
Maximum 2 hours spent on each mitigation measure
Follow proposed mitigation measures in order;
1. Adjust overflow position of the TSHD and SHBs
2. Minimize the de-watering process
3. Stop dewatering completely
4. Use a different dredging technique
5. Stop dredging and move to another area

Suspended sediment levels for bathing waters action plan   Aberdeen Harbour Expansion Project