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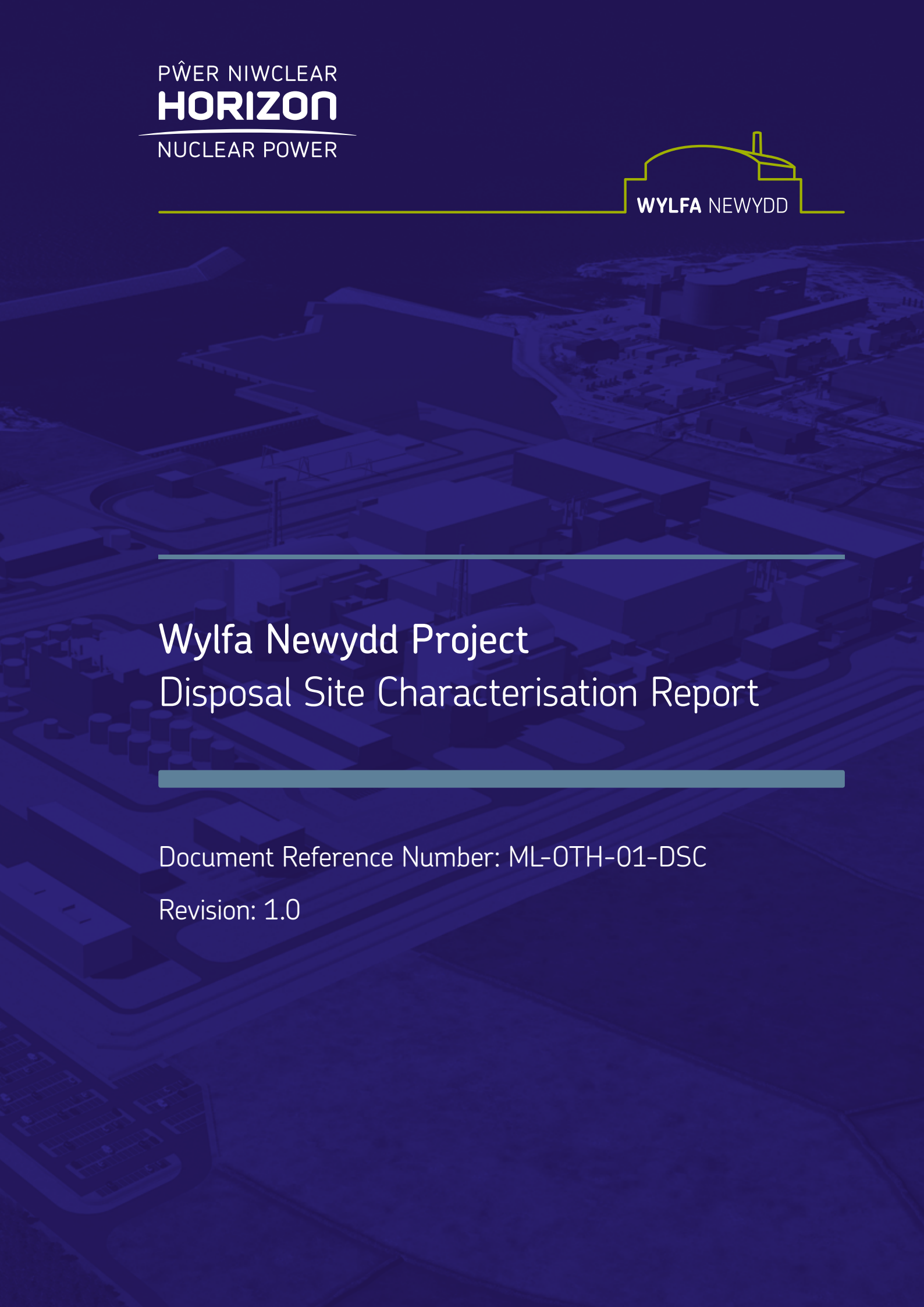
WYLFA NEWYDD



Wylfa Newydd Project
Disposal Site Characterisation Report

Document Reference Number: ML-OTH-01-DSC

Revision: 1.0

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1 Executive Summary

1.1.1 Horizon Nuclear Power Wylfa Limited is a UK Energy company developing a new generation nuclear power station on the Wylfa peninsula, the development is known as the Wylfa Newydd Project. The construction of the Power Station (and relevant infrastructure) has marine works that will result in excess marine dredged/excavated material (both rock and sediment) that will require disposal at sea.

1.1.2 This report presents the results of a disposal site selection exercise, where suitable sites for marine disposal of capital dredge material were investigated. The disposal site selection considered four possible options; three existing sites (IS043, IS050, IS055) and the option to designate a new disposal site. Environmental, economic and operational feasibility were considered and from this preliminary assessment of constraints, disposal at IS043, known as Holyhead North, was deemed to be the most appropriate option.

1.1.3 The site selection exercise identified that Holyhead North has not previously received large volumes of rock material. It was therefore determined, in consultation with Natural Resources Wales Marine Licensing Team, that supplementary characterisation of this existing and open disposal site would be required. This is to better understand the potential effects of the disposal operation, to enable capital dredged material from Wylfa Newydd Project to be disposed there.

1.1.4 As Holyhead North is an existing and open disposal site, it was agreed that the characterisation would focus on supplementing existing information about the site and assessing the effects that are outside of the 'normal' use of the disposal site.

1.1.5 This report goes on to present this supplementary characterisation of Holyhead North by identifying the biological, chemical, physical and human environment characteristics of the site and assessing the potential for adverse effects from the Wylfa Newydd Project disposal both alone and cumulatively with other known disposal operations utilising the disposal site. An assessment is also provided of the future function and capacity of Holyhead North following the Wylfa Newydd Project disposal.

1.1.6 The assessment of potential effects concludes that disposal of capital dredged material from the Wylfa Newydd Project would have negligible or minor effects on all receptors both alone and cumulatively with other projects.

1.1.7 The assessment of future function and capacity of the site, following disposal from the Wylfa Newydd Project, identifies that the only permanent changes to the site would be an approximate1m reduction in water depth over a small area and very localised changes in hydrodynamics. Both of these changes are assessed as having negligible effects on the site's future function and capacity.

1.1.8 It is therefore concluded that the characteristics of the environment at Holyhead North make it a suitable site to receive capital dredged material (both rock and sediment) from the Wylfa Newydd Project.

2 Introduction

2.1 Purpose

2.1.1 Horizon Nuclear Power Wylfa Limited (Horizon) is a UK Energy company developing a new generation nuclear power station on the Wylfa peninsula. The Wylfa Newydd Project will require dredging and excavation of the seabed as part of the construction, some of which will require disposal at sea. There may also need to be infrequent maintenance dredging once the Wylfa Newydd Project is operational, however, the details of this are not yet known and therefore it does not form part of the current Marine Licence application. It is proposed to dispose of dredged/excavated material at Holyhead North (IS043), an offshore disposal site that is located west of Holy Island, Anglesey, approximately 18km from the Wylfa Newydd Marine Works at Porth-y- Pistyll, Anglesey (figure 2-1).

2.1.2 Holyhead North is a relatively new disposal site, designated in April 2017, within the footprint (northern half) of the now closed disposal site, Holyhead Deep (IS040). Holyhead Deep was closed in April 2017 due to a Marine Licence being granted by Natural Resources Wales (NRW) to Minesto Limited for the 'Deep Green' project, to install a tidal kite within the southern half of Holyhead Deep disposal site. Due to the physical overlap of Holyhead Deep and Holyhead North disposal sites, historic data from Holyhead Deep is relevant to this characterisation and both sites are referred to in this report.

2.1.3 Dredging and disposal of material at sea is heavily regulated by international conventions, national legislation and regional agreements, and is only permitted if strict criteria are met. Horizon was advised by NRW that further characterisation of Holyhead North was required in order to assess its suitability for Horizon's disposal requirements [RD1]. This is due to the volume and type of material requiring disposal being different to the parameters of the historic use of the site (as part of IS040). This report provides the further characterisation of Holyhead North requested by NRW and has been produced in support of the Marine Licence application for dredging and disposal at sea.

2.1.4 As disposal has been ongoing at the site of Holyhead Deep for many years, this characterisation is targeted at filling gaps in knowledge, specifically in the areas where the disposal requirements of the Wylfa Newydd Project differ or go beyond the historic use of the site.

2.1.5 A proposed scope for this site characterisation was provided to NRW Marine Licencing Team (NRW MLT) for comment on 28 March 2017 [RD71]. A response to the proposed scope, providing guidance on the requirements of the characterisation, was received from NRW MLT on 30 May 2017 [RD4] which has been utilised in the drafting of this report [RD4]. NRW's comments are summarised in appendix 1-1 along with comments on how they have been addressed.

2.2 Wylfa Newydd Project overview

2.2.1 As set out in chapter A2 of the Environmental Statement (ES), the Wylfa Newydd Project comprises the construction, operation and decommissioning of:

- Power Station: the proposed new nuclear power station at Wylfa, including two UK Advanced Boiling Water Reactors (ABWR), the Cooling Water System (CWS), supporting facilities, buildings, plant and structures, radioactive waste and spent fuel storage buildings and the Grid Connection (apparatus to transfer electrical energy to the National Grid high voltage electricity transmission network);
- Other on-site development: including landscape works and planting, drainage, surface water management systems, public access works including temporary and permanent closures and diversions of public rights of way, new Power Station access road and internal site roads, car parking, construction compounds and temporary parking areas, laydown areas, working areas and temporary works and structures, temporary construction viewing area, diversion of utilities, perimeter and construction fencing;
- Marine Works:
  - Permanent Marine Works: the CWS, the Marine Off-Loading Facility (MOLF), breakwater structures, shore protection works, surface water drainage outfalls, waste water effluent outfall (and associated drainage of surface water and waste water effluent to the sea), fish recovery and return system, fish deterrent system, navigation aids and Dredging; and
  - Temporary Marine Works: temporary cofferdams, a temporary access ramp, temporary navigation aids, temporary outfalls and a temporary barge berth; and
- Site Campus: a temporary facility that would house up to 4,000 construction workers in modular type accommodation blocks, providing an independent living space for each worker, with shared campus-style amenities.

2.2.2 The Wylfa Newydd Development Area is located on the north coast of Anglesey, and is the indicative areas of land and sea (433 hectares) including the areas surrounding the Power Station Site that would be used for the construction and operation of the Power Station, the Marine Works, the Site Campus and other on-site development. The marine works associated with this development are described in detail in the “Marine Licence Application – Schedule of Licensable Marine Activities” (ML-PLD-01-PDD). The layout of the main components of the marine works is shown in figure 2-2 and summarised below.

Marine Off-Loading Facility

2.2.3 The MOLF will provide two quays and two ancillary berths including a 'layby berth' and a 'pontoon berth'. The bulk quay (with two quays) for the offloading of bulk materials and a 'Roll on-Roll off' (Ro-Ro) quay – to allow transport by sea of the large pre-fabricated elements required for the construction of the Power Station. The layby berth is provided as a safe haven for ships to moor at if the other berths are occupied.

2.2.4 The two berthing platforms of the bulk MOLF two berthing platforms will each have approximate surface area dimensions of 65m by 30m. The area behind the platforms will be filled to a platform level of between +5mAOD and +6mAOD, with the areas to either side of the platforms being protected by a rock armour revetment to the south and breakwater to the north. The Ro-Ro quay will be approximately 100m in length and its quay surface set at a platform level of between +5mAOD and +6mAOD, and will be approximately 40m wide, allowing approximately 36m of width for the Ro-Ro ramp. The temporary layby berth will consist of a series of berthing and mooring dolphin structures adjacent to a dredged pocket. The berth is remote from the land and would be accessed by small boats.

2.2.5 A berthing pocket will be dredged alongside the Bulk quay. The berthing pocket will extend approximately 30m from the quay. The depth of the bulk berth pocket would be approximately -11.9mAOD plus dredging tolerance of approximately 0.6m (i.e. approximately - 12.5mAOD). Sediment would be removed by standard dredging plant such as a trailing suction hopper dredger or a backhoe dredger. Rock would be removed by peckering with a breaker and dredging with a barge mounted excavator.

2.2.6 In addition to the various cargo vessel berths, a Pontoon berth will be required for mooring tugboats, pilot vessels, safety boat and other small workboats during the construction of the power station. It will be located between the Ro-Ro berth and the CW intake structure. The floating pontoon will be restrained either by guide piles socketed into the seabed, or by H piles fixed to the vertical wall behind the pontoon berth. The pontoon will be linked to the shore by a suitable access gangway which would also carry any necessary services such as power and water.

Shore protection

2.2.7 The shoreline surrounding the berthing platforms will be protected by placing a rock or precast concrete armour revetment, and the area behind will be reclaimed using suitably graded material obtained from the site. The reclaimed land will extend from the quay walls landwards.

2.2.8 Shore protection will also be provided where dredging or excavation could lead to shore erosion and/or unacceptable wave overtopping discharges. This will take the form of rock revetments or seawalls.

Cooling Water System

2.2.9 Most of the CWS for the Power Station will be located landwards of the current line of Mean HighWater Springs (MHWS). However, some key works associated with the CW intake and CW outfall will be positioned seawards of the current line of MHWS.

2.2.10 In order to carry out the CW intake construction in the dry, a temporary cofferdam will be constructed in front of the intake to seal the area from seawater ingress during construction.

2.2.11 An intake channel will be dredged or excavated within Porth-y-Pistyll to configure the seabed bathymetry in such a way that it will provide the necessary water velocity. The CW intake channel will be dredged or excavated from the seabed such that it will create a -10mAOD formation level (plus a 0.3m excavation tolerance). The walls of the dredged channel immediately in front of the CW intake structure will be cut through the natural rock to the -10mAOD formation level of the intake and stabilisation of the walls may be required. The preferred method for creating the CW intake channel will be to undertake a significant portion of bedrock removal in dry working conditions. This will be achieved by constructing temporary rubble mound cofferdams that, along with the adjacent land form, will create a basin within the sea that will be pumped dry. The temporary cofferdams will be constructed by depositing rubble stone and rock armour obtained from the Power Station Site over the foreshore and seabed to form rubble mound structures. The temporary cofferdam will be removed on completion of the CW intake channel construction.

2.2.12 The soft sediment would be removed by conventional dredging plant such as a backhoe dredger, cutter suction dredger or trailing suction hopper. From the existing rock head level, down to around low tide level, and inside the temporary cofferdam, the bedrock would be fractured by blasting (i.e. with explosives) and then excavated using tracked excavators and dump trucks. Outside the temporary cofferdam, the bedrock would be initially fractured by peckering with a breaker and then ripped out and dredged with a barge mounted excavator and loaded into barges. Methods of deterring fish and other marine life from entering the intakes will be deployed on the CW intake structure in the form of acoustic fish deterrents (AFDs).

2.2.13 An industry standard fish recovery and return (FRR) system will be built into the CW intake and will recover fish (and other marine organisms) that have become impinged on the drum and band screens at the CW intake, and return them to the sea.

2.2.14 The CW outfall structure is the discharge point to the Irish Sea for all process effluents and cooling water discharges. This onshore structure is located within Porth Wnal adjacent to the CWS discharge for the existing Power Station. The tunnels for the outfall will be located landwards of the current line of MHWS, however, a temporary cofferdam will be required to facilitate construction of the outfall.

Breakwaters

2.2.15 There will be two breakwaters extending out into Porth-y-Pistyll that will provide protection and create acceptable wave conditions for operation of the CW intake equipment. Both breakwaters will have rock-filled cores covered with pre-cast concrete armour units and, where practical, rock armour.

2.2.16 The CW Intake West Breakwater (western breakwater) will be approximately 400m in length with a crest height of between 10m AOD and 14m AOD. At the roundhead (widest point) the base will be approximately 136m in width. The western breakwater will not be connected to the shore. A temporary causeway will be constructed to create a haul road between the land and the southern end of the western breakwater (i.e. crossing the shallow rocky coastal zone) to facilitate construction of the western breakwater. The causeway will take the form of a rubble mound structure protected by rock armour.

2.2.17 The CW Intake East Breakwater (eastern breakwater) will be approximately 150m in length with a crest height of between 9m AOD and 12.2m AOD. At the roundhead (widest point) the base will be approximately 92m in width. A permanent haul road will be constructed on the foreshore adjacent to the Existing Power Station to facilitate construction of the eastern breakwater.

2.2.18 Soft sediments in the footprint of the breakwaters will be removed if they do not provide a suitable foundation for the construction of the breakwaters. The sediment would be removed by standard dredging plant such as a trailing suction hopper dredger or a backhoe dredger.

Temporary access ramp

2.2.19 As one of the initial marine construction activities, a temporary access ramp would be constructed from crushed rock at the southern end of Porth-y-Pistyll. The ramp will be approximately 12m wide and up to 160m long, and will have a slope of between 1:10 and 1:15. Once built, it is anticipated that the ramp will remain in place for a limited period of time (to be determined, but potentially in the order of one year). It will then be dismantled and removed after it has served its purpose.

Temporary barge berth

2.2.20 A further initial marine construction activity will be the construction of a temporary berthing and unloading facility for barges. It will comprise a modular retaining wall constructed using either steel shipping containers filled with crushed rock or other suitable fill, or another suitable modular type retaining wall structure. An access ramp will be provided from the quay level down to the beach in front of the quay to facilitate plant access for maintenance of the platform. The temporary barge berth will be required to be in place for a period of approximately two years.

Disposal of dredged material

2.2.21 Dredged material arising from the dredging works associated with the CW intake channel, berthing pockets and breakwater foundations will be re-used

onsite (e.g. for core material in the breakwaters) or offsite where practicable, and the remaining material will be disposed of at sea.

Maintenance dredging

2.2.22 Following the initial capital dredge it is anticipated that infrequent maintenance dredging may be needed to maintain the operational depths for the berthing pockets and CW intake channel. Maintenance dredging requirements are currently unknown and therefore do not form part of this marine licence application. A low rate of sediment accretion is expected in the marine part of the Wylfa Newydd Development Area, and future maintenance dredging requirements will be informed by a hydrographic survey to determine rates of sedimentation. It is anticipated that maintenance dredged material would be disposed to sea.

2.3 Background

2.3.1 Dredging is the process of excavating/removing material from the sea and/or river beds to increase water depth. Within this report, dredged material is deemed to be sediments and rocks including associated water and organic matter content, removed from areas that are normally or regularly covered by water using dredging or other excavation equipment.

2.3.2 Dredging can be categorised into capital and maintenance dredging. The categorisation of capital or maintenance material denotes whether dredging is an ongoing activity or dredging of a new area. Capital dredging is the activity of creating new civil engineering works by means of dredging, such as harbour basins or canals, and the deepening of existing waterways or approach channels. Capital dredged material is typically more consolidated and can comprise silts, gravels, clays and rock material. Maintenance dredging is the activity of keeping existing watercourses or harbour basins at the required nautical and/or hydrological depth by removing siltation. Maintenance dredged material is typically soft unconsolidated sediments that have been relocated by environmental conditions since the last dredging campaign. If an area has not been dredged for 10 years or more it would be classified as capital dredging.

2.3.3 Most dredged material is disposed of at sea at established disposal sites, but it can also be re-used for a variety of purposes such as construction fill, beach nourishment or land reclamation.

2.3.4 The assessment to determine the suitability of material for dredging and/or disposal at sea requires an understanding of the properties of the material to be dredged/disposed including levels of chemical contamination. One of the main concerns over dredging and disposal is the release of contaminants to the water column as this can harm marine species and lead to increased availability of contaminants to the food chain.

2.3.5 When applying for a Marine Licence to dispose of dredged material, chemical contamination data are utilised as part of a ‘weight of evidence approach’ to establish the suitability of material for disposal at sea. Contaminants are

monitored and assessed against standards to help reduce pollution at disposal sites. Within the UK, Cefas Action Levels (ALs) are used [RD2]. Samples below AL1 are generally considered acceptable for disposal at sea, pending other considerations such as physical suitability for the disposal site and potential beneficial uses. Sediments above AL2 are generally considered unsuitable for disposal at sea without special handing and containment. Samples between AL1 and AL2 are assessed for suitability on a case by case basis [RD2]. The ALs are shown in table 2-1.

2.3.6 Another approach often adopted to evaluate sediment quality is the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life [RD3]. These standards have two guideline values; the Interim Sediment Quality Guideline (ISQG) and Probable Effect Level (PEL). The ISQG correspond to threshold level effects below which adverse biological effects are not expected. The ISQGs are more conservative than the PEL which represents “the lower limit of the range of chemical concentrations that are usually or always associated with adverse biological effects” [RD3]. The ISQGs and PEL are given in table 2-1. An interpretation of the guideline values of the potential biological effect of the sediment on receiving flora and fauna is:

- sediment concentrations < ISQG = rare biological effect;
- sediment concentrations > ISQG, < PEL = occasional biological effect;
- sediment concentrations > PEL = frequent biological effect.

2.3.7 Both UK ALs and Canadian ISQG and PEL are referred to in this report.

Table 2-1 Chemical standards for assessing dredge material contamination

Determinand	Assessment Criteria			
	AL1	AL2	ISQG	PEL
Acenaphthene (µg kg^{-1})	100	n/a	6.71	88.9
Acenaphthylene (µg kg^{-1})	100	n/a	5.87	128
Anthracene (µg kg^{-1})	100	n/a	46.9	245
Benzo(a)anthracene (µg kg^{-1})	100	n/a	74.8	693
Benzo(a)pyrene (µg kg^{-1})	100	n/a	88.8	763
Benzo(b)fluoranthene (µg kg^{-1})	100	n/a	n/a	n/a
Benzo(k)fluoranthene (µg kg^{-1})	100	n/a	n/a	n/a
Benzo(ghi)perylene (µg kg^{-1})	100	n/a	n/a	n/a
Benzo(e)pyrene (µg kg^{-1})	100	n/a	n/a	n/a
C1-Napthalenes (µg kg^{-1})	100	n/a	n/a	n/a
C1-Phenanthrenes (µg kg^{-1})	100	n/a	n/a	n/a
C2-Napthalenes (µg kg^{-1})	100	n/a	n/a	n/a

Determinand	Assessment Criteria			
	AL1	AL2	ISQG	PEL
C3-Napthalenes (µg kg^{-1})	100	n/a	n/a	n/a
Chrysene (µg kg^{-1})	100	n/a	108	846
Dibenzo(ah)anthracene (µg kg^{-1})	100	n/a	6.22	135
Fluoranthene (µg kg^{-1})	100	n/a	113	1494
Fluorene (µg kg^{-1})	100	n/a	21.2	144
Indeno(1,2,3-c,d)pyrene (µg kg^{-1})	100	n/a	n/a	n/a
Naphthalene (µg kg^{-1})	100	n/a	34.6	391
Perylene (µg kg^{-1})	100	n/a	n/a	n/a
Phenanthrene (µg kg^{-1})	100	n/a	86.7	544
Pyrene (µg kg^{-1})	100	n/a	153	1398
Total Hydrocarbons (µg kg^{-1})	1000	n/a	n/a	n/a
Arsenic (mg kg^{-1})	20	100	7.24	41.6
Cadmium (mg kg^{-1})	0.4	5	0.7	4.2
Chromium (mg kg^{-1})	40	400	52.3	160
Copper (mg kg^{-1})	40	400	18.7	108
Lead (mg kg^{-1})	50	500	30.2	112
Mercury (mg kg^{-1})	0.3	3	0.13	0.7
Nickel (mg kg^{-1})	20	200	n/a	n/a
Tributyltin (TBT) (µg kg^{-1})	100	1000	n/a	n/a
Zinc (mg kg^{-1})	130	800	124	271
Σ (ICES-7) PCBs (µg kg^{-1})	10	n/a	n/a	n/a
Σ (25 congeners) PCBs (µg kg^{-1})	20	200	21.5	189

3 Consultation

3.1.1 This section provides a topic-specific account of consultation undertaken to support the disposal site characterisation for Holyhead North. For a full overview of the environmental consultation activities undertaken for the Wylfa Newydd Project, refer to chapter A7 of the ES, and for consultation specifically in relation to the marine environmental assessment see the Marine Environment Chapter (chapter B13 of the ES).

3.1.2 Consultation on the disposal site characterisation has primarily been with NRW MLT and NRW Marine Advisors through regular face to face meetings. NRW MLT has sought the views of their wider consultees as necessary. A summary of the consultation activities that have been undertaken to date is summarised in table 3-1.

3.1.3 An outline of the proposed disposal site characterisation report was provided to NRW MLT to scope out the contents of the report. NRW MLT Consulted their in-house technical experts, Cefas, Trinity House Lighthouse Service, Maritime and Coastguard Agency, Stena Line Ports Ltd, and Isle of Anglesey County Council on the scoping report. NRW MLT received responses from the following stakeholders: NRW technical experts, Cefas, Trinity House Lighthouse Service, Maritime and Coastguard Agency, and Stena Line Ports Ltd. A summary of the comments received and how they have been addressed in this report is provided in appendix 1-1.

Table 3-1 Summary of topic specific consultation

Date	Stakeholder	Title and format	Summary
01/06/16	Cefas	Request for disposal site information	Request for licensed quantities and disposal returns for IS040, IS050 and IS055
06/06/16	Cefas	Response to request for disposal site information	Licensed and disposed amounts provided along with conditions/restrictions that relate to the sites.
23/08/16	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
15/09/16	NRW MLT	Letter to NRW MLT	Letter proposing to use Holyhead Deep to dispose of dredged material from Wylfa Newydd and seeking NRW's agreement for this.

Date	Stakeholder	Title and format	Summary
28/09/16	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
14/10/16	NRW MLT	Letter from NRW MLT to Horizon	Response from NRW MLT to letter dated 15/09/16 which advised that a site characterisation report of Holyhead Deep (IS040) should be submitted as a supporting document to the Marine Licence application
19/10/16	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
21/10/16	Cefas	Request for disposal site information	Request for information held by Cefas regarding the original characterisation of Holyhead Deep disposal site and any subsequent monitoring.
31/10/16	Cefas	Response to information request	Response to information request received. There is no characterisation or monitoring data available.
23/11/16	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
22/02/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at

Date	Stakeholder	Title and format	Summary
			sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
08/03/17	NRW MLT	Letter to NRW from Horizon	Letter requesting advice on the handling of dredging material prior to disposal at sea.
28/03/17	NRW MLT	Submission of Holyhead Deep disposal site characterisation report for comments	Report provided to NRW to outline the proposed characterisation work to be undertaken and to seek their Acceptance of approach.
29/03/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
30/03/17	NRW MLT	Response letter from NRW to Horizon	Response to letter dated 08/03/17. NRW advised 'in principle' that short distance transportation of marine material over land prior to deposit at sea, if the process is continuous (i.e.: there is no stockpiling at all on land, however temporary), should be acceptable. Further information and justification would be required to confirm this.
10/05/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.

Date	Stakeholder	Title and format	Summary
30/05/17	NRW Marine Licensing	Response from NRW to the Holyhead Deep disposal site characterisation report	Comments from NRW MLT incorporating responses received from: NRW technical experts, Cefas, Trinity House Lighthouse Service, Maritime and Coastguard Agency, Stena Line Ports Ltd. A summary of the scoping response is presented in appendix 1-10 of this report
16/06/17	NRW MLT and NRW Advisory	Rock disposal micro-siting teleconference	Meeting to discuss the approach to micro-siting the disposal of rock to minimise impacts on sabelleria reef which is known to occur within the site.
26/06/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
26/07/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
31/08/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
14/11/17	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project

Date	Stakeholder	Title and format	Summary
			updates, consenting strategy, scope of the marine licence application and licensing programme.
09/01/18	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.
31/01/18	NRW MLT and NRW Advisory	Marine Licensing meeting	Ongoing discussion and engagement regarding marine licensing including disposal at sea. Meeting covered project updates, consenting strategy, scope of the marine licence application and licensing programme.

4 Regulatory and policy background

4.1.1 The following legislation and policy has been used to inform the scope and content of the disposal site characterisation. Wider legislation that is of relevance to the marine environmental assessment is provided in the Marine Environment Chapter (chapter B13 of the ES).

Legislation	Description
The Marine and Coastal Access Act (MCAA) 2009	The Marine and Coastal Access Act (MCAA) 2009 provides the mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a system of management and protection of the marine and coastal environment. Part 4 of the MCAA sets out the requirement for a Marine Licence for certain marine activities. These activities include carrying out any form of dredging, and the deposition of substances on the seabed. In determining a Marine Licence application, the regulator (in this case NRW on behalf of Welsh Ministers) must have regard for the need to: • Protect the environment; • Protect human health; • Prevent interference with legitimate uses of the sea; and • Other relevant matters. The regulator must also take full account of relevant policy and legislation. The key legislation of relevance to disposal at sea is the London Convention/Protocol and the OSPAR Convention. In Wales, Marine Licensing provides the mechanism through which the requirements of these conventions are regulated and reported. This report is provided in support of the Wylfa Newydd Marine Licence application, and characterises the environment at the disposal site in accordance with Part 4 of the MCAA.
The "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", (the	The London Convention, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by disposal of wastes and other matter.

Legislation	Description
"London Convention" and the “London Protocol”)	The Convention considers disposal at sea according to the hazard that the waste presents to the environment. Items listed in Annex I (the “blacklist”) are prohibited from disposal at sea. Items listed under Annex II (the grey-list) require a special permit from a designated national authority under strict control and provided that certain conditions are met. All other materials or substances can be disposed after a general permit has been issued. In 1996, the "London Protocol" was agreed to further modernise the Convention and, eventually, replace it. Under the Protocol all disposal is prohibited, except for possibly acceptable wastes on the so-called "reverse list". The purpose of the Protocol is similar to that of the Convention, but the Protocol is more restrictive. Application of a "precautionary approach" is included as a general obligation, and the "reverse list" approach implies that all disposal is prohibited unless explicitly permitted. This list of permitted disposal includes the following: 1. dredged material; 2. sewage sludge; 3. fish wastes; 4. vessels and platforms; 5. inert, inorganic geological material (e.g. mining wastes); 6. organic material of natural origin; 7. bulky items primarily comprising iron, steel and concrete; and 8. carbon dioxide streams from carbon dioxide capture processes for sequestration. The UK is a contracting party to both the London Convention and Protocol and therefore must take effective measures to prevent pollution of the marine environment caused by dumping at sea. As a contracting party the UK must also provide annual reports on all permits issued and monitoring activities undertaken to demonstrate compliance.

Legislation	Description
	The London Convention and Protocol provide the global rules and standards on disposal as called for in Article 210.6 of the UN Convention on the Law of the Sea (1982). Since the London Convention came into force in 1975, many additional global and regional agreements and programmes to protect the environment have also come into force. In the UK the key regional agreement which governs the disposal of wastes at sea is The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention'). This report assesses the suitability for disposal at sea of the dredged material from the Wylfa Newydd Project, and characterises the environment at the disposal site in accordance with the requirements of the London Convention and Protocol.
The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention")	The UK is a contracting party to The OSPAR Convention. The Convention requires parties to take all possible steps to prevent and eliminate pollution and take the necessary measures to protect the maritime area against the adverse effects of human activities to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected. Contained within the OSPAR Convention are a series of Annexes which deal with specific topics. Annex II relates to prevention and elimination of pollution by dumping (disposal) or incineration. The Convention prohibits disposal of all wastes or other matter except where explicitly permitted. The list of permitted wastes includes dredged material and inert materials of natural origin that are solid, chemically unprocessed geological material, the chemical constituents of which are unlikely to be released into the marine environment. Permitted wastes can only be disposed with authorisation from the competent authority (in this case NRW on behalf of Welsh Ministers). The Convention requires that such authorisation is granted in accordance with guidelines and procedures adopted by the OSPAR Commission. Each Contracting Party must keep, and report to the Commission, records of the nature and the quantities of wastes or other matter

Legislation	Description
	disposed, and of the dates, places and methods of disposal. This report assesses the suitability for disposal at sea of the dredged material from the Wylfa Newydd Project, and characterises the environment at the disposal site in accordance with relevant guidance produced by the OSPAR commission.
Waste Framework (Directive 2008/98/EC)	The waste hierarchy is set out in Article 4 of the revised Waste Framework (Directive 2008/98/EC). The waste hierarchy ranks waste management options according to what is best for the environment. It gives priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal. When handling waste, all measures must be taken that are reasonable in the circumstances to apply the waste hierarchy to prevent waste. Reducing adverse effects from dredge and disposal on the marine environment should be accomplished through: • Minimising the volumes of material that are dredged by, for example, refining project requirements and using Best Environmental Practice (BEP) when dredging; • Maximising the use of dredged material for beneficial purposes; and • Controlling and reducing sources of contamination. This report follows the waste hierarchy in determining the most appropriate management option for the dredged material.
Marine Policy Statement	The UK Marine Policy Statement (MPS) is the framework for preparing Marine Plans and taking decisions affecting the marine environment. It was adopted for the purposes of Section 44 of the Marine and Coastal Access Act 2009, and under Section 58 a public authority must have regard for the MPS when making any decision that is capable of affecting the marine environment. The purpose of the MPS is to facilitate and support the formulation of marine plans, ensuring the sustainable use of marine resources in line

Legislation	Description
	with the following high-level marine objectives including sustainable economic development, moving towards a low carbon economy, ensuring a sustainable marine environment and contributing to the societal benefits of the marine area. The MPS recognises that dredging and disposal is required for navigation of existing and future ports and for specific construction activities; and that appropriately targeted disposal can have an ancillary benefit in maintaining sedimentary systems as well as having social and economic benefit. The MPS sets out the main environmental considerations associated with dredging and disposal which should be considered, and also states that application to dispose of wastes must demonstrate that appropriate consideration has been given to the internationally agreed hierarchy of waste management options for sea disposal. It states that wastes should not be accepted for disposal where appropriate opportunities exist to re-use, recycle or treat the waste without undue risks to either human health or the environment, or disproportionate costs.
Draft Welsh National Marine Plan	In accordance with the Marine and Coastal Access Act 2009 and based on the high-level objectives for marine planning outlined in the MPS, the Welsh National Marine Plan (WNMP) is being prepared by the Welsh Government. An initial draft (pre-consultation) was published in November 2015, and a further draft was published in December 2017 for additional consultation. The WNMP covers both Welsh inshore water from high water out to 12 nautical miles, and Welsh offshore waters beyond 12 nautical miles. The specific sector objective is ‘To maintain safe and effective navigational access for shipping, fishing and leisure craft and support future growth and increases in port facilities and vessel size whilst promoting the optimal sustainable use of dredge material and ensuring adequate disposal facilities are available.’ The draft highlights and acknowledges that dredging is required for a number of purposes, but applications to dispose of wastes must demonstrate that appropriate consideration has been given to the internationally

Legislation	Description
	agreed hierarchy of waste management options for sea disposal. Where possible, dredge material should be re-used or recycled before choosing to dispose at sea. Where no alternative can be found then, as long as the dredge material is deemed suitable by regulators, it is usually disposed of at sea at designated disposal sites. All operations to dispose dredge material at sea require a Marine Licence from NRW. On average between 2010 – 2015 there was 1.7mt (range 1.43-1.98mt) of dry dredge material disposed to licenced disposal sites around the Welsh coast. Determinations on the suitability of dredged material for re-use or sea disposal are subject to regulatory assessments to reduce adverse impacts on the environmental, human health and legitimate uses of the sea. Assessments are undertaken in order to characterise the physical, chemical and biological characteristics of the dredge material at the sources, and at the re-use or disposal site.

5 Assessment of the need for characterisation of a disposal site

5.1 Dredging requirements

5.1.1 The CW intake channel will be dredged to achieve a depth of -10m AOD and the berthing pockets will be dredged to a depth of -11.9m AOD. The amount of material anticipated to require dredging/excavation within the marine area (below MHWS) is given in table 5-1.

5.1.2 It is anticipated that standard dredging plant such as a trailing suction hopper dredger or a backhoe dredger would be used to remove the soft sediment material. To remove rock material, peckering will be used in the wet and blasting will be used behind the cofferdam, in the dry.

Table 5-1 Volume and weight of material to be dredged from the marine environment

Classification	Total in-situ volume (m^3)	Total weight of material (tonnes)	Density in-site (t/m^3)	Bulking factor	Total bulked volume m^3
Soft sediment deposits	220,000	352,000	1.6	1.1	242,000
Dredging of rock in wet	262,857	709,714	2.7	1.4	368,000
Excavation of rock in dry	500,000	1,350,000	2.7	1.4	700,000
Total rock dredged/ excavated	762,857	2,059,714	2.7	1.4	1,068,000

5.1.3 Following the initial capital dredge it is anticipated that infrequent maintenance dredging will be needed to maintain the required operational depths for the berthing pockets and CW intake channel. The maintenance dredging requirements are yet to be determined and will be informed by hydrographic survey to determine rates of sedimentation. Currently a low rate of sediment accretion is expected at the Wylfa Newydd Development Area.

5.2 Consideration of alternative options to disposal at sea

5.2.1 When dredged material is produced, it is classed as a waste material. Once the material has entered the waste stream it is strictly controlled under the London Convention (1972), the OSPAR Convention (1992) and the EU Waste Framework Directive 2008/98/EC. At the core of the Waste Framework Directive is the waste hierarchy which comprises: prevention; re-use; recycle; other recovery; and disposal. Where prevention or minimisation is not possible, management options for dealing with dredged material must

consider the alternative options in the outlined order of priority (i.e., re-use, recycle, other recovery and then disposal). The consideration of alternatives to disposal of dredged material from the Wylfa Newydd Project is an important part of the disposal options appraisal process and is outlined below.

5.2.2 A Waste Hierarchy Assessment for the marine works has also been produced (see ML-OTH-02_WFSA). It should be noted that the Waste Hierarchy Assessment considered the material dredged outside of the cofferdam only, whereas the below assessment considered all marine dredged material (from both inside and outside of the temporary cofferdam).

Prevention

5.2.3 The waste hierarchy places strong emphasis on waste prevention or minimisation of waste. In accordance with this, Horizon has assessed its dredging plan by considering the water flow requirements for the CW intake and the vessel draughts and berth accessibility over the tidal cycle to reduce dredged material volumes as much as possible. Nevertheless, a certain amount of dredging will be required to achieve the necessary water depth for the CW and berths.

5.2.4 Additionally, soft sediments located within the footprint of the proposed west breakwater will only be dredged if they do not provide a suitable foundation for the construction of the breakwater. The worst case assumption used in this report is that this sediment would require removal, however, if it is determined that the breakwater can be founded on this sediment, this would result in a further reduction in dredge volume.

Re-use

5.2.5 In line with the waste hierarchy, where prevention is not possible, the next step in the process is to identify any re-uses of the dredged material. Potential options for the re-use of dredged material from the Wylfa Newydd Project are provided below. These include re-use options within and outside of the Wylfa Newydd Project.

Reuse of dredged material within the Wylfa Newydd Project

5.2.6 Geotechnical investigations have been carried out to get a better understanding of the properties of the material to be dredged, which in turn inform the potential re-use options.

5.2.7 It is anticipated that the soft sediment would be unsuitable for re-use and NRW has advised that disposal at sea is the preferred option, rather than re-use, so that the material is retained within the wider natural sediment system [RD4].

5.2.8 The re-use of rock material will be subject to its suitability. In terms of fill materials there are a number of fill classes that will be required in different elements of the Wylfa Newydd Project, these are:

- Class 1, granular fill, covering a range of grain sizes and distributions. Crushed and graded rock, could be considered as a granular fill.

- Class 2, cohesive fill, covering a range of plasticities, with varying subsidiary granular content.
- Class 4, landscape fill, covering a very wide range of materials, and placed with minimal compaction.
- Class 5, topsoil, arising or imported.
- Class 6, selected granular fill. Crushed and graded rock compacted to produce fill for a range of functions, such as fill to structures and fill for drainage layers.

5.2.9 It is currently envisaged that most of the rock will be reused within the construction works. Options for this include using the rock material within the landscape mounds, engineering embankments, and as marine fill within the core of the breakwaters and the core of the temporary causeway. In the case of the temporary causeway, once it is no longer required, it will be dismantled and the rock material re-used on land.

5.2.10 **Landscape mounds**. The mounds will be created as part of the final and temporary landscape. Typically, Class 4 fill is adopted for landscape fill, but this is a relatively uncontrolled material placed with minimum compaction. Thus, it may be necessary to adopt fill Classes 1 and 2, to ensure more reliable and consistent properties and performance.

5.2.11 **Engineering embankments**. Fill may be required as part of the new site infrastructure, providing building platforms, embankments for roads, and structural fills. This is likely to take the form of Class 1, 2 and 6 fills.

5.2.12 **Marine Fill**. A significant amount of material will be required for the marine works, amongst other things as general fill for the cofferdams, and breakwaters, and as armour stone for wave protection layers to protect the cofferdam and breakwaters. While a Class 1 or Class 6 specification may be generally appropriate, a bespoke specification may be needed. This is likely to be particularly the case for the armour stone.

5.2.13 The class of rock that is produced from the excavations, and therefore its suitability for re-use within the Wylfa Newydd Project, will be driven by the geology of the rock and will also be influenced by the methodology of the dredging/extraction. Rock excavated from the marine environment is likely to be contaminated with salt and organic matter which would require processing/washing prior to reuse. This additional step increases the handling requirements and limits re-use options.

5.2.14 Re-use of rock material within the construction of the Wylfa Newydd Project will also be subject to the timing of the different elements of the works. For re-use of material to be viable, the material would need to be produced on a timeframe that fits in with the construction programme for the elements that would receive the material or it would need to be stored. Storage of rock material on land and within the sea has been considered, however, there is very little capacity to store the material on land, and a suitably protected site in the sea that is out of the way of the ongoing construction activity has not

been identified. The ability for the Wylfa Newydd Project to stockpile dredged rock material is therefore limited.

5.2.15 Given the scale of the Wylfa Newydd Project, coordinating the timing of the dredging and re-use will be a challenge. It is currently anticipated that the timing of the works would allow re-use of most, but not all, of the rock material. Given this, the Wylfa Newydd Project intends on re-using all dry rock material excavated from behind the cofferdam but not the rock material that will dredged in the wet from outside of the cofferdam.

Re-use of dredged material outside of the Wylfa Newydd Project

5.2.16 Welsh Government and NRW have both been contacted (James Hooker, Welsh Government 2017 pers. comm; and Katherine Route-Stephens, NRW 2017 pers. comm) to identify potential re-use opportunities for rock material outside of the Wylfa Newydd Project. These investigations are ongoing and at the time of writing this report they have only identified possible re-use opportunities at Holyhead Harbour for land reclamation on Salt Island; and repairs to the breakwater. The estimate of the amount of rock required for these schemes is up to 1.8 million tonnes.

5.2.17 The feasibility of using excess rock material in schemes outside of the Wylfa Newydd Project relies upon many factors including:

- Engineering considerations e.g. the geotechnical characteristics of the material;
- Operational factors, e.g. timing of both project schedules;
- Environmental suitability, e.g. in relation to the transport of material and the chemical, biological and physical characteristics of the material;
- Additional environmental effects, e.g. due to handling or pre-treatment (if required);
- Environmental benefits produced, e.g. ecosystem services, habitat and fisheries benefits; and
- Cost, e.g. related to the transportation of the material to the beneficial use site and other handling or treatment costs.

5.2.18 Given the above factors, re-use of the rock material within the Wylfa Newydd Project is the preferred option, however, external options continue to be investigated.

Recycle

5.2.19 Recycling of material is where the material is used in a different form to that which it was in originally. Investigations suggest that the excavated rock is unlikely to be suitable for use as aggregate to form concrete in nuclear classified structures, however, it could be suitable for use for non-nuclear classified structures. This concrete could be used for a variety of ancillary structures on the Wylfa Newydd Development Area.

5.2.20 Recycling of rock excavated in the dry into concrete will be undertaken for the development of the Wylfa Newydd Project where possible.

Recovery

5.2.21 Recovery of waste refers to the selective extraction of materials for a specific further use. This step in the hierarchy is not relevant to dredged material.

Disposal at sea

5.2.22 The Wylfa Newydd Project intends to reduce, re-use and recycle as much of the excavated and dredged material as possible, however, any material that is unsuitable for these purposes or surplus to requirements will require disposal at sea.

5.2.23 As noted above, it is anticipated that all of the dry rock material excavated from behind the cofferdam will be re-used, recycled or disposed of on land. Therefore, the material that will require disposal at sea is:

- All of the soft sediment material as NRW has advised that it should be disposed at sea to retain it within the sediment system; and
- The rock material dredged in the wet from outside the cofferdam.

5.2.24 Table 5-2 sets out the intended dredge/excavation, re-use and disposal quantities. In terms of the volume to be disposed of at sea, this represents the worst case, and in practice this could be a smaller amount.

Table 5-2 Dredge disposal quantities

Classification	Total in-situ volume (m^3)	Total weight of material (tonnes)	Total volume to be disposed at sea (bulked up) (m^3)	Total volume to re-used (bulked up)
Soft sediment deposits	220,000	352,000	242,000	0
Dredging of rock in wet	262,857	709,714	368,000	0
Excavation of rock in dry	500,000	1,350,000	0	Up to 700,000

5.2.25 The dredging works are predicted to last for a duration of approximately 17-18 months. Firstly, the soft sediment material would be dredged and disposed. It is anticipated that as a worst case this could require transit to the disposal site every 12 hours for a period of 35 days. Following this, the dredged rock material is anticipated to be disposed over an ongoing 16-month period as it is produced from the 'wet excavations'.

Conclusion

5.2.26 Dredging volumes for the Wylfa Newydd Project have been reduced as much as possible, however, capital dredging is required to achieve the necessary water flow requirements for the CW intake, to provide the necessary water depths for the berths and possibly required to provide a suitable foundation for the construction of the breakwaters.

5.2.27 It is anticipated that maintenance dredging will be required following the capital dredge to retain the required operational depths for the CW intake and the berths. The amount of maintenance dredging that will be required is yet to be determined, but it is anticipated to be infrequent.

5.2.28 As advised by NRW, all of the soft sediment material from the capital dredge will be disposed of at sea to retain the material within the natural sediment system. It is assumed that NRW would also want any soft sediment material from future maintenance dredging to be disposed of at sea for the same reason.

5.2.29 Where possible rock material from the capital dredge will be re-used and recycled, however, any material that is unsuitable for re-use or surplus to requirements will be disposed of at sea.

5.2.30 Due to re-use and recycling of rock material, the proposed disposal volumes are significantly lower than the dredge volumes.

5.2.31 Based on the findings of the assessment of alternative options, the volume of material proposed for disposal at sea is 242,000m^3 (352,000 tonnes) of soft sediment and 368,000m^3 (709,714 tonnes) of rock.

5.2.32 As disposal of dredged material at sea will be required, an assessment to determine the most suitable site has been undertaken (section 5.3).

5.3 Consideration of potential disposal sites

5.3.1 The selection of a site for sea disposal involves considering the receiving environment and also economic and operational feasibility. Site selection should ensure that the deposition of dredged material does not produce significant effects in the marine environment, nor interfere with, or devalue, legitimate commercial and economic uses of the sea.

5.3.2 There are three existing disposal sites within a 30km radius of the Wylfa Newydd Project. These are IS043 – Holyhead North, IS050 – Point Lynas, and IS055 – Conwy Bay (figure 5-1). These three sites along with the potential option to designate a new disposal site have been considered for the disposal of material from the Wylfa Newydd Project.

5.3.3 Summary information on the physical characteristics and historical use of the three existing sites is provided in table 5-3. Historical data for Holyhead Deep (IS040) has been utilised for Holyhead North (IS043) due to the geographical overlap in these two sites. Holyhead North is the only one of the three sites that is currently classified as open for use. IS050 is currently closed and IS055 is currently classified as disused (Jemma Lonsdale, Cefas 2016 pers. comm.).

These sites have been reviewed in this assessment as it may be possible to reopen either of the sites if they are deemed to be the most appropriate option for disposal.

Table 5-3 Disposal site information

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
IS043	Holyhead North (HHN)	Open	3.45nm x 2.4nm	Water depths at Holyhead North range from 35 – 96m. In the northern most part of HHN there is a shallow rocky platform with depths ranging from 35 -40m. Seabed height surrounding the disposal	18km	573,950	451,129	1,658,732 tonnes during the period 1983 to 2015	Capital and Maintenance material	IS043 was opened in 2017 and at the time of writing there is one active marine licence to dispose of dredged material at this site. This is for Stena Line Ports to dispose of up to 99,000 tonnes per year of maintenance dredged material from Holyhead Harbour (Licence ref DML1648) (Adam Cooper,

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
				site is shallower, ranging from 25 – 40m water depth.						NRW 2017. Pers. comm.) At the same location, the now closed IS040 site was in regular use between 1983 and 2017. IS040 received both capital and maintenance material from a number of dredge locations. The most recent capital dredge disposal licence (10/45/F) at IS040 was for Anglesey Aluminium Metal

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
										Renewables Limited to dispose of up to 246,740 tonnes (169,000m^3). This licence expired in 2011.
IS050	Point Lynas	Closed	Circle with 0.5nm radius	Situated in wide flat shelf area. A depth of -38mCD is noted. The surrounding seabed is approximately -40mCD.	14km	1,402,500	398,989	615,997 during the period 1987 to 2000	Capital material	IS050 was in use between 1987 and 2000. The site is currently classified as closed. The reason for closure is that it had not been used in over 10 years. The most recent disposal at the site

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
										was undertaken in 1989 and the most recent licence that permitted disposal at the site expired in 2000.
IS055	Conwy Bay	Disused	Circle with 1 nm radius	-20mCD contour passes through the area. Depths can be as shallow as -15mCD. The surrounding seabed to the north is 20mCD and deepens with	30km	1,150,000	79,751	255,349 during the period 1986 to 2004	Capital and Maintenance material	IS055 was in use between 1986 and 2004. It has received both capital and maintenance dredged material. IS055 is currently classified as 'disused'. Sites are classified as disused when they

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
				distance and to the south and west it shallows towards the coast.						have not been used in 5-10 years. The most recent licence for this disposal site expired in 2004 and the most recent disposal activity at the site was also undertaken in 2004. Cefas have advised that they are likely to close the site at the end of this reporting year as it has been over 10 years since its last use (Jemma

Disposal Site Reference	Site Name	Status	Size	Water Depth (from Admiralty Charts 1121 / 1413 and bathymetric data)	Distance from Wylfa Newydd Project	Max annual licensed quantity (tonnes)	Max quantity disposed per annum (tonnes)	Total quantity disposed at the site (tonnes)	Capital/ Maintenance	Summary of use
										Lonsdale, Cefas, 2016, pers. comm.).

Characteristics of the sites

Capacity

5.3.4 The size and depth of a disposal site are important factors in understanding its capacity to receive material. The disposal site should be large enough:

- to have the bulk of the material remain either within the site limits or within a predicted area of impact after disposal; unless the site is dispersive, the size should be sufficient to minimize mounding;
- to accommodate anticipated volumes of dredged material so that the quantities of sediment or any constituents reaching site boundaries are below levels of concern; and
- to accommodate the anticipated disposal volumes so that it will serve its function for the duration of its intended use, including consideration of its use by multiple projects.

5.3.5 Due to the strong tidal streams that are present around Anglesey (further detail is provided in section 6.2 paragraph 6.2.5), it is anticipated that most soft sediment material placed at any of the three sites would disperse quickly leaving a minimal increase in bed level. Depending on the deposit location within the disposal site, the settlement of this material could be both within and outside of the boundary of the disposal site, with the amount of deposition decreasing with increasing distance from the disposal site.

5.3.6 Rock material placed at any of the three sites would remain in-situ and would cause a shallowing of water depth. It is assumed that the rock material would be spread to avoid mounding to any greater height than 1m. All three disposal sites are large enough to allow distribution of material within the site boundary that prevents rock mounding from being greater than 1m from the seabed.

5.3.7 All three disposal sites have water depths of at least 15m, meaning that if disposed rock material were to protrude 1m from the seabed, it is unlikely to cause an obstruction to vessels. As Holyhead North is both the largest and deepest site it has the greatest capacity to receive material that will both disperse and remain in-situ.

5.3.8 Where sites are dispersive, the likely fate of the material is considered when the disposal site is characterised to ensure that it would not have a significant impact on the surrounding environment or other users of the sea. If the quantity of dispersive material proposed for disposal, in conjunction with other known volumes to be disposed during the year at the site, are comparable or less than the quantities that have previously been disposed per annum at the site, and there have been no known issues associated with this, it is generally accepted by NRW and Cefas that the disposal site has the capacity to accept this volume of dispersive material. If the total volume of material to be disposed per annum is greater than the volume that has previously been disposed at the site, further characterisation work may be required to understand the fate and impacts of this material.

5.3.9 Historic disposal volumes at each of the disposal sites have been investigated to help understand the capacity of the sites. Disposal volumes can be looked at in two ways – licensed quantities and actual disposal volumes (known as disposal returns). Licensed annual quantities provide information on the volume of material that the regulator has consented for disposal at the site. These quantities would have been assessed through the licensing process to determine suitability, and would have been deemed acceptable, suggesting that the disposal site can accommodate this volume of material. The disposal returns volume is the quantity of material that has actually been deposited at the site in any particular year. This is usually less than the licensed quantity as operators may not use up their full allowance each year. Use of disposal return data is beneficial as these are actual known volumes that have been deposited at the site, and if no adverse impacts have been recorded, reassurance is provided to the regulator that a dispersive disposal site can accommodate this volume of dispersive material per annum without adverse effects.

5.3.10 The historic maximum licensed quantity and maximum disposal returns per annum for the three disposal sites are given in table 5-3. Disposal returns for IS040 have been utilised for IS043. This shows that IS050 and IS055 have had large quantities licensed for disposal in the past but the quantity disposed at the site was significantly less. IS040/IS043 has lower quantities than IS050 and IS055 licensed for disposal per annum but the quantities disposed are closer to the licensed amounts. The site that has received the greatest quantity of material (disposal returns) in one year is IS040/IS043 and this site has also received the greatest quantity of dredged material over its lifetime.

Table 5-4 Historic disposal quantities

Disposal Site	Max per annum licensed quantity (tonnes)	Max quantity disposed per annum (disposal returns) (tonnes)	Total quantity disposed at the site (tonnes)
IS040/IS043	573,950	451,129	1,658,732
IS050	1,402,500	398,989	615,997
IS055	1,150,000	79,751	255,349

5.3.11 The Wylfa Newydd Project disposal requirements are:

- Soft sediment – 352,000 tonnes (242,000 m^3)
- Rock – 709,714 tonnes (368,000 m^3)
- Total – 1,061,714 tonnes (610,000 m^3)

5.3.12 When historic disposal data for the three sites are compared to the Wylfa Newydd Project disposal requirements it can be seen that the total proposed disposal tonnage of both sediment and rock (1,061,714 tonnes) is lower than the maximum annual licensed quantity for IS055 and IS050 but greater than the maximum annual licensed quantity for IS040/IS043. When the Wylfa Newydd Project disposal requirements are compared to annual disposal returns it can be seen that the total disposal requirement is greater than the maximum annual disposal returns for all three sites.

5.3.13 It is however understood from discussion with NRW and Cefas that historically most of the material that would have been disposed at the three sites would have been soft sediments (silt, sand) and possibly gravel material. If the Wylfa Newydd Project rock and soft sediment disposal requirements are looked at separately, which is appropriate as the two types of material will interact differently with the environment when disposed, it can be seen that the maximum annual licensed quantity for all of the three sites is greater than the maximum quantity of soft sediment requiring disposal from the Wylfa Newydd Project (352,000 tonnes).

5.3.14 When compared to disposal returns it can be seen that IS040/IS043 and IS050 have both previously received annual disposal volumes greater than the Wylfa Newydd Project soft sediment disposal requirements and IS055 has previously received lower volumes.

5.3.15 The capacity of the disposal site to receive material from the Wylfa Newydd Project is also dependent on other projects that are utilising the disposal site. There is currently one Marine Licence that permits disposal at Holyhead North; this is for Stena Line Ports to dispose of 99,000 tonnes per annum of maintenance dredged material from Holyhead Port (Licence number: DML1648). Stena Line Ports Ltd have highlighted that a proposed reclamation project within Holyhead Port (which is currently being scoped) may involve disposal of capital dredged material at Holyhead North [RD4]. The timescales and potential disposal volumes for this project are currently unknown. It is therefore not possible to comment on the capacity of the disposal site to receive this material. There are no current licences to dispose at IS050 or IS055.Therefore, the total known cumulative amount of sediment for disposal per annum would be 451,000 tonnes at Holyhead North. There are currently no licences permitting disposal at IS050 and IS055 therefore the total cumulative disposal volume would be 352,000 tonnes (the Wylfa Newydd Project disposal requirement). This cumulative annual disposal quantity is below previous annual disposal return levels at IS043 but greater than that for IS050 and IS055.

5.3.16 Maintenance dredging requirements for the Wylfa Newydd Project are currently unknown so it is not possible to provide a comparison against

licensed quantities or disposal returns. Maintenance dredging requirements will be informed by hydrographic survey to determine rates of sedimentation and it is anticipated that maintenance dredging would be required infrequently.

5.3.17 The comparison of disposal requirements against historic disposal returns shows that IS040/IS043 and IS050 have both previously received greater volumes of sediment than the cumulative sediment disposal requirement from the Wylfa Newydd Project and all other known disposal operations. This suggests that these sites have the capacity to again accommodate this amount of dispersive material without significant negative impacts on the environment.

5.3.18 The analysis above assumes that the maximum allowable quantity would be disposed, and that all of the disposal would occur within one year. This represents the worst case, but will not necessarily happen in practice.

5.3.19 As it is understood that previous disposal at all three sites would primarily have been of soft sediment material, the disposal of a large quantity of rock represents a new type of disposal at all three sites. Rock disposed on the seabed will interact with the surrounding environment differently to soft sediment as it would be retained within the site, rather than disperse. As rock has not previously been disposed at any of the sites, there is no historic data to inform the determination of the suitability of the sites to receive rock material.

5.3.20 This review of disposal quantities demonstrates that offshore disposal of soft sediment material from the Wylfa Newydd Project would be lower than quantities previously licensed at all three disposal sites and fall within the range of previous disposal returns at IS043 and IS050.

Seabed substrate

5.3.21 The material to be disposed and the seabed substrate at the chosen disposal site should be of similar characteristics as far as possible. Detailed information on the properties of the material to be dredged was collected as part of the summer 2016 geotechnical campaign. This shows that the material to be excavated/dredged from the marine environment is comprised of a thin veneer of soft sediment overlain on bedrock. The soft sediment is predominantly sandy gravel, or gravelly sand with very little silt content. Samples collected from towards the toe of the western breakwater and RORO MOLF contained a higher proportion of silt (51% and 76%, respectively) but with gravel and sand also present. The composition of the seabed at the three disposal sites is characterised as rock and sediment, sandy gravel at IS043; gravel at IS050; and gravelly sand at IS055 [RD5]. This suggests that Holyhead North (IS043) disposal site has the most similar seabed characteristics to the material to be disposed.

5.3.22 Limited information is available on the type of material previously disposed as this has only been recorded as capital or maintenance on the Cefas database. Maintenance dredged material is typically soft unconsolidated sediments that has been relocated by environmental conditions since the last dredging campaign, and capital dredged material is typically more consolidated and can

comprise silts, gravels, clays and rock material. A review of the physical characteristics of material that have previously been licensed for disposal at the three disposal sites is provided in table 5-5. Information from historic licences provided by Cefas has been used to supplement this data.

Table 5-5 Physical characteristics of historic disposal material

Disposal Site Reference	Site Name	Disposal site seabed composition [RD5]	Type of material previously licensed for disposal
IS040/IS043	Holyhead Deep/Holyhead North	Rock and sediment, sandy gravel	• Capital and maintenance material • Licence condition stating rock material should be disposed to land or used in reclamation rather than being disposed at Holyhead Deep. • Licence condition stating that surplus material from blasting works that cannot practically be utilised in the reclamation works may be disposed of at the Holyhead Deep disposal site. Such material should be restricted to cobbles and pebbles.
IS050	Point Lynas	Gravel	Capital material
IS055	Conwy Bay	Gravelly sand	Capital and maintenance material

5.3.23 All three sites have previously received capital dredged material which is likely to comprise gravels, clays or rocks that may not disperse from the disposal site and therefore remain in-situ. The information collated for Holyhead Deep/Holyhead North suggests that rock material (cobbles and pebbles) has previously been permitted for disposal at the site, and on another occasion the disposal of rock material was not permitted. The reasoning behind this is not clear as there is no justification provided in the Marine Licence.

Summary of disposal site options

IS043 Holyhead North

5.3.24 Disposal has been ongoing at this location since 1983 as part of Holyhead Deep disposal site. The site has received both capital and maintenance dredged material which suggests that both silt/sand material and more consolidated gravel/clay/rock material has previously been disposed. The seabed substrate within the disposal site is understood to be rock, sediment

and gravel which is similar to the composition of the material to be disposed. Holyhead North is the largest of the three disposal sites and is located in the deepest water suggesting that the assumed 1m bed level increase from rock disposal would be well within the capacity of the site, and very unlikely to cause negative impacts to other sea users.

5.3.25 Disposal returns data shows that the site has been regularly used over its lifetime. The maximum annual licensed quantity and disposal returns are greater than the proposed disposal quantity of soft sediment from the Wylfa Newydd Project but lower than the total (rock and sediment) worst case Wylfa Newydd Project disposal requirements. This indicates that Holyhead North would be a suitable site for the disposal of dredged material from the Wylfa Newydd Project.

IS050 Point Lynas

5.3.26 Point Lynas, IS050 is the smallest of the three existing disposal sites considered and is currently classified as closed. This site has been considered as it may be possible to re-open the site. The water depth at the site is approximately 40m which means that a bed level increase of approximately 1m is unlikely to cause concerns for other sea users. The site is located approximately 14km from the Wylfa Newydd Project making it the closest disposal site.

5.3.27 Point Lynas was opened in 1987 to receive capital dredged material and has not been used for disposal since 1989. Its use for capital dredged material suggests that consolidated (gravel/clay/rock) material was deposited here, but it is unknown whether this specifically included rock. The seabed substrate at the site is understood to be gravel which would mean that the disposal of rock would introduce a different substrate type into the environment. The review of licensed quantities and disposal returns (table 5-5) demonstrates that significantly larger quantities than the Wylfa Newydd Project's soft sediment disposal requirements have been licensed for disposal at the site, and larger volumes have previously been disposed at the site.

5.3.28 This suggests that Point Lynas could be a suitable site for the disposal of dredged material from the Wylfa Newydd Project, however, the shallower water depth compared to Holyhead North, the gravelly seabed substrate, and its closed status, means that this site is less preferable that IS043.

IS055 Conwy Bay

5.3.29 Conwy Bay, IS055 is a disused disposal site located approximately 30km to the east of the Wylfa Newydd Project. This site has been investigated as it may be possible to reclassify the site from disused to open. The site was in use between 1986 and 2004, and received both capital and maintenance dredged material. This suggests that both consolidated and unconsolidated material was disposed here but it is unknown whether this included rock. The seabed substrate at the site is understood to be gravelly sand which would mean that the disposal of rock would introduce a different substrate type into the environment.

5.3.30 This is the shallowest of the three sites, located in approximately 20m of water, though it could be as shallow as 15m in places. The review of licensed quantities and disposal returns (table 5-5) demonstrates that significantly larger quantities than the Wylfa Newydd Project's soft sediment disposal requirements have previously been licensed for disposal at the site but historic disposal returns are low, and less than the Wylfa Newydd Project's soft sediment disposal requirements.

5.3.31 The information gathered about this site suggests that Conwy Bay could be a suitable site for the disposal of dredged material from the Wylfa Newydd Project, however it is less preferable than IS043 and IS050 due to its shallower water depth, sandy gravel seabed substrate and increased distance from the Wylfa Newydd Project.

New disposal site

5.3.32 Designating a new site would require a characterisation process to be undertaken. The first stage in this process would be to determine if a new site is required, and this would consider the capacity of existing sites near to the Wylfa Newydd Project. As there are three existing sites in the vicinity of the Wylfa Newydd Project that appear from this high-level review to be possible options for the disposal of the dredged material, it is expected that the outcome of the assessment would conclude that a new site is not required as an existing site could be utilised. The creation of a new disposal site and the placement of dredged material on an area of seabed that has not previously received dredged material is likely to have a greater environmental impact than utilising an existing disposal site where the environment is used to disposal operations. The creation of a new disposal site is therefore not considered a suitable option for the disposal of dredged material from the Wylfa Newydd Project.

Conclusion

5.3.33 The disposal site that has been determined to be the most appropriate for the disposal of material from the Wylfa Newydd Project is Holyhead North (IS043). This is because its physical characteristics mean that disposal here is anticipated to have the least impact on the environment and other sea users, of all of the sites considered. Summary of the need for characterisation of a disposal site.

5.3.34 The use of Holyhead North disposal site was proposed to NRW Marine Licensing Team in a letter dated 15th September 2016. A response to this letter was received from NRW MLT dated 14th October 2016, which stated that *"NRW welcomes Horizon's will to reduce and re-use dredged material wherever possible to reduce the quantity needed for disposal at sea. However, NRW do recognise that there is likely to be a need to dispose of dredge material arising from the project at sea….NRW note that Horizon seek to utilise Holyhead Deep (IS040) disposal site. This site was designated to receive dispersive material. If Horizon intend to dispose of rock material at the site, a site characterisation will need to be undertaken. This is to understand how the disposal site may perform if different material is deposited... NRW*

recommends that a site characterisation report of Holyhead Deep (IS040) is submitted as a supporting document to the Marine Licence application" [RD1].

5.3.35 In line with the advice provided by NRW MLT, additional characterisation of Holyhead North disposal site has been undertaken, the results of which are presented in this report. As Holyhead North is an existing disposal site, the site characterisation report focuses on assessing the potential effects of the Wylfa Newydd Project's disposal that are outside of the current use of the site, namely the disposal of larger quantities of material and the disposal of rock.

6 Characteristics of the disposal site

6.1.1 The baseline characteristics of the disposal site have been derived from surveys carried out by Horizon in late 2016. These included physico-chemical analyses of sediment and water; and faunal analysis of seabed samples. In addition, wider surveys of the north Anglesey coast have been conducted by the Wylfa Newydd Project over several years which are utilised in this characterisation. These include fish, plankton and ornithology surveys. This survey data is supplemented by Wylfa Newydd Project specific desk based assessments covering topics including archaeology, navigation, and marine mammals.

6.1.2 In addition, survey data commissioned by others including NRW, SEACAMS and Minesto has been utilised along with literature, including the ES and supporting technical appendices of the Minesto Deep Green Tidal Energy Project [RD6]. The Minesto Project Development Area is located in the southern part of the now closed Holyhead Deep disposal site, immediately south of the Holyhead North disposal site. Whilst environmental baseline surveys conducted by or on behalf of Minesto Limited focused on characterising the marine environment inside the Minesto Project Development Area, broad scale surveys were also carried out to assess potential effects in the context of the wider sea area.

6.2 Site description

6.2.1 Holyhead North is an existing and open disposal site located 5km north-west of Holy Island, Anglesey. The site covers the northern half of the now closed Holyhead Deep (IS040) disposal site. Due to the overlap in area of these two disposal sites, information on the historic use of Holyhead Deep has been used as a proxy for Holyhead North.

6.2.2 Holyhead North covers an area of approximately 6.5km (3.45nm) x 4.45km (2.4nm) giving an area of approximately 28.8km^2. The site is located in a natural depression with water depths ranging from 35 – 96m. At its nearest point, Holyhead North is approximately 18 km from the Wylfa Newydd Development Area at Porth-y-Pistyll, on the north coast of Anglesey. The southern and northern sections of the disposal site's eastern boundary are approximately 9km and 10km, respectively, from Holyhead Harbour, whilst the north-west corner is approximately 15km. A summary of information about the disposal site and its previous use is provided in table 5-3.

6.2.3 Since Holyhead Deep (IS040) disposal site was opened in 1983 licences have been granted for the disposal of dredged material to the following licence holders [RD7]:

- Cyngot Dosbath Dwyfor;
- Stena Lines Ports Limited;
- Mouchel Consultancy Limited;
- Anglesey Boat Cmpany Limited;

- Dwr Cymru Welsh Water;
- PVW International Dredging and Harbour Works Limited; and
- Anglesey Aluminium Metal Renewables Limited.

6.2.4 These include both capital and maintenance dredging applications. The volumes of material licensed and disposed of over the lifetime of the site have been provided by Cefas and are shown in figure 6-1. The largest quantity of material licensed for disposal in any one year is 573,950 tonnes and the total volume of material licensed for disposal between 1983 and 2015 is 3,563,478 tonnes. The largest quantity of material disposed at the site in any one calendar year was 451,129 tonnes and the total quantity disposed between 1983 and 2015 was 1,658,732 tonnes (Jemma Lonsdale Cefas, 2016 pers. comm.).

6.2.5 Since 2012, the only company to utilise Holyhead Deep, and now, Holyhead North disposal site is Stena Lines Ports Limited. This is for the disposal of up to 99,000 tonnes of maintenance dredged material per annum from Holyhead Port.

6.2.6 The Minesto Ltd Deep Green project reviewed historic use of the disposal site and identified where within the site material has been deposited during the period 2009-2013 [RD7]. Figure 6-2, taken directly from the Minesto Ltd report [RD7], illustrates that material has primarily been placed within the north-east part of Holyhead Deep (the south-eastern part of Holyhead North) site, as this provides the shortest steaming distance from Holyhead Port.

6.3 Physical characteristics

Seabed environment

6.3.1 Holyhead North is located within a large depression in the seabed to the west of Anglesey. The waters off the north-west coast of Anglesey are notable for several such depressions in the hard pre-Cambrian rock that extends out from Anglesey in a north-westerly direction [RD8]. High-resolution multibeam bathymetry data collected by SEACAMS between 2013 and 2014 shows that much of the disposal site is greater than 50m deep with depths in the middle of the site reaching up to 96m (figure 6-3).

6.3.2 A survey of the seabed environment at Holyhead North was undertaken in 2016. The results of this survey are presented in the Wylfa Newydd benthic surveys report (appendix D13.02 of the ES) and summarised below. The disposal site survey used a multi-method approach to provide an accurate characterisation of the benthic environment. This included taking drop down camera (DDC) images and grab samples from eight sites for granulometric and chemical analysis.

6.3.3 The survey data shows that the seabed in this area is a combination of coarse sediments, boulder and bedrock. The majority of rock and bedrock was identified along the south-eastern boundary of the disposal site. It is estimated that an area of 2.74 km^2 (~10% of the whole disposal site) is bedrock and adjacent to this, covering approximately 9.59 km^2, is an area described as

'rock and sediment', with grab samples collected by SEACAMS recording 'sandy coarse gravel' to 'very coarse gravel' [RD7]. This is validated by British Geological Survey (BGS) data [RD5] which shows that the western region of the disposal site is characterised by 'sandy gravels' whilst, to the east, the seabed is comprised of 'rock and sediment' (figure 6-4). The areas of bedrock and rock tend to occupy the shallower waters (50m to 60m) with the coarse gravels found accumulated in the deeper plateaus.

6.3.4 Granulometric analysis of the eight sediment samples identified similar substrata at all sampling sites. All samples were dominated with gravels with finer sediments (muds and sands) contributing between 2% and 6% to the composition.

Water column

6.3.5 The hydrodynamic environment at Holyhead North is characterised by semi-diurnal tides with a tidal range of approximately 4.5m on a spring tide. This results in high tidal current velocities (generally between 1.75 – 2m/s with velocities exceeding 2.5m/s during spring tides (figure 6-5)), which creates a dynamic environment. Tidal current velocity tends to vary little with depth, except near the seabed, where there is a high shear layer a few metres thick. This results in well mixed unstratified waters, with only a weak thermocline developing during times of fine weather [RD9].

6.3.6 Waves are mostly locally generated due to the semi-enclosed nature of the Irish Sea with a significant wave height over a 50-year period of 8m [RD9]. Wave data from a point approximately 1.1nm north of the Wylfa Newydd Development Area suggests that waves are predominantly from the south west and west where the wave height is most frequently 0.5-1m. The highest frequency of larger waves (2m to 3.5m) comes from the south-west direction. The waves from these sectors have the longest fetch distance and are therefore larger.

6.3.7 Under typical wave conditions, due to the water depths, wave energy is not anticipated to reach to the seabed. Studies (e.g. [RD6]) have shown that across the site as a whole, bed shear stresses are dominated by tidal processes. However, in rare, extreme wave conditions (e.g. an 8m wave) it is possible that some wave interaction with the seabed could occur in the shallower parts of the site.

6.3.8 SEACAMS modelled bed shear stresses (the frictional force exerted by the flow per unit area of bed) for Minesto Ltd in a 15 day simulation. The modelling showed that within the Holyhead Deep area, bed shear stress was generally predicted to range between 6 to 10Nm-2 decreasing to 4N/m2 in the northern most depression [RD7]. The bed shear stress threshold for bedload transport of fine sediments, such as material disposed from maintenance dredging, is 0.18Nm-2 [RD13], therefore the area is dispersive of fine sediments, moving them in a north-easterly direction.

6.3.9 Due to the depth of water and distance from the coastline, the geomorphology at Holyhead North is defined by the local bathymetry, seabed features

(bedrock form and sediments) and their interaction mainly with the tidal currents rather than waves.

6.4 Biological characteristics

Nature conservation designated sites

6.4.2 The designated sites of national/international importance for nature conservation with marine components within 20km of Holyhead North are shown on figure 6-6 and include:

- North Anglesey Marine/Gogledd Môn Forol candidate Special Area of Conservation (cSAC);
- Anglesey Terns/Morwenoliaid Ynys Môn Special Protection Area (SPA);
- Glannau Ynys Gybi / Holy Island Coast Special Protection Area (SPA)
- Ynys Feurig, Cemlyn Bay and The Skerries Special Protection Area (SPA);
- Glannau Ynys Gybi / Holy Island Coast SAC;
- Bae Cemlyn / Cemlyn Bay SAC;
- North George Channel candidate Marine Conservation Zone (cMCZ);
- Glannau Ynys Gybi: Holy Island Coast SSSI;
- Glannau Rhoscolyn SSSI;
- Beddmanarch-Cymyran SSSI;
- Ynys Feurig SSSI;
- Rhosneigr Reefs SSSI;
- Clegir Mawr SSSI;
- The Skerries SSSI; and
- Carmel Head SSSI.

6.4.3 Holyhead North is located within the North Anglesey Marine candidate SAC and the Anglesey Terns SPA (which is an extension to the Ynys Feurig, Cemlyn Bay and The Skerries SPA). Glannau Ynys Gybi / Holy Island Coast SAC, SPA and SSSI are all located approximately 5km from the disposal site on the Holy Island Coast. The remaining sites are located >5km to 20km from the disposal site. The features of these sites are given in table 6-1. Further details about international designations and their conservation objectives are provided in the Shadow Habitats Regulations Assessment (HRA) for the Wylfa Newydd Project which also covers a wider geographical area than this assessment, to meet the requirements of the Habitats Regulations.

6.4.4 Horizon's test of Likely Significant Effects (LSE) within the shadow HRA assesses the potential for activities associated disposal at Holyhead North to have a likely significant effect on the conservation objectives of European designated sites (SAC, SPA and Ramsar) both alone and in-combination with other projects. A LSE has the potential to arise when the presence of a

receptor (qualifying interest feature) overlaps with the influence of an effect associated with a project that the receptor is sensitive to.

6.4.5 The LSE test identifies the following qualifying interest features where a likely significant effect cannot be excluded, due to disposal at Holyhead North:

- Harbour porpoise: Land-take, including seabed or intertidal land; Changes in marine water quality; Changes in visual and acoustic stimuli;
- Coastal lagoons: Changes in marine water quality;
- Atlantic salmon: Changes in visual and acoustic stimuli; Changes in marine water quality;
- Grey seal: Changes in visual and acoustic stimuli; Changes in marine water quality; Land-take, including seabed or intertidal land;
- Bottlenose dolphin: Changes in visual and acoustic stimuli; (Changes in marine water quality; Land-take, including seabed or intertidal land;
- Lesser black backed gull: Land-take, including seabed or intertidal land; Changes in marine water quality; Changes in visual and acoustic stimuli;
- Arctic tern: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Sandwich tern: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Roseate tern: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Common tern: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Great cormorant: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Manx shearwater: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Gannet: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Seabird assemblage: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Fulmar: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality;
- Guillemot: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality; and
- Puffin: Changes in visual and acoustic stimuli; Land-take, including seabed or intertidal land; Changes in marine water quality.

Table 6-1 Conservation designations with marine components

Site Name	Designation	Distance from disposal site (km)	Features
North Anglesey Marine/Gogledd Môn Forol	cSAC	0km	Annex I habitats and species – n/a Annex II habitats and species Harbour porpoise *Phocoena phocoena*
Anglesey Terns/Morwenoliaid Ynys Môn	SPA	0km	The SPA is a marine extension to the existing Ynys Feurig, Cemlyn Bay and The Skerries SPA. Breeding population of arctic tern *Sterna paradisae* Breeding population of common tern *Sterna hirundo* Breeding population of roseate tern *Sterna dougallii* Breeding population of sandwich tern *Sterna sandvicensis*
Glannau Ynys Gybi / Holy Island Coast	SPA	5km	Breading population of chough *Pyrrhocorax pyrrhocorax* Overwintering population of chough *Pyrrhocorax pyrrhocorax*
Glannau Ynys Gybi / Holy Island Coast	SAC	5km	Annex I habitats and species Vegetated sea cliffs of the Atlantic and Baltic Coasts European dry heaths Northern Atlantic wet heaths with *Erica tetralix* Annex II habitats and species – n/a

Site Name	Designation	Distance from disposal site (km)	Features
Ynys Feurig, Cemlyn Bay and The Skerries	SPA	10km	Breeding population of arctic tern *Sterna paradisae* Breeding population of common *tern Sterna hirundo* Breeding population of roseate *tern Sterna dougallii* Breeding population of sandwich *tern Sterna sandvicensis*
Bae Cemlyn / Cemlyn Bay	SAC	16km	Annex I habitats and species Coastal lagoons Perennial vegetation of stony banks Annex II habitats and species – n/a
North George Channel	cMCZ	10km	moderate energy circalittoral rock, high energy circalittoral rock, subtidal mud, subtidal sand, subtidal coarse sediment, subtidal mixed sediment, subtidal biogenic reefs, horse mussel (*Modiolus modiolus*) beds, drumlins.
Glannau Ynys Gybi / Holy Island Coast	SSSI	5km	Geological and biological features, including heathland and maritime grassland communities, coastal cliffs and ledges, assemblages of vascular plants and birds,

Site Name	Designation	Distance from disposal site (km)	Features
			invertebrates and solid geology
Glannau Rhoscolyn	SSSI	12km	Botanical, ornithological and geological features and has substantial marine biological interest for its diverse algal communities and the presence of specialised communities such as bedrock overhangs
Beddmanarch-Cymyran	SSSI	12km	A variety of coastal habitats selected primarily for ornithological and botanical interest including large areas of sandbank, mudflat and saltmarsh, as well as two stands of dune heath. A wide range of water birds, both on passage and in winter, are attracted to the area including ringed plover, greenshank, red breasted merganser and goldeneye. Marine biological interest includes beds of eelgrass Zostera spp and saltmarsh vegetation
Ynys Feurig	SSSI	18km	The largest tern colony in Wales breeds on Ynys Feurig. The tern species involved are: roseate, sandwich, common and arctic
Rhosneigr Reefs	SSSI	19km	A group of rocks and flanking reefs situated just to the south west of Rhosneigr. Extensive areas of intertidal bedrock and sandy sediments are

Site Name	Designation	Distance from disposal site (km)	Features
			included within the site. It is of particular importance for the abundance and variety of rock pools present and for diverse and rare species of marine algae
Clegir Mawr	SSSI	13km	This site is designated for its botanical interest. The most noteworthy feature is the presence of a large population of the nationally rare annual rockrose Tuberaria Guttata growing in one of its nine known British localities
The Skerries	SSSI	10km	A group of small rocky islets used by seabirds and grey seals. Species include arctic terns, herring and lesser black - backed gulls, puffin, shag, oystercatcher, red–breasted merganser and rock pipit. Grey seals use the islands principally as a hauling-out place
Carmel Head	SSSI	12km	Designated for geological interest as the ancient rocks of the Mona Complex have pushed over younger rocks to form the "Carmel Head Thrust"

Phytoplankton and zooplankton

6.4.6 A plankton monitoring programme was carried out between May 2010 and September 2014. Samples were collected from the waters off the north Anglesey coast in a study area covering 5km from the Wylfa Newydd Development Area. The study did not collect any samples from within Holyhead North disposal site, however, due to the similarities in water quality

characteristics between the two areas results are considered to be applicable to the disposal site. The results of the monitoring are provided in the Water quality and plankton appendix to the ES (D13.01) and summarised below.

6.4.7 Phytoplankton and zooplankton are not considered to be of specific conservation value themselves, and there are no designated species of conservation importance within these groups. However, they play a key role in the ecological function of marine ecosystems through the support of features of conservation value, as they provide a vital food resource for invertebrate and fish species.

Phytoplankton

6.4.8 Sampling was carried out monthly from May 2010 to October 2012, encompassing full seasonal variations of phytoplankton communities and pigments around the north Anglesey coast. In 2014 samples were collected monthly during the phytoplankton growing period (March – September). Samples were collected at sites during neap and spring tidal cycles, and over flood, ebb and slack tides.

6.4.9 Phytoplankton abundance and community composition in the study area exhibited seasonal patterns, driven by changes in the light and nutrient regime in the water column. The main phytoplankton genera found during the surveys are shown in figure 6-7.

6.4.10 The start of the phytoplankton production period was characterised by a spring peak in abundance in May/June. Diatoms were the most abundant phytoplankton group for the majority of the monitoring period, and they generally dominated the peak abundance in spring during all years that were sampled.

6.4.11 Other groups such as microflagellates can represent an important component of the spring bloom [RD10] and have numerically dominated the spring bloom in the past (e.g. in 2001; [RD10]). This was also observed in May 2010, when *Phaeocystis globosa* contributed the same as diatoms (38%) to the total phytoplankton abundance, and also in April 2012 when microflagellates were observed in very high abundances, dominating the spring phytoplankton peak abundance. Other dominant genera reported in this study such as *Chaetoceros, Skeletonema, Pseudo-nitzschia, Thalassiosira, Leptocylindrus* and *Cerataulina*, have been recorded as abundant during spring blooms elsewhere in the Irish Sea [RD10].

6.4.12 Some phytoplankton produce toxins that are harmful to marine fauna such as shellfish and fish, and also to humans if affected fauna are consumed. Other species can be a nuisance by causing mechanical damage such as gill clogging, production of foam or anoxia. During the monitoring period, 11 nuisance/harmful and 12 toxic algal species were reported at the sampling locations. All cell densities of these species were very low compared to the number at which an individual taxon is considered to reach bloom densities according to the Water Framework Directive (WFD) classification. Most of the harmful/toxic species observed in this study have been reported in the Irish Sea since 1993 [RD10].

6.4.13 Two invasive non-native diatom species were recorded during the monitoring period: *Coscinodiscus wailesii* and *Odontella sinensis*. Both of these diatoms are well established in British and European waters. *C. wailesii* can have an economic impact when reaching high numbers, as a result of the mucilage produced clogging fishing gear [RD11].

Zooplankton

6.4.14 Sampling was carried out monthly between 2010 and 2013 at sites during neap and spring tidal cycles, and over flood and ebb tides. During the 2014 programme, a reduced number of sites were sampled, and these were carried out on any state of tide (flood, ebb or slack tide).

6.4.15 Zooplankton contains a very wide range of organisms and representatives from many animal phyla can be found here since many species (referred to as meroplankton) have planktonic life stages before settlement. Other groups from the phylum Cnidaria and the subclass Copepoda are termed holoplankton, spending all their life in the water column.

6.4.16 The key phyla contributing to the zooplankton community assemblage were Arthropoda, Annelida, Chordata, Mollusca and Bryozoa (figure 6-8). Abundance was numerically dominated by Arthropoda, and specifically Copepoda, which are known to be an important food source for the larval stages of many commercial fish species in the Irish Sea. The most abundant copepod was the calanoid copepod *Temora longicornis*; other calanoid copepods, such as *Centropages hamatus, Paracalanus parvus, Pseudocalanus elongatus* and *Acartia spp*., were also prevalent at certain seasons.

6.4.17 Other important zooplankton groups recorded in this study were members of the Crustacea (including Decapoda) and Chordata; these formed 11% and 3.8% of the zooplankton composition respectively.

6.4.18 In all years, the highest zooplankton abundances were recorded in spring, whilst lowest numbers were recorded during winter (0). Differences identified in the zooplankton analysis between months indicated that the zooplankton community is driven predominantly by the varying environmental factors that constitute changes in season as well as the timing of the spring phytoplankton peaks. Zooplankton exhibited a lag response to the seasonal peaks in phytoplankton abundance. There were no statistically significant differences in zooplankton abundance or composition between the sites monitored and the zooplankton community recorded was similar to other observations from the Irish Sea.

6.4.19 There were no protected species of zooplankton identified in the survey, however, a number of benthic species of conservation importance, which have planktonic larval life stages have been identified from other baseline surveys of the monitoring programme (e.g. dive, intertidal biotope and subtidal grab surveys). These species are:

- *Mytilus edulis* (blue mussel); blue mussel beds on sediment are a UK BAP priority habitat;
- *Modiolus modiolus* (horse mussel, previously named Mytilus modiolus); horse mussel beds are an Annex I habitat;
- *Sabellaria spinulosa* and S. alveolata; Sabellaria reefs are an Annex I habitat; and
- *Palinurus elephas* (spiny lobster); spiny lobster is a UK BAP priority species.

6.4.20 Since all of the above species have planktonic larval life stages, their presence within the north Anglesey coast zooplankton community is expected. *Mytilus spp*. was recorded within the zooplankton and could therefore represent both the blue mussel and the horse mussel. *Sabellaria sp*. was also recorded within the zooplankton and could represent *S. spinulosa* and/or *S. alveolata*. The spiny lobster could have been recorded under the order Decapoda.

6.4.21 The invasive non-native barnacle *Austrominius modestus* was recorded from benthic surveys at the power station outfall and was most likely recorded in the zooplankton within the group of barnacle larvae (*thoracica nauplii*). *Caprella sp*. was also identified from zooplankton samples; this could be a representative of the invasive Japanese skeleton shrimp, *Caprella mutica*, which is a non-native marine species of concern in north Wales.

Benthic habitats and species

6.4.22 A survey of the benthic habitats at Holyhead North was undertaken in 2016. This survey extended approximately 1.6km from the disposal site boundary. The results of this survey are presented in the Wylfa Newydd benthic surveys report (appendix D13.02 of the ES) and summarised below. The disposal site survey used a multi-method approach to provide an accurate characterisation of the benthic environment. This included taking drop down camera (DDC) images and grab samples for faunal analysis.

6.4.23 To broadly characterise the biological communities, sites were selected to provide good spatial coverage of the disposal site while acknowledging historical benthic data. Recognition was given to the location of ongoing and historical disposal activity. Acknowledging the above, the sampling regime was focused on the eastern margin of the disposal site and included a number of sampling stations outside this focal area, allowing representation of the wider benthic environment in and around Holyhead North. A total of 19 sites were targeted using a combination of DDC (17 sites) and grab (eight sites) (see figure 6-9) from water depths ranging from approximately 60m to 85m.

6.4.24 In addition, the data from this survey has been supplemented with a literature review and data from research undertaken by others within or in close proximity to the disposal site, including CMACS and NRW.

6.4.25 Habitat mapping of the seabed around the Welsh coast by the HABMAP project [RD14] used a predictive model to assign likely biotopes to the seabed. This mapping covers the area of Holyhead North disposal site, which it

categorises into four predicted biotopes. The western half of the disposal site is categorised as '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment'. Moving east the biotope changes to '*Mysella bidentata* and Thyasira spp. in circalittoral muddy mixed sediment'. The eastern edge of the disposal site is characterised as 'faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' with a couple of small areas of '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock'. The HABMAP predicted biotopes are shown on figure 6-10.

6.4.26 The majority of Holyhead North is categorised by biotopes associated with circalittoral mixed sediment habitat. Infauna associated with this habitat are predicted to include a wide range of taxa, including polychaetes, bivalves and brittlestars. Harder substrata may enable sessile epifaunal species to become established, particularly hydroids such as *Nemertesia* spp and *Hydrallmania falcate;* and scour-tolerant species such as the anemones *Urticina* spp. may be common.

6.4.27 In recent years, benthic surveys by CMACS [RD15], Horizon (D13.02) and NRW [RD16] have not recorded the presence of the *Mysella bidenta* and *Thyasira spp*. biotope within Holyhead North. Nor was the biotope characterised by 'faunal and algal crusts' recorded during the Horizon benthic survey of the disposal site or the NRW commissioned work [RD16].

6.4.28 Horizon's 2016 survey of Holyhead North recorded a mosaic of sedimentary and rocky habitats, with subtidal features supporting, in general, a relatively impoverished tide-swept epifaunal community. However, some discrete features of conservation interest were recorded as *Sabellariidae* aggregations (consisting of *Sabellaria spinulosa* and *S. alveolata*) at some locations.

6.4.29 No Invasive Non-Native Species (INNS) were recorded during Horizon's survey nor were any Section 7 priority species identified. INNS were also not recorded in the NRW's 2016 survey of the disposal site, for which recording of INNS was one of the key objectives [RD16].

6.4.30 DDC images showed that the rocky habitats were characterised by tide-swept scour-resistant species and, overall, there was a low richness and density of epifaunal species observed. The most commonly observed erect species were the scour-tolerant *Flustra foliacea* (hornwrack bryozoan) and the large anemone *Urticina* spp. Other erect species included the hydroids Sertulariidae (e.g. *Hydrallmania falcata* and *Abietinaria abietina*) and *Nemertesia* sp. and sponges (Porifera). Encrusting sessile biota were dominated by barnacles, and with calcareous worms (*Spirobranchus sp*.) also commonly recorded. At many sites, low crusts of Sabellariidae worm tubes were recorded on pebbles and cobbles. Commonly observed mobile fauna across almost all sites were the common starfish *Asterias rubens* and the prawn *Palaemon* sp.

6.4.31 Infaunal analysis from grab samples was used to supplement the DDC data at sedimentary sites to provide a greater degree of information about the community. The results show that the benthic community varied greatly between grab sampling sites. The epifaunal communities were relatively impoverished at all the sedimentary sites with sparse coverage of hydroids

and bryozoans present. Although the infaunal populations were often recorded in low abundances, considerably higher abundances were recorded at sites HHD_02, HHD_16 and HHD_20, all of which were characterised by high numbers of the tube-building worms Sabellariidae.

6.4.32 In total, 135 taxa were recorded with communities generally dominated taxonomically by annelids, with crustaceans and echinoderms the least diverse groups. The most abundant annelid taxa were the polychaetes *Sabellaria spinulosa, Sabellaria alveolata, Jasmineira elegans* and small syllids (*Syllis spp.).* The most abundant arthropod overall was the long-clawed porcelain crab *Pisidia longicornis*, and molluscs were dominated by juveniles of the bivalve *Mya truncata*.

6.4.33 Potential Annex I 'reef' features were recorded during the DDC and grab surveys. All the rocky sites assessed for reefiness exhibited reef features, with all but one (HHD_01) considered as a stony reef. Of the 10 sites identified, four were of medium stony reefiness and the remaining six of low reefiness.

6.4.34 There was no evidence of *M. modiolus* (horse mussel) beds from the DDC work, with only a few empty *M. modiolus* valves recorded.

6.4.35 Across 11 of the 19 benthic sites there was evidence of Sabellariidae tubes. Of the 11 sites where Sabellariidae tube structures were recorded, nine were not considered to meet the criteria to be classified as a biogenic reef, as they were deemed to be not significant in terms of patchiness and/or elevation. The remaining two sites, HHD_17 and HHD_20, were predicted to be of medium and low quality respectively. At these 11 sites, the tubes were mainly present as low crusts or veneers on pebbles with very few appearing to be elevated above the seabed. Only at site HHD_17 were erect structures >5 cm consistently observed.

6.4.36 Across Holyhead North, a number of different habitats and species were identified, resulting in the ascription of nine separate rocky and sedimentary biotopes. These biotopes are shown in table 6-2. Information about these biotopes, including their sensitivity/resilience to hydrological, chemical and physical pressures, that could result from disposal, are provided in table 6-3, the description of the identified biotopes is derived from the JNCC Marine Habitat Classification for Britain and Ireland [RD17], and the sensitivity/resilience from The Marine Life Information Network (MarLIN) Marine Evidence based Sensitivity Assessment (MarESA) approach [RD18] . Within this table, the criteria used to define sensitivity are set out in table 6-4 [RD18]. For each sensitivity assessment, the confidence assessment categories (Quality of Evidence Q, Applicability of Evidence A and Degree of concordance C) are also provided, and a discussion of the suitability of the MarESA benchmark pressures versus the Wylfa Newydd Project pressures is given in table 6-5 which indicates that all the pressures that are likely to be experienced during construction or operation are in-line or lower than the benchmarks, and so the the benchmarks are considered suitable.

Table 6-2 Holyhead North biotopes reported in the 2016 survey

Site	Survey method	Depth (m)	Circalittoral rock biotope codes					Sublittoral sediment biotope codes			
			CR. HCR. Fat	CR. HCR.FaT.Bal Tub	CR. HCR. XFa	CR. MCR. EcCr. Urt Scr	CR. MCR. CSab Sspi	SS. SMx. CMx	SS. SMx. CMx. Flu Hyd	SS. SBR. PoR.SpiMx	SS. SCS. CCS. PKef
HHD_01	DDC	69		•		•					
HHD_02	DDC +Grab	68							•		•
HHD_03	DDC	67							•		
HHD_04	DDC	55			•						
HHD_05	DDC	65		•							
HHD_06	DDC	79				•		•			
HHD_07	DDC	85		•							
HHD_08	DDC + Grab	59						•			•
HHD_09	DDC	61				•					
HHD_10	DDC + Grab	79						•			
HHD_11	DDC*	73	•								
HHD_12	DDC + Grab	82						•			•
HHD_13	DDC + Grab	62				•					•
HHD_14	DDC	69						•			
HHD_15	DDC	67		•							
HHD_16	DDC + Grab	64							•	•	
HHD_17	DDC	67					•				
HHD_19	Grab	64						•			•
HHD_20	Grab	65							•	•	

Table 6-3 Benthic biotopes identified in Holyhead North and their sensitivity/resilience including confidence assessment categories as determined by [RD18].

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
CR.HCR.Fat	Very tide-swept faunal communities This biotope complex occurs in wave-exposed, tide-swept narrows and straits on circalittoral bedrock and boulders. The biotopes within this complex are characterised by a high abundance of the robust hydroid *Tubularia indivisa*. The barnacle *Balanus crenatus* is characteristic of BalTub, the cushion sponges *Halichondria panicea* and *Myxilla incrustans* are characteristic of CTub.CuSp and *Alcyonium digitatum* is characteristic of CTub.Adig. The anemones *Sagartia elegans*, *Actinothoe sphyrodeta*, *Urticina felina*, *Corynactis viridis* and *Metridium senile* are all found within this complex. Other species present in this high-energy complex are the sponges *Esperiopsis fucorum* and *Pachymatisma johnstonia*, the bryozoans *Alcyonidium diaphanum* and *Flustra foliacea*, *Cancer*	Assessed for CR.HCR.FaT.BalTub Biotope characterised by early colonising species (*Tubularia indivisa,* barnacles and tube worms*).* If the community suffers significant mortality from a pressure resilience would be ‘Medium’, however if resistance to the pressure is 'Medium' or 'High' then resilience would be ‘High’ as there would be less impact for the populations to recover from. Re-establishment of typical biomass will be driven by surviving individuals as well as recruitment. Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:High, A:Low, C: High) smothering: not sensitive (Q:High, A:Medium,

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	pagurus, *Sertularia argentea* and *Asterias rubens*. Within this complex, two biotopes have been identified: BalTub and CTub.	C:High) to medium sensitivity (Q:Low, A:Low, C:Low) loss/change: high sensitivity (Q:High, A:High, C:High)
CR.HCR.FaT.BalTub	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock This biotope typically occurs on upward-facing, extremely tide-swept, circalittoral bedrock, boulders and cobbles found in a broad spectrum of wave-exposures. It is characterised by a few species that are capable of maintaining a foothold in strong tides. These species either form a flat, adherent crust in the case of the barnacle *Balanus crenatus*, or have strong attachment points and are flexible, bending with the tide, such as the turf of the hydroid *Tubularia indivisa*. Other species able to tolerate these very strong tides, or just situated slightly out of the main force of the current, include the sponge *Halichondria panicea*, the robust hydroid *Sertularia argentea* and current-tolerant anemones such as *Sagartia*	Biotope characterised by early colonising species (*Tubularia indivisa,* barnacles and tube worms*).* If the community suffers significant mortality from a pressure and the assemblage is completely removed from the habitat resilience is assessed as 'Medium', however if resistance to the pressure is 'Medium' or 'High' then resilience is 'High' as there is less impact for the populations to recover from. Re-establishment of typical biomass will be driven by surviving individuals as well as recruitment. Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:High, A:Low, C: High) smothering: not

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	elegans, *Urticina felina* and *Metridium senile*. Mobile species such as the starfish *Asterias rubens*, the crab *Cancer pagurus* and the whelk *Nucella lapillus* may also be present.	sensitive (Q:High, A:Medium, C:High) to medium sensitivity (Q:Low, A:Low, C:Low) loss/change: high sensitivity (Q:High, A:High, C:High)
CR.HCR.XFa	Mixed faunal turf communities This biotope complex occurs on wave-exposed circalittoral bedrock and boulders, subject to tidal streams ranging from strong to moderately strong. This complex is characterised by its diverse range of hydroids (*Halecium halecinum*, *Nemertesia antennina* and *Nemertesia ramosa*), bryozoans (*Alcyonidium diaphanum*, *Flustra foliacea*, *Bugula flabellata* and *Bugula plumosa*) and sponges (*Scypha ciliata*, *Pachymatisma johnstonia*, *Cliona celeta*, *Raspailia ramosa*, *Esperiopsis fucorum*, *Hemimycale columella* and *Dysidea fragilis*) forming an often dense, mixed faunal turf. Other species found within this complex are *Alcyonium digitatum*, *Urticina felina*, *Sagartia*	Assessed for: CR.HCR.XFa.ByErSp Overall, if community suffers significant mortality from a pressure (resistance of 'None', 'Low') resilience is assessed as 'Medium' (recovery within 2-10 years). If resistance is assessed as 'Medium' or 'High' then resilience will be assessed as 'High' (recovery within 2 years). Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q:Medium, A:Medium, C: Medium) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: medium (Q:Low, A:Low, C:High) smothering: not sensitive (Q:Medium, A:Medium and C:Low) to low sensitivity (Q:Low, A:Low, C:Low) loss/change: high sensitivity (A:High, A:High, C:High)

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	elegans, *Actinothoe sphyrodeta*, *Caryophyllia smithii*, *Pomatoceros triqueter*, *Balanus crenatus*, *Cancer pagurus*, *Necora puber*, *Asterias rubens*, *Echinus esculentus* and *Clavelina lepadiformis*.	
CR.MCR.EcCr.UrtScr	*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock This biotope typically occurs on tide-swept circalittoral bedrock, rock adjacent to mobile sand/gravel in gullies, and cobbles on gravel and sand, characterised by scour-tolerant robust species. Although many of these species are found on subtidal rock, they tend to occur in larger numbers in these highly sand-influenced conditions. The dominant species by far is the anemone *Urticina felina* which commonly occurs on rocks at the sand-rock interface, where the scour levels are at a maximum and few species can tolerate this abrasion. The sponge *Ciocalypta penicillus* is also very characteristic of	Where resistance is 'High', resilience is assessed as 'High' by default. Where resistance is 'Medium' then recovery is considered to be 'High' based on reproduction and recolonization from the remaining population of the anemone *Urticina felina* and the sponge *Ciocalypta penicillus*. Where resistance is 'Low' or 'None', recovery to pre-impact abundance and density of the key characterizing anemone and sponge may be delayed and resilience is assessed as 'Medium'. Both *Balanus crenatus* and *Spirobranchus triqueter* are rapid colonisers and likely to recover quickly, probably within months. Therefore, resilience, of these species, is assessed as 'High' for any level of perturbation. However, a biotope consisting of only *Balanus crenatus* and *Spirobranchus triqueter* would not be classified as the assessed biotope. Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q:High, A:Low, C:High) **Chemical pressures:**

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	shifting sand-covered rock. Other species (which are able to survive, and benefit from the reduced competition) include *Balanus crenatus*, *Pomatoceros triqueter*, *Cellepora pumicosa*, *Alcyonidium diaphanum*, *Cliona celata*, encrusting red algae and *Asterias rubens*.	contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:High, A:Low, C:High) smothering: not sensitive (Q:High, A:High, C:High to low sensitivity(Q:Low, A:Low, C:High) loss/change: high sensitivity (Q:High, A:High, C:High)
CR.MCR.CSab.Sspi	*Sabellaria spinulosa* encrusted circalittoral rock This biotope is typically found encrusting the upper faces of wave-exposed and moderately wave-exposed circalittoral bedrock, boulders and cobbles subject to strong/moderately strong tidal streams in areas with high turbidity. The crusts formed by the sandy tubes of the polychaete worm *Sabellaria spinulosa* may even completely cover the rock, binding the substratum together to form a crust. A diverse fauna may be found attached to, and sometimes obscuring the crust, often reflecting the character of surrounding biotopes. Bryozoans	The evidence for recovery rates of *Sabellaria spinulosa* reefs from different levels of impact is very limited and the rates at which reefs recover from different levels of impact, and whether these rates are similar or not between biotopes, have not been documented. Recovery rates are likely to be determined by a range of factors such as degree of impact, season of impact, larval supply and local environmental factors including hydrodynamics. Areas of limited damage on a reef, e.g. where resistance is 'Medium', the assessment of resilience is ‘High’ indicating that recovery would be likely to occur within 2 years. Recovery from significant impacts (where resistance is assessed as ‘None’ or 'Low') is therefore predicted to be ‘Medium’ (2-10 years). Sensitivity to:

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	such as *Flustra foliacea*, *Pentapora foliacea* and *Alcyonidium diaphanum*, anemones such as *Urticina felina* and *Sagartia elegans*, the polychaete *Pomatoceros triqueter*, *Alcyonium digitatum*, the hydroid *Nemertesia antennina* and echinoderms such as *Asterias rubens* and *Crossaster papposus* may all be recorded within this biotope.	**Hydrological pressures:** water flow: not sensitive **Chemical pressures** contaminants: not sensitive **Physical pressures:** SSC: not sensitive(QHigh, A:Low, C:High) smothering not sensitive (Q:High, A:Medium, C:Low) to medium sensitivity (Q:Low, A:Low, C:Low) loss/change: high/medium sensitivity (Q:Low, A:Low, C:Low)
SS.SMx.CMx	Circalittoral mixed sediment Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as Cerianthus lloydii are often present in such habitats and the presence of hard substrata (shells and	Assessed for: SS.SMx.CMx.Flu.Hyd The biotope is considered to have a high recovery potential. Based on the available evidence, resilience for the hydroid species is 'High' (recovery within two years) for any level of perturbation. Bryozoans tend to be fast growing fauna that are capable of self-regeneration. Dispersal of the larvae is limited and it is likely that the bryozoan turfs would regenerate rapidly, within 2 years (resilience of 'High') from most levels of damage. *Flustra foliacea* may take at least five years to recover its original dominance. If the community suffers significant mortality from a pressure (resistance of 'None', 'Low') resilience is assessed as 'Medium' (recovery within 2-10 years). If resistance is assessed as 'Medium' or 'High' then

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities.	resilience is assessed as 'High' (recovery within 2 years). Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q:Medium, A:Medium, C:Medium) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:Medium, A:Medium, C:Low) smothering: low sensitivity (Q:Medium, A:Medium, C:Medium) loss/change: high/medium sensitivity (Q:High, A:High, C:High)
SS.SMx.CMx.Flu.Hyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment This biotope represents part of a transition between sand-scoured circalittoral rock. *Flustra foliacea* and the hydroid *Hydrallmania falcata* characterise this biotope; lesser amounts of other hydroids such as *Sertularia argentea,*	Assessed for: SS.SMx.CMx.Flu.Hyd The biotope is considered to have a high recovery potential. Based on the available evidence, resilience for the hydroid species is 'High' (recovery within two years) for any level of perturbation. Bryozoans tend to be fast growing fauna that are capable of self-regeneration. Dispersal of the larvae is limited and it is likely that the bryozoan turfs would regenerate rapidly, within 2 years (resilience of 'High') from most levels of damage.

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	Nemertesia antennina and occasionally *Nemertesia ramose*, occur where suitably stable hard substrata is found. The anemone *Urticina feline* and the soft coral *Alcyonium digitatum* may also characterise this biotope. Barnacles *Balanus crenatus* and tube worms *Pomatoceros triqueter* may be present and the robust bryozoans *Alcyonidium diaphanum* and *Vesicularia spinosa* appear amongst the hydroids at a few sites. *Sabella pavonina* and *Lanice conchilega* may be occasionally found in the coarse sediment around the stones.	*Flustra foliacea* may take at least five years to recover its original dominance. If the community suffers significant mortality from a pressure (resistance of 'None', 'Low') resilience is assessed as 'Medium' (recovery within 2-10 years). If resistance is assessed as 'Medium' or 'High' then resilience is assessed as 'High' (recovery within 2 years). Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q:Medium, A:Medium, C:Medium) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:Medium, A:Medium, C:Low) smothering: low sensitivity (Q:Medium, A:Medium, C:Medium) loss/change: high/medium sensitivity (Q:High, A:High, C:High)
SS.SBR.PoR.SpiMx	*Sabellaria spinulosa* on stable circalittoral mixed sediment The tube-building polychaete *Sabellaria spinulosa* at high abundances on mixed sediment. These	The evidence for recovery rates of *Sabellaria spinulosa* reefs from different levels of impact is very limited and the rates at which reefs recover from different levels of impact, and whether these rates are similar or not between biotopes, have

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	species typically forms loose agglomerations of tubes forming a low lying matrix of sand, gravel, mud and tubes on the seabed. The infauna comprises typical sublittoral polychaete species such as *Protodorvillea kefersteini*, *Pholoe synophthalmica, Harmothoe* spp, *Scoloplos armiger*, *Mediomastus fragilis*, *Lanice conchilega* and cirratulids, together with the bivalve *Abra alba,* and tube building amphipods such as *Ampelisca* spp. The epifauna comprise a variety of bryozoans including *Flustra foliacea*, *Alcyonidium diaphanum* and *Cellepora pumicosa*, in addition to calcareous tubeworms, pycnogonids, hermit crabs and amphipods. The reefs formed by *Sabellaria* consolidate the sediment and allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infauna species.	not been documented. Recovery rates are likely to be determined by a range of factors such as degree of impact, season of impact, larval supply and local environmental factors including hydrodynamics. Areas of limited damage on a reef, e.g. where resistance is 'Medium', the assessment of resilience is 'High' indicating that recovery would be likely to occur within 2 years. Recovery from significant impacts (where resistance is assessed as 'None' or 'Low') is therefore predicted to be 'Medium' (2-10 years). Sensitivity to: **Hydrological pressures:** (water flow: not sensitive (Q:High, A:Low, C:High) **Chemical pressures:** contaminants: not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC) not sensitive (Q:High, A:Low, C:High) smothering: not sensitive (Q:High, A:Medium, C:Low) to medium sensitivity (Q:Medium, A:Medium, C:Medium) loss/change: high/medium sensitivity (Q:Medium, A:Low, C:Low)
SS.SCS.CCS.PKef	*Protodorvillea kefersteini* and other polychaetes in	The sensitivity assessments focus on the sediments which are a key factor structuring the

Biotope	Description [RD17]	Sensitivity/resilience assessment [RD18]
	impoverished circalittoral mixed gravelly sand In coarse gravelly or shelly sand sometimes with a slight mud content, along open coasts in depths of 10 to 30m, and in shallower offshore areas, an impoverished community characterised by *Protodorvillea kefersteini* may be found. This biotope has a number of other species associated with it including Nemertea spp., *Caulleriella zetlandica*, *Minuspio cirrifera*, *Glycera lapidum*, *Ampelisca spinipes* and numerous other polychaete species all occurring at low abundances. The polychaete *Sabellaria spinulosa* is also found in low numbers in this biotope	biological assemblage and the polychaetes *Protodorvillea kefersteini* and *Glycera lapidum* and the amphipod *Ampelisca spinipes*. Where impacts also alter the sedimentary habitat, recovery of the biotope will also depend on recovery of the habitat. Some elements of the biotope have a high recoverability (e.g. *Protodorvillea*) due to short life span and rapid growth rate, while others may have a reduced recoverability from larger mortality events due to longer life span and lower breeding rate (e.g. *Glycera*), however, recoverability to smaller mortaility events will be increased by migration from adjacent areas. Burrowing behaviour may also increase survivability. Sensitivity to: **Hydrological pressures:** water flow: not sensitive (Q:Low, A:Low, C:Low) **Chemical pressures:** (contaminants): not sensitive (Q, A, C: All considered not relevant as the evidence base suggests that there is no direct interaction between the pressure and biotope group) **Physical pressures:** SSC: not sensitive (Q:Low, A:Low, C:Low) smothering: No Evidence loss/change: high/medium sensitivity (Q:High, A:High, C:High)

Table 6-4 Definition of biotope sensitivity used in table 6-3 [RD18]

Rank	Definition
Very High	"Very high" sensitivity is indicated by the following scenario: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, "high" intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (recoverability is "very low" or "none"). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is not expected to recover at all (recoverability is "none").
High	“High" sensitivity is indicated by the following scenarios: •The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ("low" recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is "low", or "very low"). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is not expected to recover at all (recoverability is "none"), so that the habitat or species may be vulnerable to subsequent damage
Moderate	"Moderate" sensitivity is indicated by the following scenarios: •The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to take more than 1 year or up to 10 years to recover ("moderate" or "high" recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years ("moderate" recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is "low", "very low"), during which time the habitat or species may be vulnerable to subsequent damage

Rank	Definition
Low	"Low" sensitivity is indicated by the following scenarios: •The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to recover rapidly, i.e. within 1 year ("very high" recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ("very high" or "high" recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to take more than 1 year or up to 10 years to recover ("moderate" or "high" recoverability).
Very Low	"Very low" is indicated by the following scenarios: •The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) but is expected to recover rapidly i.e. within a week ("immediate" recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is expected to recover rapidly, i.e. within a week ("immediate" recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover within a year ("very high" recoverability).
Not sensitive	"Not sensitive" is indicated by the following scenarios: •The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, "low" intolerance) but is expected to recover rapidly, i.e. within a week ("immediate" recoverability). • The habitat or species is tolerant of changes in the external factor.
Not Relevant	The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor.

Table 6-5 Description of MarESA benchmarks for the pressures assessed in table 6-3 [RD18], and comparison to the Wylfa Newydd Project specific pressures

Pressure	MarESA Benchmark [18]	Wylfa Newydd Project Pressure
Hydrological: water flow	A change in peak mean spring bed flow velocity of between 0.1m/s to 0.2m/s for more than 1 year	The modelling of current flows areound the rock disposal showed a 25% reduction in speed on the flood tide which recovers within 50m. 15% reduction in speed on the ebb tide which recovered within 150m and only for a short duration over the tidal cycle (see section 8.6). The predicted reduction in flow velocity around the rock disposal area is larger than the 0.1-0.2m/s used as the benchmark, however, as the change will only be experienced up to 150m from the rock disposal, and that these changes are only expected to occur over a limited part of the tidal cycle, the benchmark pressure is greater than that of the Wylfa Newydd Project pressure.
Chemical: Contaminants (Transition elements and organo-metal contamination and hydrocarbon and PAH contamination)	Compliance with all AA EQS, conformance with PELs, EACs, ER-Ls	The chemical contaminant analysis results (see section 7.3) show that all the sediments were suitable for disposal at sea as assessed against UK Action Levels and Canadian EQS. Therefore, the benchmarks are suitable for use in this assessment.
Physical: SSC	A change in one rank on the WFD (Water Framework Directive) scale e.g. from clear to intermediate for one year.	The modelled increases in suspended sediments concentrations (see section 8.3) will not results in a change in rank on the WFD scale. Therefore, the benchmark pressure is more significant than the pressure from the

Pressure	MarESA Benchmark [18]	Wylfa Newydd Project Pressure
		Wylfa Newydd Project, but still suitable for use in this assessment.
Physical: Smothering	'Light' deposition of up to 5 cm of fine material added to the habitat in a single, discrete event 'Heavy' deposition of up to 30 cm of fine material added to the habitat in a single discrete event	The modelled depths of deposition have been discussed over both 'single' dredge disposal events and over the whole dredge campaign so that the MarESA benchmarks could be use in this assessment.
Physical Loss/change	1) Change in sediment type by one Folk class (based on UK SeaMap simplified classification). 2) Change from sedimentary or soft rock substrata to hard rock or artificial substrata or vice-versa.	

Fish and shellfish ecology

Fish

6.4.37 Fish surveys were conducted along the north Anglesey coast for the Wylfa Newydd Project from spring (April) 2010 and autumn (November) 2014. The fish survey programme used a multi-method approach to characterise fish communities from a variety of habitats. Whilst no dedicated fish surveys were carried out within the immediate vicinity of Holyhead North disposal site, inferences can be made drawing upon survey results within the wider area, published literature and an understanding of the movement and habitat preferences of different fish species. The results of the surveys are presented in the Fish and Fisheries appendix of the ES (D13.04) and summarised below. This information along with data from other sources has been used to characterise the use of the disposal site by fish and shellfish.

6.4.38 Subtidal fish surveying was conducted at five sites along the north Anglesey coast using otter and beam trawl. In total, 54 fish taxa were recorded from beam trawls and 62 were taken by otter trawls. The beam trawl catches were characterised by species living in close association with the seabed, such as flatfish, rays, rocklings and clingfish. The otter trawl sampled a greater diversity of pelagic species such as sprat and herring, and demersal species such as whiting, haddock and cod. The survey results show that dab, whiting, plaice, poor cod, dragonette, lesser spotted dog fish and sprat were important in all sampling sites along the north Anglesey coast.

6.4.39 Ichthyoplankton (fish larvae) samples were dominated by sandeels and consisted mainly of inshore species such as gobies and blennies as well as some flatfish species such as plaice and dab.

6.4.40 Both fish larvae and juvenile fish can be particularly sensitive to, or less able to tolerate, changes in environmental conditions. Some fish species are known to use certain areas at specific life stages which makes these locations important for population recruitment. Spawning grounds are areas where fish go to release their eggs. Some species have extensive spawning grounds, while other species aggregate over a more restricted spatial extent. The grounds where juveniles are found are termed nursery grounds. It has been suggested that nursery grounds are those sites where juveniles occur at higher densities, have reduced rates of predation and have faster growth rates than in other habitats, which should result in nursery grounds providing a greater relative contribution to adult recruitment in comparison to non-nursery ground habitats (see [RD19] and [RD20]).

6.4.41 Spawning and nursery grounds of selected fish species have been mapped by Cefas [RD21][RD22]. These maps have been created using data collected during numerous national and internationally co-ordinated ichthyoplankton surveys and provide valuable information on ichthyoplankton abundance and distribution in the Irish Sea. The species identified from these studies as potentially using Holyhead North as a spawning and/or nursery area are shown in figure 6-11– figure 6-13 and summarised below.

6.4.42 Pelagic fish species live in the water column. Their distribution and abundance is strongly affected by hydrographic conditions and can vary significantly from year to year. The pelagic species that Ellis *et al.* [RD22] and Coull *et al.* [RD21] identified as likely to utilise Holyhead North disposal site and the surrounding area for spawning are mackerel and sprat. These species are understood to have low intensity spawning grounds in the region. The timing of spawning for these species is shown in table 6-6.

6.4.43 Demersal fish species are those that live on or near the seabed, feeding on bottom living organisms and other fish. Demersal species such as cod, plaice, sandeel, sole, and whiting are suggested by [RD22] to have low intensity spawning grounds that encompass Holyhead North. Spawning is seasonal and, depending on the life strategies of these species, they are not necessarily permanent residents within the area. The general timing of spawning of these species is provided in table 6-6.

6.4.44 Only whiting and anglerfish are suggested to utilise Holyhead North as nursery grounds. This use is considered to be year-round and of low intensity [RD22].

6.4.45 Elasmobranchs are cartilaginous fish that include sharks and rays. Elasmobranchs that may be present within the vicinity of Holyhead North include basking shark (*Cetorhinus maximus*), nursehound (*Scyliorhinus stellaris*), small spotted catshark (*Scyliorhinus canicula*), spotted ray (*Raja montagui*) and tope shark (*Galeorhinus galeus*) [RD23]. Data from [RD22] indicate that no elasmobranch species spawn near Holyhead North. However, tope shark and spotted ray are suggested to use the area for nursery grounds year-round at low intensity.

6.4.46 Diadromous fish are those that migrate between fresh water and marine water, spending portions of their lifecycle in each. Diadromous fish species that may transit through Holyhead North disposal site on an occasional basis include twaite shad (*Alosa fallax*), river lamprey (*L.fluviatilis*), European Eel *(Anguilla Anguilla)* and Salmon (*Salmo salar*) [RD23]. The closest spawning region for twaite shad is located in the Menai Strait [RD24]. The Menai Strait is also the closest area of importance to Holyhead North for Atlantic salmon [RD25]. Whilst these species may be present at the disposal site, they are only likely to occur for short periods of time (i.e. migrating through) and in low abundance.

Table 6-6 Spawning times of key fish species in Holyhead North

Species	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Cod		*	*									
Plaice	*	*										
Sandeel												
Sole				*								
Whiting												
Mackerel					*	*						
Sprat					*	*						

[RD21][RD22] Blue = spawning * = peak spawning

6.4.47 Larval densities observed during the Horizon Ichthyoplankton surveys are more or less consistent with values reported by [RD22] for the corresponding area. This comparison gives confidence in the validity of data presented by [RD22] for the area surrounding the Holyhead North disposal site. Given the rapid dispersion of larvae, peak abundances at the disposal site are only likely to occur for a short period, coinciding with the timing of peak spawning.

6.4.48 Based on the above information and the habitat preferences of different fish species, it is expected that fish communities at Holyhead North would be dominated by pelagic species such as sprat and herring; bentho pelagic species such as poor cod, whiting and other gadoids species; and demersal species such as lesser spotted dogfish, common dragonet and perhaps species such as pogge.

6.4.49 Those species, which are highly unlikely to be present in significant abundance, include flatfish species (e.g. dab, plaice and Dover sole) and sandeel. This is primarily owing to the presence of hard rocky substrates which are not a preferred habitat type for these species.

6.4.50 Of the Section 7 species of *The Environment (Wales) Act 2016,* recorded during the Wylfa Newydd Development Area subtidal trawl surveys, the following species are likely to occur at the disposa sitel: spurdog (*Squalus acanthias*), tope, cod, whiting, Dover sole, plaice, herring, scad/horse mackerel (*Trachurus trachurus*), mackerel, anglerfish, Raitt's sandeel, blonde ray (Raja brachyura) and the thornback ray. Of these species, it is considered that whiting and herring represent key characterising species of the fish communities at Holyhead North.

6.4.51 No Annex II fish species were recorded from the subtidal trawls, however, as noted above, species such as Atlantic salmon, twaite shad and European eel may transit through Holyhead North.

Shellfish

6.4.52 Although not specifically targeted in the Horizon surveys of the north Anglesey coast, a number of shellfish species were recorded in beam trawls including queen scallop (*Aequipecten opercularis*), king scallop (*Pecten maximus*), shrimps, prawns, edible crabs (*Cancer pagurus*), 'other crab species' and whelks. These species were not, however, recorded in Horizon's disposal site benthic survey, nor were any recorded from this area in reports by NRW [RD16] or CMACS [RD15].

6.4.53 Due to the water depth and sediment types known to be present in Holyhead North disposal site, it is predicted that edible crab (*C.pagarus*), velvet crab (*Necora puber*), queen scallop (*Aequipecten opercularis*), king scallop (*P.maximus*) and ocean quahog (*A.islandica*) are all likely to be present. However, their distribution would be limited to areas of mixed coarse ground, sand or gravel and soft sediments [RD26][RD27][RD28][RD29][RD30].

Marine mammals

6.4.54 The baseline marine mammal data collated for the Wylfa Newydd Project is considered to be representative of Holyhead North disposal site due to the mobility and large home ranges of these species. This baseline is made up of survey work, records of casual sightings and desk based information, which includes taking account of marine mammal management units and SACs up to 200km from the Wylfa Newydd Development Area. Full details of the baseline are presented in the Marine mammals appendix of the Wylfa Newydd ES (D13.06), and summarised below.

6.4.55 Marine mammals that frequent the Irish sea and welsh coastline can be grouped into cetaceans (whales, dolphins and porpoise) and pinnipeds (seals).

Cetaceans

6.4.56 The Sea Watch Foundation (SWF) database [RD31] has reported a total of 18 species of cetacean in the Irish Sea since 1990, 14 of which have been sighted within the last ten years. These are bottlenose dolphin, harbour porpoise, risso's dolphin, short-beaked common dolphin, minke whale, humpback whale, fin whale, Atlantic white-sided dolphin, long-finned pilot whale, northern bottlenose whale, white-beaked dolphin, sei whale and pygmy sperm whale. Most of these species are termed by the SWF as occasional visitors, with only five species (harbour porpoise, bottlenose dolphin, risso's dolphin, minke whale and the short-beaked common dolphin) recorded as regularly occurring. Minke whale and the short-beaked common dolphin are summer visitors to the Irish Sea and generally occupy the offshore Celtic Deep area. The cetacean species therefore identified from this database as frequently

occurring around the north coast of Anglesey are harbour porpoise, bottlenose dolphins, Risso's dolphin.

6.4.57 The cetacean species recorded around the north coast of Anglesey during vessel and Vantage Point (VP) surveys were primarily bottlenose dolphin, harbour porpoise, and the Risso's dolphin. These survey results correspond with the species identified from the SWF database and are therefore the species under consideration within this report.

6.4.58 In general, the bottlenose dolphin is a coastal species in the UK, often sighted within 10 miles of land, frequently within two miles of the coast. They show a preference for water depths between 5-10m, although areas of 25 -30m have seen an increase in sightings since 2005, with most the sightings in this region occurring over the slope range of Cardigan Bay [RD32]. Bottlenose dolphin prey on a wide variety of schooling fish including bass, cod, herring, mackerel, salmon, and sea trout, but they are thought to favour bottom-living fish such as flounder and mullet [RD34].

6.4.59 Bottlenose dolphins are the most abundant cetacean species recorded in Welsh waters, accounting for over 50% of individuals sighted between 2004 and 2014 [RD33]. Bottlenose dolphins are present throughout the year with most sightings occurring during the summer months in the Irish Sea Management Unit. In contrast to this general pattern it is known that individuals from the Cardigan Bay SAC move northwards during the winter and [RD34] reports that whilst this species is present all year around, it generally occurs more frequently here during the winter months. SWF records [RD31] show that the distribution of bottlenose dolphin is concentrated to the east of Anglesey where the average pod size in winter has been estimated to be 26.4 individuals. During dedicated surveys carried out within the area of Holyhead North disposal site, no bottlenose dolphins were recorded from the entire survey area (375km survey effort) [RD6]. Considering this, and the depth of water at the disposal site, it is unlikely that Holyhead North is of particular importance to this species, although it is possible that they could use the area on occasion.

6.4.60 The harbour porpoise is a small cetacean that feeds regularly to fulfil its energetic requirements. They are known to be relatively short lived (maximum of 24 years) and are highly mobile and wide-ranging individuals [RD35]. Studies have shown that the distribution of harbour porpoises is directly influenced by the distribution of prey (cited [RD36]) as well as being indirectly affected by environmental variables that influence prey distribution or foraging efficiency. Harbour porpoise are known to feed on a variety of fish species including flounder, herring, sandeel, sprat, sole and whiting, as well as a variety of cephalopods and crustaceans [RD37].

6.4.61 Harbour porpoise is the second most commonly occurring marine mammal species within the study area. The distribution of sightings shows a localised hotspot of abundance around the area of Holyhead North disposal site [RD38]. Harbour porpoise are known to be present year-round with seasonal peaks in abundance during the summer months (particularly July and August).

6.4.62 Risso's dolphin generally favour deep offshore waters, however, in Britain and Irelandmost sightings occur within 10km of the coast [RD39]. Evans *et al.* [RD40] stated that the Risso's dolphin is thought to breed in the Celtic and Irish Sea. Risso's dolphin are usually found in pods of fewer than 20 individuals but occasionally may exceed 50 individuals [RD40]. Their diet consists of cephalopods (such as octopus, cuttlefish and small squid), crustaceans and occasionally small fish.

6.4.63 The seasonal distribution of Risso's dolphin for the Irish Sea Management Unit shows that there is a presence along the north coast of Anglesey throughout the year with an increased abundance during the autumn.

6.4.64 Risso's dolphin has a relatively localised distribution in the Celtic and Irish Sea, covering Pembrokeshire, the western end of the Llŷn Peninsula and Anglesey [RD33]. Although Risso's dolphin are known to be present in the area, neither SEACAMS [RD41] nor Gordon *et al*. [RD42] recorded any observations of Risso's dolphin during their studies of the north Anglesey coast. However, two sightings of Risso's dolphin, with an average pod size of two individuals, were reported during boat based transect surveys in 2016. It is therefore unlikely that Holyhead North is of particular importance to this species, although it is possible that they could use the area on occasion.

Pinnipeds

6.4.65 Two species of pinniped, the grey seal and harbour seal, frequent the Irish Sea and of these, only the grey seal has been recorded on a regular basis by [RD43], [RD44], [RD36] around north Anglesey. Since there is no documented evidence to suggest that harbour seals are present in Welsh waters or around Anglesey in any significant numbers, harbour seals have not been considered any further in this report.

6.4.66 Grey seals have large foraging ranges and they frequently travel over 100km between haul-out sites with foraging trips lasting anywhere between one and 30 days [RD45]. They also spend a high percentage of time at or near haul-out sites. Seals will haul-out on land to breed, moult, rest and digest their food. In north Wales, they are known to use habitats such as intertidal rocky outcrops, beaches and sea caves that are tidally exposed [RD46]. Grey seals feed mainly on benthic or demersal fish species such as sandeel, cod and other gadoid species, flatfish (such as flounder), herring and skates [RD46].

6.4.67 Wales is thought to have between 3% and 4% (1,650 individuals) of the total UK pup production [RD47], with north Wales being of importance for this Welsh population. Jones *et al*. [RD36] produced maps for grey seal distribution-at sea estimates for the UK using telemetry data and aerial survey counts at haul-out sites. Around north Anglesey, the estimated density of grey seals reaches a maximum of 0.83km^2 (95% CI 0 2.07) at The Skerries. Grey seals are present year-round within the study area with peak sightings occurring between April and May.

6.4.68 There are many suitable haul-out locations for grey seal across Anglesey, three of which (North Stack, Carmel Head and The Skerries) are known for grey seal breeding [RD43][RD44]. The nearest site to Holyhead North, North

Stack, is situated just off Holy Island on the North-west coast of Anglesey and a relatively high proportion of pups have been recorded, signifying that the site is heavily used during the breeding season (August to December) but little outside that time, whilst Carmel Head and The Skerries are utilised year-round as haul-out sites.

6.4.69 Marine mammal surveys by SEACAMS in the west Anglesey area recorded low numbers of grey seals (0.10 sightings per hour) [RD41]. There is therefore evidence to suggest that both adult and juvenile grey seal use Holyhead North disposal site area, with the nearby coast of importance to a small number of animals during the breeding season, but it is unlikely that Holyhead North represents a particularly important area in the context of the wider Irish Sea.

Seabirds

6.4.70 Baseline data on seabirds is presented in appendix D13.07 of the ES and information from this report relating to Holyhead North disposal site is summarised below. The baseline was produced from a review of desk based literature sources, consultation and site specific surveys. The land-based and boat-based surveys were carried out between 2009 and 2017, however, these were focused on the Wylfa Newydd Development Area rather than the disposal site. Therefore, to supplement this information, the results of ESAS surveys undertaken by the Minesto Deep Green project of the disposal site area, have been shared with Horizon. These survey results cover the period August and September 2016, and for March to May 2017 and broadly correspond to the breeding and the post-breeding periods for most of the seabird species.

6.4.71 Seabird colony data from the JNCC Seabird Monitoring Programme (SMP), specifically the seabird 2000 surveys [RD94], provide an estimate of the regional breeding population for species. Within the zone of influence (the mean maximum foraging range) of Holyhead North disposal site the following species were identified from the SMP data:

- Sandwich tern
- Common tern
- Arctic tern
- Roseate tern
- Fulmar
- Manx shearwater
- Gannet
- Guillemot
- Puffin
- Cormorant
- Shag
- Razorbill
- Kittiwake
- Great skua
- Black guillemot
- Lesser black- backed gull
- Black-headed gull
- Common gull
- Herring gull
- Great black-backed gull
- Mediterranean gull

6.4.72 The JNCC SMP data shows that for target species, regional breeding populations ranged from two for roseate tern to 1,705 for Arctic tern (by sea-only distances). For secondary species, the breeding populations ranged from 0 (for 13 species) (straight-line and by sea-only distances) to 173,445 for Manx shearwater (by sea-only distances).

6.4.73 No target species had breeding colonies within Holyhead North Disposal Site worst extent ZOI. The percentage of regional breeding populations present within the Holyhead North disposal site worst extent ZOI for secondary species ranged from 0% (nine species) to 14.8% (shag).

6.4.74 The Minesto ESAS surveys identified relatively low densities of seabirds in the vicinity of Holyhead North with many species' presence being limited to the breeding season. Auks (guillemots and razorbills) and Manx shearwater were the most common species recorded during the breeding season. Other species such as gannet, kittiwake and common and Arctic tern occurred in low densities. During the post-breeding and non-breeding periods, these species either disperse offshore or migrate south and are therefore absent or much less common in the area at this time of year. The results of the Minesto ESAS surveys are as follows:

6.4.75 Fulmars were recorded in very low numbers in all months. Fulmars have very large foraging ranges. (Mean Maximum Foraging Range (MMFR) 400 km, [RD49] and so the birds seen could have potentially originated from any of the colonies distributed around the Irish Sea and south-west Scotland, including sites in North Wales.

6.4.76 Manx shearwater is a summer visitor and was recorded in low to moderate numbers. Manx shearwaters have very large foraging ranges (MMFR 330 km, [RD49]). The birds seen could have potentially originated from any of the colonies distributed around the Irish Sea. The closest Manx shearwater colony is on Bardsey Island, lying approx. 53 km to the south.

6.4.77 Gannets were recorded in consistently low numbers in all months. Gannet have very large foraging ranges (MMFR 229 km, [RD49]) and so the birds seen could have potentially originated from any of the colonies distributed around the Irish Sea or in south-west Scotland. The closest colonies are the relatively small colonies on Lambay Island and Ireland's Eye (both lying approx. 85 km to the west). The closest large gannetry is Grassholm, lying approx. 179 km to the SSW.

6.4.78 Lesser black-backed gulls were present in the survey area in very low numbers. The birds were most likely to originate from breeding colonies on Anglesey.

6.4.79 Great black-backed gulls were present in the survey area in very low numbers on some surveys and were not recorded on others. The birds were likely to originate from breeding colonies on Anglesey including South Stack.

6.4.80 Herring gulls were present in the survey area in low to moderate numbers. The birds were likely to originate from breeding colonies in North Wales, especially those on Anglesey including South Stack.

6.4.81 Kittiwakes were present in the survey area in consistently low numbers. Kittiwakes have moderate foraging ranges (MMFR 60 km, [RD49]) and so the birds seen during the breeding season could have potentially originated from almost any of the colonies in North Wales, in particular South Stack.

6.4.82 Arctic terns were recorded in moderate numbers in May 2017 only. This species is a summer visitor typically arriving in late April and departing around early August, thus it was likely to only be recorded on the May survey. The survey area lies comfortably within the foraging range of Arctic tern nesting on The Skerries (MMFR 20 km, [RD49]), a very important breeding site for this species. Thus, the disposal site is likely to have some value as a foraging area for Arctic terns breeding on the Skerries.

6.4.83 The only common terns seen were four birds seen on the 25th August 2016 survey. These were likely to be passage migrants moving through the site.

6.4.84 Common guillemots were recorded in moderate to large numbers on all surveys. Guillemots have a large foraging range (MMFR 84 km, [RD49] and so the birds seen during the breeding season could have potentially originated from almost any of the colonies in North Wales and even colonies off eastern Ireland and the Isle of Mann. However, the flight headings of many of the guillemots seen during the colony attendance months (March, April and May) indicated that there is strong connectivity between the survey area and the South Stack colony, by far the closet guillemot colony. Thus, the survey area is likely to have some value as a foraging area for guillemots breeding on South Stack. In the post-breeding months of August and September (at this time breeding birds are no longer attending colonies) it is likely that birds from further afield in the Irish Sea also use the survey area.

6.4.85 Razorbills were recorded in moderate to large numbers on all surveys. Razorbill have a relatively modest foraging range (MMFR 49 km, [RD49]) and the birds seen during the breeding season are thus likely to have originated from colonies in North Wales. Flight headings of many of the birds seen during the colony attendance months (April and May) indicated that there is strong connectivity between the survey area and South Stack colony, by far the closet colony. Thus, the survey area is likely to have some value as a foraging area for razorbills breeding on South Stack. In the post-breeding months of August and September (at this time breeding birds are no longer attending colonies) it is likely that birds from colonies further afield in the Irish Sea also use the survey area.

6.4.86 Puffins were recorded on the March and April surveys only and then only in very low numbers (five birds in total). Puffins have a large foraging range (MMFR 105 km, [RD49]) and so the birds seen in the survey area could have potentially originated from any of the colonies in North Wales and even colonies off eastern Ireland. They could also have been passage birds from Scottish colonies.

6.5 Chemical characteristics

Water Quality

6.5.1 Baseline water quality surveys have been carried out for the Wylfa Newydd Project which are presented in appendix D13.01 of the ES and summarised below. Appendix D13.01 details the findings of the water quality surveys which were carried during the baseline period (between May 2010 and November 2014) and two additional water quality surveys carried out in December 2015 and February 2016 within the same area. These surveys give a useful indication of the wider water quality environment off the north coast of Anglesey. In addition, the report also presents the findings of a single water quality survey carried out within Holyhead North (IS043).

6.5.2 Physico-chemical data recorded near the Wylfa Newydd Development Area between May 2010 and November 2014 showed no evidence of a permanent thermocline, halocline or seasonal stratification of the water body along the north Anglesey coastline, and were consistent with a fully mixed marine water body.

6.5.3 Chemical analysis results from the north Anglesey coast were reported at concentrations typical of coastal waters and in line with previous studies carried out around the north of Anglesey. Many concentrations were consistently reported as below the Minimum Reportable Value (MRV) or below the Limits of Detection (LoD).

6.5.4 The Water Framework Directive (WFD) provides a classification system for waterbodies where ‘high’ status means that the waterbody is near natural conditions, ‘good’ relates to a slight change from natural conditions as a result of human activity; ‘moderate’ relates to a moderate change; ‘poor’ relates to a major change; and ‘bad’ relates to a severe change from natural conditions.

6.5.5 The survey results indicate good WFD chemical status based on the specific pollutants, priority substances and other pollutants covered under the WFD. Total suspended solids data indicate clear/intermediate turbid water. Nutrient concentrations were low and consistent throughout the monitoring programme, indicating very little nutrient enrichment in the survey area. Average concentrations of dissolved inorganic nitrogen (DIN) indicate that DIN meets the high standard under the WFD classification. Most metals analysed were reported at low levels. Mercury exceeded the short-term Environmental Quality Standards (EQS) or maximum allowable concentration (MAC-EQS) on one occasion in Oct 2010. Most of the organic compounds monitored were consistently found below or marginally above the MRV.

6.5.6 Kennington and Rowlands [RD51] classified areas of the Irish Sea with respect to hydrology, nutrient chemistry and ecology. Holyhead North falls within an area classified as ‘offshore mixed waters’. Here, waters are highly saline (>34) and exhibit moderate winter nutrient conditions. Waters in this typology are generally well mixed, although a weak thermocline can develop during extended times of fine weather.

6.5.7 Holyhead North is located approximately 4km offshore from Caernarfon Bay North coastal water body designated under the WFD. Caernarfon Bay North is currently achieving 'good' ecological and chemical status [RD50]. On the west coast of Anglesey there are eight classified bathing waters, all of which are currently rated as achieving excellent status [RD50].

6.5.8 Six sites were monitored for water quality in Holyhead North on 31st October 2016. Four sites were located within the disposal site and two sites were located outside of the disposal site boundary (figure 6-2). Water samples for chemical and biochemical analysis were collected below the surface (1m depth) and at mid depth. The main physico-chemical parameters were measured in situ throughout the vertical water column, including temperature, conductivity, salinity, dissolved oxygen (DO), pH and oxidation-reduction potential (ORP). The chemical and biochemical determinants monitored were total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD), total suspended solids (TSS), cations and anions, nutrients, metals, organic compounds and cyanide.

6.5.9 The physico-chemical properties of the vertical profiles are shown in table 6-7.

Table 6-7 Physico-chemical properties measures in-situ

Parameter	Results
Temperature	Temperature within the survey area varied between 13.99°C and 14.08°C. The difference recorded within the vertical water column at each site was 0.05°C or lower.
Salinity	Salinity values recorded within the survey area varied between 33.99 and 34.15. The difference recorded within the vertical water column at each site was 0.16 or lower
Dissolved Oxygen (% saturation)	Dissolved oxygen (saturation) recoded within the survey area varied between 90.5% and 96.2%. The difference recoded within the vertical water column at each site was 5.7% or lower.
Dissolved Oxygen (concentration)	Dissolved oxygen (concentration) recorded within the survey area varied between 7.54mg L-1 and 8.01mg L-1. The difference recorded within the vertical water column at each site was 0.47mg L-1 or lower.
pH	pH values recorded within the survey area varied between 8.18 and 8.23. The difference recoded within the vertical water column at each site was 0.03 or lower
oxidation-reduction potential (ORP)	ORP values recoded within the survey area varied between 291.3mV and 325.7mV. The difference recoded within the vertical water column at each site was 14.1 mV or lower.

6.5.10 Monitoring of water quality within the disposal site shows that the waterbody is well mixed. Temperature and salinity were very stable throughout the water column and throughout the survey area. All physico-chemical properties (DO,

pH and ORP) are typical of a well-mixed coastal water body. DO values recorded within the vertical water column at all sites are 'High' according with current WFD classification.

6.5.11 A summary of the results of laboratory analysis of water samples is shown in table 6-8. The full results including details of the MRV and EQS (where relevant) are presented in appendix H of the water quality and plankton baseline report (appendix D13.01 of the ES)

Table 6-8 Laboratory water quality analysis results

Parameter	Results
Total organic carbon (TOC)	TOC concentrations were between 0.77mg/L and 0.86mg/L. The mean value reported within the survey area was 0.81mg/L.
Dissolved Organic Carbon (DOC)	DOC concentrations were between 0.90mg/L and 1.20mg/L. The mean value reported from all samples was 1.06mg/L.
Biological Oxygen Demand (BOD)	BOD values were reported below the (MRV (1.00mg/L) in all samples except at one surface sample, where it was reported marginally above (1.15mg/L)
Total Suspended Solids (TSS)	TSS for samples collected at surfaces ranged from <3.0mg/L and 5.2mg/L, while samples collected at mid depth ranged from 3.9mg/L and 14.7mg/L. The mean value reported at surface was 3.6mg/L while the mean value reported at mid depth was 7.5mg/L. The mean value reported within the survey area (considering all samples collected) was 5.5mg/L.
Cations and Anions	All concentrations for cations and anions reported around Holyhead North were found within the expected values for coastal waters [RD51], with no significant variations between sites and in line with concentrations reported during the baseline monitoring programme.
Nutrients	Most nutrient concentrations were found below the laboratory's (MRV or marginally above the relevant value.
Metals	All mean metals concentrations reported for the area were found below the relevant EQSs. However, zinc was reported between 1.37μg/L and 12.80μg/L. The mean concentration reported within the survey area was 4.32μg/L, below the current EQS (7.9μg/L). Concentrations for boron, copper, zinc, arsenic and lead were all found within the expected values for coastal waters [RD51]. Nickel was reported marginally above the MRV in four samples, however, the mean value reported remained below the MRV. Vanadium, chromium, manganese, iron, cobalt, selenium, cadmium, tin and mercury were all found below MRV in all samples.

Parameter	Results
Organic compounds	Total petroleum hydrocarbons (TPH) and di-2-ethylhexyl phthalate (DEHP) were reported as below the MRV (0.2mg/L) in all samples collected.
Cyanide	All results were reported below their MRV (0.5mg/L for total cyanide as CN and 0.005mg/L for free cyanide as CN).

6.5.12 There was no exceedance of EQS, and all concentrations were in line with 'good' chemical status as defined by the WFD and consistent with other coastal waters that are absent of pollutants.

6.5.13 The mean suspended solids (as total) reported in all samples classified the areas as clear water under WFD criteria used to identify the type of waters.

Sediment Quality

6.5.14 Seabed sediment samples were collected for analysis of chemical contaminants during the October to December 2016 disposal site baseline survey monitoring. Six samples were collected, five within the disposal site and one just outside, to the east. The full results of the sampling are provided in the Benthic Ecology appendix of the ES (D13.02) and summarised below.

6.5.15 All the samples predominantly comprised of gravelly sediments, although two sites contained slightly muddy gravelly sediment.

6.5.16 The samples were analysed for heavy metals, Tributyl Tin (TBT), Polyaromatic Hydrocarbons (PAHs) and the ICES7 Polychlorinated Biphenyl's (PCBs). The results show that levels of contamination in all the sediment samples were below Cefas AL1, the national standards used for assessing the level of contamination for disposal of dredge material at sea, indicating that contaminants are at low levels and unlikely to cause significant negative impacts (see section 2.3). The chemical analysis results have also been compared to the relevant Interim Sediment Quality Guidelines (ISQG) [RD3]. Arsenic was the only metal with concentrations reported above the relevant ISQG (7.24mg/kg). The highest concentration reported was 12.4mg/kg, which is well below the relevant PEL of 41.6mg/kg and AL1 of 20mg/kg.

6.5.17 All PAH, PCB and organotin compounds monitored were found to be at low concentrations (below the relevant AL and ISQG).

Table 6-9 Holyhead North sediment contamination results

Analyte	Units (Dry weight)	AL1	AL2	Sampling station					
				HHD_13	HHD_10	HHD_12	HHD_19	HHD_20	HHD_08
Carbon, Organic	%			1.21	1.48	1.23	0.155	1.65	1.71
Mercury	mg/kg	0.3	3	0.0135	<0.01	<0.01	<0.01	0.0155	<0.01
Aluminium	mg/kg	n/a	n/a	15500	6940	5330	3670	6560	2310
Arsenic	mg/kg	20	100	7.7	9.57	12.4	9.4	8.12	7.28
Cadmium	mg/kg	0.4	5	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chromium	mg/kg	40	400	23.6	15.2	9.9	8.7	14.3	5.8
Copper	mg/kg	40	400	6.31	4.22	3.14	2.06	3.89	1.69
Lead	mg/kg	50	500	16.3	9.39	8.16	7.4	10.7	6.64
Nickel	mg/kg	20	200	18.8	12.9	13.9	7.7	8.6	5.8
Zinc	mg/kg	130	800	55.3	30	36.3	23.3	30	20.3
C2 Naphthalene	ug/kg	100	n/a	22.9	<10	<10	<10	10.8	<10
Acenaphthene	ug/kg	100	n/a	1.44	<1	<1	<1	<1	<1
Acenaphthylene	ug/kg	100	n/a	<1	<1	<1	<1	<1	<1
Anthracene	ug/kg	100	n/a	2.75	<1	<1	<1	1.15	<1
Benzo(a)anthracene	ug/kg	100	n/a	10.4	<1	3.02	<1	4.3	<1
Benzo(a)pyrene	ug/kg	100	n/a	12.4	<1	3.93	<1	5.36	<1
Chrysene + Triphenylene	ug/kg	100	n/a	17.2	<3	5.5	<3	8.21	<3
Dibenzo(ah)anthracene	ug/kg	100	n/a	3.14	<1	1.02	<1	1.41	<1
Fluoranthene	ug/kg	100	n/a	20.9	1.57	5.93	<1	9.23	<1
Fluorene	ug/kg	100	n/a	5.16	<5	<5	<5	<5	<5
Naphthalene	ug/kg	100	n/a	12.7	<5	<5	<5	5.95	<5
Phenanthrene	ug/kg	100	n/a	23.5	<5	6.74	<5	10.5	<5

Analyte	Units (Dry weight)	AL1	AL2	Sampling station					
Pyrene	ug/kg	100	n/a	15.8	1.42	4.97	<1	6.77	<1
Hydrocarbon Screen >C5-C44	mg/kg	100	n/a	96.2	<60	<60	<60	<60	<60
Tributyl Tin	ug/kg	100	1000	<4	<4	<4	<4	<4	<3
PCB - 028	ug/kg	20	200	0.154	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 052	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 101	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 118	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 138	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 153	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB - 180	ug/kg	20	200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethan	ug/kg	n/a	n/a	<0.6	<0.6	<0.6	<0.5	<0.6	<0.6
Bromoform {Tribromomethane}	ug/kg	n/a	n/a	<2	<2	<2	<2	<2	<2
Chloroform {Trichloromethane}	ug/kg	n/a	n/a	<0.6	<0.6	<0.6	<0.5	<0.6	<0.6
Dibromochloromethane	ug/kg	n/a	n/a	<3	<4	<3	<3	<3	<3
Dry Solids @ 30°C	%	n/a	n/a	77.3	80.5	85.1	82.6	79.6	88

6.6 Human environment characteristics

6.6.1 Holyhead North is utilised for a variety of human purposes including fishing, recreation and navigation. The following sections set out the existing use of this area of the sea and its archaeological and seascape characteristics.

Fishing

6.6.2 Fishing activity around Holyhead North has been characterised using a variety of desk based sources including UK Sea Fisheries Statistics, the Sea Fishing Atlas for Wales, NRW and Cefas research projects and vessel activity data

reported in the Wylfa Newydd Navigation Risk Assessment (appendix D15.01 of the ES) and the Minesto project Navigation Risk Assessment.

6.6.3 The broad range of seabed and resulting habitats found along the Anglesey coastline support diverse fish and shellfish assemblages with various species being commercially exploited by local fishermen [RD54].

6.6.4 In 2014 there were 116 fishing vessels utilising Holyhead Port, most of which were under 10m in length. Vessels smaller than 10m are rarely at sea for more than 24 hours on any one trip and tend to fish close to their home port. Even the largest vessels in this class size tend to work inshore, generally within 6nm (11.1km) of the coast.

6.6.5 The Sea Fishing Atlas for Wales [RD54] was compiled in 2010 from information collected between 2000 and 2005 from various sources including fishermen, fishery officers and fishery regulators and other marine users. Whilst the outputs of the data are now a little dated, they provide a useful indication of the fishing activity that is likely to occur in the disposal site. The Sea Fishing Atlas data suggests that long lining and potting occurs in the Holyhead North area.

6.6.6 Fish Map Mon [RD55], a project run by NRW and the recreational and commercial fishing community in North Wales, collected data during 2011-2012 from 47 commercial fishermen and 500 anglers to produce a series of maps describing the patterns of fishing activity. Holyhead North falls within the study area for this project. The results of the study suggest that commercial potting and charter angling occurs within Holyhead North at a low intensity [RD54][RD55].

6.6.7 Research by Walmsley and Pawson [RD56] and UK Sea Fisheries Statistics [RD53] confirms that shellfish including king scallop, queen scallop, whelk, lobster and crabs are by far the most important commercial species constituting the main resources for many fishermen operating on Anglesey. On average, scallops accounted for over 70% of total landings at Cemaes, Amlwch and Holyhead (2,658 tonnes) between 2010 and 2014. Whelk and lobster for a further 28.5% (1,081 tonnes), 0.5% (17 tonnes), respectively. Whelks and lobsters are caught using pots and traps and king and queen scallops are caught using dredgers and beam trawlers. Whelks are fished throughout the year, while king scallops, queen scallops and lobster are caught at certain times of the year.

6.6.8 Haddock, skates and rays represented the most important finfish although collectively, these only accounted for, on average, 0.5% of total landings between 2010 and 2014, with plaice and Dover sole each contributing a further 0.1%. Other species known to be landed include: anglerfish, cod, brill, Norway lobster, common prawns, turbot, gurnards, lemon sole, whiting, megrim, dab, lesser spotted dogfish, pollack, conger eel, common ling, octopus, bib, bass, squid, mackerel, saithe and flounder. On average, each of these species accounted for less than 0.1% (≤ 1 tonne) of landings between 2010 and 2014.

6.6.9 Comparison with landings data suggests that most landings into Holyhead, Cemaes Bay and Amlwch are derived from fishing areas further afield. For

example, only 23% and 63% of annual scallop and whelk landings into Anglesey were caught within the local area (ICES rectangle 35E5). In addition, landings of haddock into Anglesey (10 tonnes on average between 2010 and 2014) were found to be entirely caught in waters further offshore (outside of ICES rectangle 35E5).

6.6.10 Comparison of these fishing statistics confirms that the coastal waters around the north coast of Anglesey do not support significant abundances of commercial finfish species, with fishing activities for these species primarily occurring further offshore.

6.6.11 Fishing vessel activity was monitored during the Minesto 2014-15 marine traffic surveys on both AIS and radar throughout both the spring and summer. The surveys show that pots & traps account for 45.5% of fishing vessel activity and mechanised dredging accounts for 22.7% of fishing vessel activity. The majority (78.6%) of fishing vessel transits were recorded travelling in excess of six knots and therefore were unlikely to be directly engaged in fishing operations. Furthermore, the fishing vessels that were recorded travelling at less than six knots were small potting vessels and thus were likely to be transiting against the tide, hence the low vessel speed. This data suggests that direct fishing in the disposal site is very limited [RD57].

Infrastructure

6.6.12 The Wales Marine Planning Portal does not identify any fixed infrastructure within Holyhead North disposal site. There are no aggregate extraction areas, oil and gas infrastructure, offshore wind infrastructure, nuclear infrastructure, submarine pipelines, or diffusers within the disposal site or surrounding area [RD58].

6.6.13 There are no military practice areas, aerodrome traffic zones, or Civil Aviation Authority consultation zones within the disposal site, however, the Valley and Mona airfields military aerodrome traffic zone extends into the southern end of the disposal site and the disposal site is within a military air traffic amber low flying zone (see figure 6-14) [RD58].

6.6.14 Within the surrounding area NRW has licensed the installation of one tidal kite to Minesto Limited (within the Minesto lease area) (figure 6-14). At the time of writing, the construction of this project has not yet commenced. In addition, to the south east of Holyhead North, the West Anglesey Tidal Demonstration Zone, known as Morlais, is being progressed by Menter Môn (figure 6-14). The West Anglesey Demonstration Zone is one of several around the United Kingdom which have been leased out by The Crown Estate in a bid to encourage and accelerate tidal energy technology development. Menter Môn plan to manage and sub-let areas within the Zone for test and demonstration of tidal energy devices alongside some of the first array scale commercial tidal energy projects. Menter Môn has not yet submitted a Marine Licence application for the Morlais project. There are also submarine cables running to the south of the disposal site (figure 6-14).

6.6.15 The closest port to the disposal site is Holyhead Port. The port is operated by Stena Line Ports Limited who is the Statutory harbour authority. The port is

utilised for commercial purposes including fishing and operates a ferry service to Dublin which handles more than 2 million passengers per year.

6.6.16 Within the disposal site, the only marine licensable activity known to occur is disposal of dredged material. At the time of writing, Stena Line Ports Ltd is the only company to hold a Marine Licence for disposal at Holyhead North, however, other companies have disposed at this location in the past. Stena Line Ports Ltd have highlighted that a proposed reclamation project within the Port (which is currently being scoped) may potentially involve disposal of capital dredged material at Holyhead North [RD4]. The timescales and potential disposal volumes for this project are currently unknown.

Recreation

6.6.17 Through analysis of AIS-A and AIS-B data, RYA published information, yacht club information and anecdotal discussions with recreational boaters, the Wylfa Newydd Navigation Risk Assessment (appendix D15.01 of the ES) determined recreational use within the NRA study area, which covers Holyhead North disposal site. Baseline recreational information from this assessment that relates to Holyhead North is summarised below.

6.6.18 Yachting covers a variety of boating activities, which for the purposes of this report includes motor boating, keelboat cruising and racing. In general, cruising takes place all year round with increased intensity in the summer months; any recreational sailing will also be heavily biased towards the weekend. The Holyhead Sailing Club organises yacht racing between April and October with their racing routes typically following the north coast of Anglesey rather than further offshore.

6.6.19 Figure 6-15 identifies indicative routes for recreational vessels and cruising areas using the RYA UK Coastal Atlas of Recreational Boating [RD59]. The cruising routes along with analysis of yacht club information and anecdotal information received from stakeholders gives a representation of recreational yacht activity in the area. AIS data suggest that boating activity in the disposal site is low to moderate and recreational vessels generally transit approximately 1nm offshore of the Anglesey coast (figure 6-15). Anecdotal information from Holyhead Sailing Club confirms that recreational yachting vessels typically remain close to the coastline.

6.6.20 Minesto Ltd undertook marine traffic surveys in 2014-15 [RD57] of Holyhead Deep disposal site, which encompasses Holyhead North disposal site. The focus of this survey was the area immediately south of Holyhead North disposal site. During the Minesto marine traffic surveys, an average of three recreational vessels per day were recorded throughout the summer. Throughout the spring survey an average of one recreational vessel every two days was recorded. Most of these vessels were recorded inshore of the disposal site. This follows the typical seasonal pattern of recreational vessel activity with higher levels of activity associated with the fairer weather summer months.

6.6.21 The Anglesey coast is a popular location for sea kayaking due to the quality of the scenery and challenges of navigating a small unpowered craft in the

strong tidal flows and wave conditions. There are a range of training centres located on Anglesey that offer courses including the circumnavigation of Anglesey. Kayaks that navigate along the coast will keep close to the shoreline (within approximately 10m) to gain protection from wind conditions under any steep-sided foreshore. If there are any waves at the time of the passage, sea kayaks will navigate further out to sea, beyond any shore breaks, but still relatively close to the coast. Nearly all journeys by sea kayaks will be carried out in daylight hours. Due to the distance offshore, Holyhead North disposal site is not known to be used by kayakers, or other non-powered craft such as dinghies.

6.6.22 Due to the location of the disposal site, approximately 5km offshore from the nearest landfall, it is concluded that there is limited recreational boating use of the disposal site area.

6.6.23 The nearest coastline at Holy Island is a popular location for bird watching and climbing [RD60].

Navigation

6.6.24 A Navigation Risk Assessment (NRA) has been produced for the Wylfa Newydd Project, which includes an assessment of disposing of dredge material at Holyhead North. The NRA is informed by data from the Automatic Identification System (AIS), Admiralty charts, Royal National Lifeboat Institution (RNLI) and Marine Accident Investigation Branch (MAIB) incident records, and anecdotal and website information. The NRA is provided in appendix D15.1 of the ES and summarised below. In Addition, the Minesto Ltd Deep Green Project undertook a marine traffic study in 2014-15 [RD6][RD57] of a five-nautical mile area around the Minesto project development area, which covers the area of Holyhead North. Information from this study has also been used to inform this baseline.

6.6.25 The closest navigation feature to Holyhead North is the Skerries Traffic Separation Scheme (TSS). This TSS overlaps with the northern part of the disposal site. This TSS is regularly used by vessels transiting to and from ports on the north coast of Wales and the north-west coast of England, in particular Liverpool (see figure 6-16which is taken from Horizon's NRA).

6.6.26 There is no Statutory Harbour Area (SHA) that covers the disposal site. The closest Port to the disposal site is Holyhead Port. Stena Line Ports Limited operate conventional and high speed cargo and passenger ferry services from the port, including Roll on Roll off (RoRo) to Dublin (Ireland). There are also facilities for handling marine diesel oil and general cargoes at a deep-water berth. Port statistics published by the Department for Transport (DfT) indicate an average of 3,116 ship calls per annum at Holyhead Port between 2009 and 2015.

6.6.27 Holyhead Marina is located within Holyhead Harbour which is primarily used by recreational vessels. The marina has approximately 350 berths and a large number of swinging moorings. Holyhead Sailing Club operates out of Holyhead Marina; the sailing club is RYA accredited and offers courses in the area.

6.6.28 There are no aids to navigation within Holyhead North disposal site. However, between the Wylfa Newydd Development Area and the disposal site there are a number of cardinal marker buoys that mark areas where there are rocks close to the surface.

A Racon is in operation at the Skerries lighthouse. The Racon will be shown on a vessel's radar as the Morse Code for the corresponding letter shown on the nautical chart. The purpose of the Racon is to present a visual representation on the vessel's radar screen highlighting, in this case, the location of the lighthouse. This is widely used so that in periods of reduced visibility vessels can navigate safely in the area.

6.6.29 AIS data, representative of 84 days of AIS collected in 2015 has been used to identify commercial transit routes within the Wylfa Newydd NRA study area. This shows that most vessels navigating around Anglesey follow routes that run through the Skerries TSS. Vessel transits by ship type within the Wylfa Newydd NRA study area are shown in table 6-10.

Table 6-10 Vessel transits by ship type within the Wylfa Newydd NRA study area

Vessel Category	Transit Line Count (84 days)	Uplifted (Yearly) Transit Count	Transit Count Percentage
Unknown	202	878	1.1
Non-port service	266	1156	1.5
Port service	252	1095	1.4
Dredging/underwater	357	1551	2
High spend craft	3777	16412	21.2
Military/law	524	2277	2.9
Cargo	2955	12840	16.5
Passenger	7355	31959	41.2
Tanker	1422	6179	8
Fishing	280	1217	1.6
Recreational	465	2021	2.6
Total	17855	77585	100

6.6.30 Minesto Ltd undertook marine traffic surveys of the Holyhead Deep area, which encompasses Holyhead North disposal site [RD57]. During the Minesto Ltd Marine Traffic surveys there was an average of 34 vessel transits per day in the summer and 30 unique vesseltransits per day in the spring within the study area. The most frequently recorded vessel types were passenger vessels (47.50%), cargo vessels (16.15%) and high speed craft (12.85%). The main destinations for vessels passing through the area were Holyhead, Dublin and Liverpool.

6.6.31 During the Minesto surveys, the average draught of vessels through the area was 5.5m. All vessels recorded inshore of Holyhead North were small fishing and recreational vessels, which are likely to have a draught of less than 4m.

Historic environment

6.6.32 A desk based assessment of marine archaeology has been undertaken at Holyhead North disposal site. This is provided in appendix D11.03 of the ES and summarised below.

6.6.33 The assessment is based on a review of records held by national and local inventories and secondary sources relating to the marine historic environment. Various sources of data for maritime and aviation history have been collated in order to develop a baseline of regional archaeological and cultural heritage and the potential for encountering unknown wreck and aircraft crash sites. The assessment examined seabed prehistory through a review of the geological mapping of seabed sediments, solid geology and bathymetry from published BGS sources.

6.6.34 Current evidence suggests that during the retreat of the Devensian ice sheet, relative sea levels in the Irish Sea remained low, exposing the disposal site as a terrestrial environment. There is therefore the potential for prehistoric archaeological remains to exists within the disposal site, however, there are no designated or non-designated pre-historic archaeological remains known to be located there. Seabed prehistory is therefore considered to have an unknown value at Holyhead North.

6.6.35 There are currently no sites within the disposal site that are subject to statutory protection from the Protection of Wrecks Act 1973, the Protection of Military Remains Act 1986 the Ancient Monuments and Archaeological Areas Act 1979; the three legislative acts that could be used to protect marine archaeological sites.

6.6.36 There are three charted non-designated maritime and aviation sites within the disposal site. All of these records are based on the loss location of a vessel or contemporary sighting of an obstruction with no tangible remains observed on the seafloor. As a result, these sites are better regarded as Recorded Losses. The value of these heritage assets cannot be fully assessed without an understanding of the nature of the remains on the seafloor. As such the value of these heritage assets has currently been assessed to be of Unknown value.

6.6.37 There is the potential for currently unknown wreck sites and other maritime-related remains to be present within the disposal site as it is possible that some were lost as a result of natural causes, human error, mechanical malfunction or war. In general, the potential for the preservation of wooden wrecks is likely to be relatively low [RD61] but the preservation of metal hulled vessels, fixtures and fittings, or more robust items of cargo, and personal effects could occur. The value of any maritime-related site, debris or derived artefacts is be considered as Unknown at present.

6.6.38 There is potential for the presence of archaeological material of an aviation nature spanning from the early 20th century to the present day within the

disposal site. Analysis of maps showing the location of WWII Air/Sea Rescue Operations that took place within the vicinity of the disposal site indicated that there were two recorded Air/Sea Rescue Operations, one of which was recorded as unsuccessful. However, the mapped location of these operations is not necessarily reliable, rather, the locations provide a useful guide to the general distribution, and suggest the potential for discovery of aircraft crash sites in the disposal site. The value of any aircraft or aircraft-related debris discovered is considered to be Unknown.

Seascape character

6.6.39 Seascape can be defined as 'an area of sea, coastline and land, as perceived by people, whose character results from the actions and interactions of land and sea, by natural and/or human factors' [RD62]. The Anglesey Area of Outstanding Natural Beauty Management Plan [RD63] also identifies the importance of seascapes as a highly valued part of the Welsh scenery that are some of the last 'wild' landscape areas and support a wealth of natural heritage.

6.6.40 The assessment of Seascape is consistent with the holistic approach to landscape of the European Landscape Convention, extending it to the sea. Seascape Character Areas (SCA) include coastal land, intertidal and marine environments and cover the offshore environment to the territorial limit (12nm).

6.6.41 In 2013, a local-level Seascape Character Assessment was undertaken for the Anglesey/Snowdonia coastlines [RD64] commissioned by Isle of Anglesey County Council (IACC). Holyhead North disposal site falls within SCA 31 – West of Anglesey which is characterised by the following:

- rocky seabed with moderate energy environment in the eastern part;
- further offshore the seabed becomes deeper and dominated by sediment, although patches of rock remain;
- a treacherous coastline containing many offshore rocks and the patterns of wrecks reflect this, including wartime losses;
- Holyhead Mountain is a prominent landmark onshore and gives a strong sense of place and orientation; and
- there is a long and continuing tradition of maritime communications, particularly with Ireland.

6.6.42 This information fed into a NRW 2015 Marine Character Areas (MCA) study [RD65]. In this report, Holyhead North lies offshore of MCA area 9: Holy Island West and Penrhos Bay MCA which is characterised as an Area of Outstanding Natural Beauty (AONB), Site of Special Scientific Interest (SSSI) and Special Protection Area (SPA) designated coastline with sheer rock faces, rock exposures, high energy wave environment, strong tidal races, varied marine habitat, a long history of human habitation and a seascape setting with panoramic views and offshore islands.

6.6.43 The seascape character is considered to have a low to moderate sensitivity to change caused by offshore industry due to the areas importance and prolonged maritime history.

7 Characteristics of the material to be disposed

7.1.1 Horizon undertook Detailed Offshore Ground Investigation (DOffGI) work between the 24th June and 29th September 2016. These investigations included the collection and testing of the material that will require dredging/excavation and disposal at sea. Testing was undertaken to provide information on the potential opportunities for re-use of the dredged material, and to provide the necessary information to support a Marine Licence application for disposal at sea.

7.1.2 The analysis and testing of the soft material was undertaken in line with The London Convention, London Protocol and the OSPAR Convention requirements. The suite of tests comprised analysis for heavy metals, organotins, Polyaromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), radionuclides, particle size distribution and carbonate content.

7.1.3 The underlying rock material was subject to geotechnical investigations but not laboratory chemical analysis. As outlined in the OSPAR requirements, previously undisturbed geological material and/or material that is exclusively composed of sand, gravel and rock is exempt from testing [RD66].

7.1.4 For regulatory purposes, the number of samples required to be tested is based on the volume and type of material to be dredged and disposed. The volume of material that could require disposal at sea from the Wylfa Newydd Project is 610,000m^3. This comprises approximately 368,000m^3 of rock material and 242,000m^3 of soft material. As only the soft material is required to be chemically analysed for sea disposal, the number of sampling stations was determined based on the volume of soft material only. Twelve sampling locations were chosen within the areas to be dredged; this is in line with the OPSAR guidelines which states that 7-15 samples should be analysed for dredge/disposal volumes between 100,000 and 500,000m^3 [RD66].

7.1.5 The sampling stations were located within the area to be dredged to create the CW intake channel and vessel berthing areas, and in the vicinity of the eastern and western breakwaters where excavation may be required to create a suitable foundation for these structures. At each of the sampling stations, samples were collected at the seabed surface and at 1m depth intervals down to where bedrock was reach. The sample locations are shown in figure 7-1.

7.1.6 Twenty marine sediment samples were taken and sent to the UKAS accredited Cefas Lowestoft Laboratory for analysis of heavy metals, organotins, Polyaromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), particle size distribution and carbonate content. Five samples were collected and sent to the UKAS accredited Amec Foster Wheeler laboratory for Radiometric and Radiochemical Analysis. The results of the Cefas analysis are provided in appendix 1-2 of this report, and the results of the Amec Foster Wheeler analysis are provided in appendix 1-3 of this report, all the results are summarised below.

7.2 Physical properties

7.2.1 The geotechnical investigations confirmed that across the site there is a thin veneer of soft sediment overlain on bedrock. At seven of the 12 sampling stations only surface samples were obtained as there was insufficient depth of soft sediment to collect a depth profile of samples. At the remaining sampling stations, both a surface sample and depth samples were obtained.

7.2.2 The composition of the samples is shown in figure 7-1 to figure 7-3. The majority of samples are predominantly sandy gravel, or gravelly sand with very little silt content. The exceptions to this are BH1202 (1.0-1.5m) and BH1236 (1.5-1.7m), located towards the toe of the western breakwater and RORO MOLF respectively, which both contained a high proportion of silt (51% and 76%, respectively); however, gravel and sand sized particles were also found in the samples.

7.2.3 The underlying bedrock geology comprises low grade metamorphic rocks belonging to the Monian Supergroup of Late Pre-Cambrian and Early Cambrian age [RD67] with igneous intrusions of undefined Palaeozoic age (most likely associated with the Caledonian orogeny). The site is crossed by faults of varying persistence and orientation. figure 7-4 provides a map showing the distribution of bedrock at the site. The majority of the site is underlain by rocks belonging to the New Harbour Group, with the Gwna Group being at the northern part of the site only (in the vicinity of Wylfa Head and the proposed outfall at Porth Wnal). The New Harbour Group originated as marine mudstones, siltstones, sandstones and conglomerates in the Ediacaran Period (late Pre-Cambrian) [RD67]. The sedimentary rocks underwent low grade metamorphism to become phyllite, psammite and metaconglomerates respectively. The igneous intrusions comprise of Dolerite/Gabbro/Basalt.

7.3 Chemical contaminant analysis

7.3.1 One of the main concerns over dredging and disposal at sea is the release of contaminants to the water column making them available for uptake by marine species. Some contaminants occur naturally in the environment, as well as being released from anthropogenic sources, while others are man-made. At high concentrations contaminants can have negative effects on the environment. Heavy metals can affect biological systems at the cellular and organ level. PAHs are well-known chemical carcinogens: many are toxins, mutagens and teratogens and are known to be highly toxic to aquatic organisms. PCBs are highly toxic, persistent pollutants that readily bioaccumulate in animals.

7.3.2 Chemical contamination data collected from DOffGI has been compared to UK ALs for dredge sediment to determine if levels of contamination in the sediment from the Wylfa Newydd Project area are suitable for disposal at sea. Where levels are recorded above AL1 the results have been compared to ISQG, PEL and dredge sediment chemical analysis results from other projects that have disposed at Holyhead Deep, to gain a better understanding of the potential effects on the environment. Background information and the

thresholds for AL, ISQG and PEL are provided in section 2.3 and table 2-1 of this report.

7.3.3 The results of the chemical contaminant testing are provided in appendix 1-2 of this report and summarised in table 7-1. Results above AL1 are highlighted in table 7-1 in yellow. There are no results above AL2. The locations of the sampling stations are shown in figure 7-1.

7.3.4 The results show that levels of all organotins and PCBs are below AL1 in all samples.

7.3.5 At six sampling stations, heavy metals exceeded AL1. These exceedances were due to elevated levels of nickel in BH1237, BH1236, BH1202, BH1234 and BH1210; elevated levels of zinc at sampling station BH1214 elevated levels of cadmium at BH1202; and elevated levels of copper at BH1210. All of the heavy metal exceedances are marginally above AL1 and well below AL2:

- Cadmium exceedance was 0.43mg/kg, only 0.03mg/kg over AL1 (0.40mg/kg) and well below AL2 (5mg/kg).
- Zinc exceedance was 163.9mg/kg which is 33.9mg/kg over AL1 (130mg/kg), but significantly below AL2 (800mg/kg).
- Nickel exceedances range between 20.2mg/kg and 32.3mg/kg, this is marginally over AL1 (20mg/kg), and significantly below AL 2 (200mg/kg).
- Copper was 102.5mg/kg, 62.5mg/kg over AL1 (40mg/kg) and well below the AL2 (400mg/kg).

7.3.6 Of the metal concentrations that exceeded the AL1, an exceedance of the ISQG was only recorded for zinc and copper. Zinc marginally exceeded the relevant ISQG of 124mg/kg by 39.9mg/kg and copper exceeded the ISQG of 18.7mg/kg by 84.3mg/kg. At all sampling locations, none of the metal concentrations exceeded the relevant PEL values.

7.3.7 Comparison of the heavy metal results for the Wylfa Newydd Project with the dredge sediment chemical analysis results from other sites (application refs 32798/050215 and MCU10/45) (Jemma Lonsdale Cefas, 2016 pers. comm.) shows that material with comparable or higher levels of nickel and zinc has previously been permitted for disposal at Holyhead Deep.

7.3.8 PAH's exceeded the AL1 of 100µg/kg at three sampling stations (BH1214, BH1238, BH1210). There is currently no AL2 for PAH's. The hydrocarbons that were measured at levels above AL1 were methyl naphthalenes (2 samples), dimethyl naphthalenes (2 samples), trimethyl naphthalenes (1 sample), Phenanthrene (2 samples), methyl phenanthrene (1 sample), Fluoranthene (2 samples), Pyrene (2 samples). The highest AL1 exceedance was 350µg/kg (trimethyl naphthalene in BH1238 closest to the cooling water intake) which is 250µg/kg over the AL1 threshold. The remainder of the exceedances were between 6 and 232µg/kg over the AL1 threshold. There were no exceedances of AL1 for any sample for Total Hydrocarbon Content (THC).

7.3.9 A number of the PAH concentrations exceeded the ISQG at sites BH1214, BH1238 and BH1210. At BH1238 an acenapthene concentration of 96.1µg/kg was recorded, 8.1µg/kg over the PEL (88.8 µg/kg). This was the only exceedance of PEL for PAHs across all samples, and it should be noted that for this determinant PEL represents a lower value than the relevant AL1 (100µg kg-1) for this compound.

7.3.10 Comparison of the data with analysis results from other sites that have been licensed for disposal at Holyhead Deep (application refs MCU10/45 and MCU13/10) shows that the level of PAH contamination found within the Wylfa Newydd Project area are comparable or lower than those measured at other local dredging sites. As there is no AL2 for hydrocarbons, and hydrocarbons can occur naturally within the environment, contamination data from other dredging sites provides useful information to help determine the level of significance of analysis results and the acceptability of dredged material for disposal to sea. As other dredging operations have previously been permitted to dispose of dredged material with similar levels of hydrocarbon contamination, this suggests that the levels of hydrocarbons found within the sediment are at levels that are acceptable for the receiving environment at Holyhead North.

7.3.11 In light of the above analysis against ALs, ISQG, PEL and historic dredge sediment chemical analysis results, the dredge sediment for the Wylfa Newydd Project is considered to have levels of chemical contamination that are acceptable for disposal at Holyhead North.

Table 7-1 Summary of chemical contaminant results using Action Levels

Sampling Station	Sample depth below seabed (m)	TOC %	Metals	DBT/TBT	PCBs (sum of 25 congeners)	PAHs
BH1210	0-0.5	0.13	Ni recorded 27.1 mg/kg Cu recorded 103mg/kg	All analysis results below AL1	All analysis results below AL1	Phenanthrene 116µg/kg Fluoranthene 246µg/kg Pyrene 166µg/kg
BH1214	0-0.5	0.16	Zn recorded 163.9mg/kg	All analysis results below AL1	All analysis results below AL1	methyl naphthalenes 130µg/kg dimethyl naphthalenes 105µg/kg Phenanthrene 230µg/kg Phenanthrene 332µg/kg Pyrene 207µg/kg Benzo[b]fluoranthene 158µg/kg

Sampling Station	Sample depth below seabed (m)	TOC %	Metals	DBT/TBT	PCBs (sum of 25 congeners)	PAHs
BH1215	0-0.7	No TOC recorded	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1202	0-0.5	0.42	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1202	1-1.5	0.34	Cd recorded 0.43mg/kg Ni recorded 27.7 mg/kg	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1202	2-2.4	0.11	Ni recorded 20.7mg/kg	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1203	0-0.3	0.11	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1203	1-1.3	0.05	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1203	2-2.3	No TOC recorded	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1228	0-0.3	0.13	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1

Sampling Station	Sample depth below seabed (m)	TOC %	Metals	DBT/TBT	PCBs (sum of 25 congeners)	PAHs
BH1229	0-0.5	0.08	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1234	0-0.5	0.09	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1234	1-1.5	0.13	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1234	2-2.5	0.14	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1235	0-0.4	0.54	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1235	1.2-1.4	0.06	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1236	0-0.4	0.13	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1236	1.5-1.7	0.14	Ni recorded 32.2mg/kg	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1
BH1237	0-0.3	0.10	Ni recorded 21.2mg/kg	All analysis results	All analysis results below AL1	All analysis results below AL1

Sampling Station	Sample depth below seabed (m)	TOC %	Metals	DBT/TBT	PCBs (sum of 25 congeners)	PAHs
				below AL1		
BH1238	0-0.3	0.52	All analysis results below AL1	All analysis results below AL1	All analysis results below AL1	methyl naphthalenes 154µg/kg dimethyl naphthalenes 218µg/kg trimethyl naphthalenes 350µg/kg methyl phenanthrene 119µg/kg

Cells coloured yellow have analysis results above AL1.

Radiological analysis

7.3.12 Five sediment samples collected as part of the DOffGI campaign were analysed for a suite of radiological parameters including key radionuclides present in authorised discharges from the Existing Power Station, proposed future discharges from the Wylfa Newydd Project, and naturally occurring radionuclides. The sample location number and depth of the samples are given in table 7-2. The samples were all located in the vicinity of the CW intake and MOLF.

Table 7-2 Location of samples for radiological testing

Borehole location	Sample Depth (m)	Sample Type	Sampling Date
BH1230	0-0.5	SEDIMENT	18/08/2016
BH1232	0-0.5	SEDIMENT	18/08/2016
BH1235	0-0.4	SEDIMENT	18/08/2016
BH1236	0.6-0.8	SEDIMENT	18/08/2016
BH1238	0-0.3	SEDIMENT	18/08/2016

7.3.13 The results of radiological sediment analyses are provided in appendix 1-3 of this report and summarised in table 7-3. Green shaded rows in table 7-3 indicate naturally occurring radionuclides. The only anthropogenic radionuclides detected were S 35, Sr 90, Cs 137, Pu 239/240 and Am 241.

Table 7-3 Results of radiological sediment analysis

Parameter	Minimum (Bq/g)	Maximum (Bq/g)	Mean (Bq/g)	Standard deviation (Bq/g)	Median (Bq/g)
Gross alpha (as Am-241)	0.195	0.395	0.298	0.077	<0.276
Gross beta (as K-40)	0.452	0.756	0.562	0.121	<0.532
H-3	<0.021	<0.024	0	0	<0.022
C-14	<0.01	<0.01	0	0	<0.01
S-35	0.07	0.14	0.10	0.03	<0.09
K-40	0.415	0.647	0.514	0.098	<0.488
Ca-45	<0.1	<0.1	0	0	<0.1
Mn-54	<0.0011	<0.0022	0	0	<0.0014
Fe-55	<0.034	<0.069	0	0	<0.058
Co-58	<0.00059	<0.0019	0	0	<0.0011
Co-60	<0.0011	<0.0025	0	0	<0.0013
Ni-63	<0.04	<0.04	0	0	<0.04
Zn-65	<0.0021	<0.0039	0	0	<0.003
Sr-90	<0.0061	0.0083	0.0017	0.0037	<0.0075
Nb-95	<0.00056	<0.0011	0	0	<0.00086
Ru-106	<0.0082	<0.02	0	0	<0.014
Ag-110m	<0.00039	<0.00089	0	0	<0.00054
Sb-125	<0.0016	<0.0048	0	0	<0.003
I-131	<0.00061	<0.0011	0	0	<0.00082
Cs-134	<0.00043	<0.00082	0	0	<0.00063
Cs-137	<0.00086	0.00483	0.00265	0.00174	<0.00296
Ce-144	<0.0014	<0.057	0	0	<0.0054
Eu-152	<0.0007	<0.0018	0	0	<0.0017
Eu-154	<0.0005	<0.0012	0	0	<0.00073
Eu-155	<0.003	<0.0051	0	0	<0.0035
Tl-208	0.00669	0.0095	0.0082	0.0012	<0.0081
Pb-210	<0.021	<0.03	0	0	<0.027
Bi-212	0.0196	0.0281	0.0240	0.0039	<0.0225
Pb-212	0.0198	0.0297	0.0236	0.0051	<0.0202
Bi-214	0.0147	0.0236	0.0196	0.0035	<0.019
Pb-214	0.0125	0.0191	0.0158	0.0028	<0.0147
Ra-226	<0.021	0.0285	0.0155	0.0142	<0.025
Ac-228	0.0218	0.0349	0.0269	0.0058	<0.0241
Pa-233	<0.00069	<0.0043	0	0	<0.00083
Pa-234m	<0.066	<0.11	0	0	<0.088

Parameter	Minimum (Bq/g)	Maximum (Bq/g)	Mean (Bq/g)	Standard deviation (Bq/g)	Median (Bq/g)
Th-234	0.025	0.046	0.037	0.008	<0.038
U-235	<0.00118	0.00138	0.00076	0.00069	<0.00122
Np-237	<0.0031	<0.0056	0	0	<0.0035
Pu-238	<0.0014	<0.002	0	0	<0.0015
Pu-239/240	<0.0012	0.00179	0.00095	0.00088	<0.0014
Am-241 (α-spec)	<0.00013	0.00121	0.00066	0.00060	<0.00109
Am-241 (γ-spec)	<0.0017	<0.0034	0	0	<0.0027
Pu-241	<0.14	<0.29	0	0	<0.16
Cm-242	<0.00036	<0.00099	0	0	<0.00042
Cm-243/244	<0.00014	<0.0014	0	0	<0.00031

7.3.14 Under the London Convention and London Protocol only dredged materials with de minimis levels of radioactivity may be considered for marine disposal. All radionuclide concentrations are below current “out of scope” limits, indicating the sediments are not classified as “radioactive” material or wastes under UK law [RD68]. Radioactive substances which are ‘out of scope’ are not subject to any regulatory requirement under this legislation. All radionuclide concentrations are also below International Atomic Energy Agency (IAEA) exemption limits for bulk materials [RD68], and thus meet the criteria for exemption from regulatory control under both UK and international Basic Safety Standards.

Dose assessment

7.3.15 Using the conservative generic radiological assessment procedure developed by the IAEA [RD69] to estimate radiation doses from disposal of the dredged sediment, based on the mean radionuclide concentrations detected in the samples, the total doses to individual members of the crew and public are calculated to be 0.97μSv/year and 0.41μSv/year respectively. The total collective dose is calculated to be 0.02manSv/year. These values for individual members of the crew and public, and the collective dose, are within the de minimis criteria of 10μSv/year (individual doses) and 1manSv/year (collective dose) respectively.

7.3.16 The dose estimates for individual crew/public (by radionuclide) derived using the generic IAEA model are shown in Figure 7-5. This illustrates that in both cases the dose received is dominated by radiation from decay of the naturally occurring radionuclides Ra 226 and U 235. The most significant anthropogenic radionuclide is Cs 137, but this contributes only 2% of the total individual dose to crew members and 0.2% of the total individual dose to members of the public.

7.3.17 Since the conservative generic radiological assessment procedure indicates that doses received will be well below the recommended limits, a subsequent,

more detailed case-specific assessment is not required. All the derived total dose values are less than the de minimis criteria of 10µSv/year and 1manSv/year for individual and collective dose, respectively. This indicates that, from a radiological perspective, the material is acceptable for disposal at Holyhead North.

7.3.18 In addition to these five samples, as part of the assessment of potential radiological effects resulting from the construction, operation and decommissioning of the Wylfa Newydd Project, as detailed in chapter D14 of the ES, additional data sources were considered. The assessment concluded that the concentrations recorded in the five samples showed low levels similar to those observed in the extensive routine monitoring programme around the Existing Power Station (see paragraph 14.3.19 onwards in section 14.3 of chapter D.14 of the ES), and that these concentrations are below out of scope radioactive definition levels. Therefore, the disposal of such low radioactivity concentrations was assessed as having negligible impact and significance.

8 Assessment of potential adverse effects

8.1.1 Sediments are part of the marine environment and relocation of non-contaminated sediments to the sea supports the sediment balance and aids natural processes. Dredging and disposal can, however, effect the human and marine environment.

8.1.2 The approach to the assessment of adverse effects follows that of Environmental Impact Assessment, where the significance of an effect is determined from the value or sensitivity of the baseline environment and the magnitude of the potential change or effect.

8.1.3 The assessment of impacts from the ES in chapters D10 Landscape and visual, D11 Cultural heritage, D12 Coastal processes and coastal geomorphology, D13 The marine environment and D15 Shipping and navigation; and the Habitats Regulations Assessment have been utilised to inform the assessment of effects for this characterisation.

8.1.4 The criteria used to determine value/sensitivity of the receptor are given in table 8-1. The resulting value or sensitivity of each of the receptors considered in this report are given in table 8-2. This is based on the values assigned to these receptors in the ES. Further details on the reasoning for assigning these values/sensitivities is provided in the relevant sections of the ES.

8.1.5 The criteria used for magnitude of change are given in table 8-3 and the determination of the significance of an effect is shown in the matrix in Figure 1-1.

Table 8-1 Criteria for determining the value/sensitivity of receptors

Value/sensitivity	General criteria
High	Of value, importance or rarity on a national scale, and with very limited potential for substitution; and/or Very sensitive to change, or has little capacity to accommodate a change.
Medium	Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or Moderate sensitivity to change, or moderate capacity to accommodate a change.
Low	Of value, importance or rarity on a local scale; and/or Not particularly sensitive to change, or has considerable capacity to accommodate a change.
Negligible	Of value, importance or rarity on a very local scale; and/or Not sensitive to change, or has very considerable capacity to accommodate a change.

Table 8-2 Receptor value

Receptor	Value/sensitivity

All designated sites of nature conservation importance and supporting features (SACs, SPAs and SSSIs, including candidate SACs and potential SPAs)	High
Plankton (phytoplankton and zooplankton)	Low
Subtidal habitats and communities of conservation importance	Medium
Subtidal habitats and communities	Low
General fish and fisheries	Low
Adult fish (of conservation and/or commercial importance)	Medium
Marine mammals (pinnipeds and cetaceans)	High
Seabirds (target species)	High
Seabirds (secondary species)	Medium
Historic environment	Medium
Seascape	Low
Infrastructure	Medium
Fishing	Medium
Navigation	Medium
Recreational boating	Medium

Table 8-3 Criteria for determining magnitude of change

Magnitude	General criteria
Large	Loss of resource or quality and integrity of resource; severe damage to key characteristics, features or elements; or Large scale or major improvement of resources quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Loss of resource, but not adversely affecting its integrity; partial loss of or damage to key characteristics, features or elements; or Benefit to, or addition of, key characteristics, features or elements; improvements of attribute quality.
Small	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one or more key characteristic, feature or element; or Minor benefit to, or addition of, one or more key characteristic, feature or element; some beneficial effect on attribute or a reduced risk of negative effect occurring.

Magnitude	General criteria
Negligible	Very minor loss or detrimental alteration to one or more characteristic, feature or element; or Very minor benefit to, or positive addition of, one or more characteristic, feature or element.

8.1.6 As Holyhead North is an existing and open disposal site, this assessment focuses on supplementing existing information about the site and assessing the effects that are outside of the 'normal' use of the disposal site. This assessment is therefore centred around the effects of disposing of a larger volume of material per annum than has previously been disposed at the site, and the disposal of rock material.

8.1.7 The potential adverse effects that have been assessed in this characterisation were agreed with NRW through consultation with the Marine Licensing Team and their consultees [RD4] [RD71].

8.1.8 The impact of dredged material disposal largely depends on the nature of the material and the characteristics of the disposal site. This assessment defines the anticipated nature, and spatial and temporal scales of effects, and assesses the expected consequences of the disposal of dredged material at Holyhead North on the receptors identified within the baseline environment.

8.2 Release of contaminants

8.2.1 A variety of harmful substances, including heavy metals, PAH, TBT, PCBs and pesticides, can be 'locked' into seabed sediments. These contaminants are often of historic origin. The disposal processes can release these contaminants into the water column, making them available to be taken up by animals and plants, with the potential to cause physiological stress, poisoning or even death. Contaminants can also accumulate in marine animals and plants and transfer up the food chain to fish and marine mammals.

8.2.2 Sediment samples from the Wylfa Newydd Project capital dredge area have been tested for chemical contaminants by Cefas. The results of this analysis have been compared to AL [RD2]. The analysis recorded a few exceedances of AL1 (below which the material is unlikely to pose a significant chemical risk to the marine environment) for heavy metals and PAH. Organotins and PCB's were all recorded below AL1. Where results were above AL1 they have also been compared to ISQG, PEL [RD3] and historic dredge sediment chemical analysis data (see section 7.3). This analysis suggests that the material is acceptable for disposal at sea.

8.2.3 Dredge sediment samples have also been assessed for radionuclides and reviewed against UK and international standards (see section 7.4). All radionuclide concentrations are below current "out of scope" limits, indicating

the sediments are not classified as “radioactive” material or wastes and are therefore acceptable for disposal at sea.

8.2.4 In addition, the mobilisation of contaminants into the water column has been assessed for the dredging operation by deriving the maximum dissolved concentration for each contaminant in the dredge sediment and adding this to the ambient levels to derive a total concentration (see Volume D13 of the ES). While this assessment was focused on the dredging operation, it is considered relevant for the disposal operation too. The estimated maximum concentrations of sediment-bound metal contaminants in suspension, the partition coefficients used and the resulting maximum concentrations of the contaminants entering the dissolved phase are shown in table 8-4.

Table 8-4 Estimated maximum concentrations of metals entering the water column and the dissolved phase as a result of sediment dredging activities in the Wylfa Newydd Development Area

Contaminant	Maximum concentration in sediment (mg/kg)	Maximum concentration in suspension (sediment-bound) (µg/l)	Partition coefficient	Maximum concentration entering dissolved phase (µg/l)
Arsenic	11.9	11.9	6,607[a]	1.8×10^{-3}
Cadmium	0.43	0.43	20,417[b]	2.1×10^{-5}
Chromium	52.6	52.6	191,000[a]	2.8×10^{-4}
Copper	102.5	102.5	22,909[b]	4.5×10^{-3}
Lead	39.6	39.6	35,481[a]	1.1×10^{-3}
Mercury	0.18	0.18	44,668[b]	4.0×10^{-6}
Nickel	32.2	32.2	2,138[a]	1.5×10^{-2}
Zinc	163.9	163.9	72,444[c]	2.3×10^{-3}

a [RD72][RD73]; b [RD74] – monitoring; c [RD74] – estimated

8.2.5 The assessment concludes that the maximum dissolved concentration for each contaminant resulting from dredging and excavation is several orders of magnitude below the relevant EQS, suggesting that the potential for disposal of dredged material from the Wylfa Newydd Development Area to affect water quality at Holyhead North through sediment contamination is negligible.

Effects on phytoplankton and zooplankton

8.2.6 The potential effect on water quality from changes in water chemistry from the release of contaminants are considered to be negligible. Consequently, it is considered that there would be no noticeable effect on phytoplankton and zooplankton populations from changes in water chemistry and the magnitude of change is predicted to be negligible. As the value of this receptor is low, the effect on this receptor from changes to water chemistry is considered negligible.

Effects on fish and shellfish

8.2.7 Comparison of sediment contamination data with Action Levels suggests that the material to be disposed contains levels of contamination which are low enough for the material to be disposed at sea, and the potential effect on water quality from changes in water chemistry from the release of contaminants are considered to be negligible. Consequently, it is considered that there would be no noticeable effect on larval, juvenile or adult fish and shellfish populations from changes in water and sediment chemistry, and the magnitude of change is predicted to be negligible on all fish and shellfish receptors. The

value/sensitivity of general fish species is low and for conservation/commercial fish species it is medium. The effect on all marine fish receptors from changes to water and sediment chemistry is therefore considered negligible.

Effects on marine mammals

8.2.8 The potential effect on water quality from changes in water chemistry from the release of contaminants is considered to be negligible. Consequently, it is considered that there would be no noticeable effect on marine mammals and the magnitude of change is predicted to be negligible. The sensitivity/value of marine mammals is high and the overall effect on highly mobile marine mammal receptors from changes to water and sediment chemistry is considered to be negligible.

Effects on nature conservation

8.2.9 Any potential effects from changes in marine water quality is highly unlikely to result in an adverse effect on the integrity of the relevant designated sites in relation to marine mammals or their prey species, Atlantic salmon or seabirds. This is because the maximum dissolved concentration for each contaminant resulting from dredging is several orders of magnitude below the relevant EQS. The magnitude of effect is therefore considered negligible.

8.2.10 The value of all nature conservation receptors is high, however, given the negligible magnitude of effects, the effect on nature conservation from changes to water and sediment chemistry is considered negligible.

Effects on seabirds

8.2.11 The potential effect on water quality from changes in water chemistry from the release of contaminants is considered to be negligible. Consequently, it is considered that there would be no noticeable effect on seabirds and the magnitude of change is predicted to be negligible. The sensitivity/value of target species is high and secondary species is medium. The effect on all seabird receptors from changes to water chemistry is considered to be negligible.

Effects on benthic ecology

8.2.12 Comparison of sediment contamination data with Action Levels suggests that the material to be disposed contains levels of contamination which are low enough for the material to be disposed at sea, and the potential effect on water quality from changes in water chemistry from the release of contaminants are considered to be negligible. Consequently, it is considered that there would be no noticeable effect on benthic ecology and the magnitude of change is predicted to be negligible. The value/sensitivity of general benthic habitats is low and for habitats or species of conservation importance it is medium. Due to the negligible magnitude of effects predicted, the effect on all benthic ecology receptors from changes to water and sediment chemistry is considered negligible.

8.3 Increased suspended sediments

8.3.1 Disposal of dredged material can release suspended sediments into the water column. Increases in suspended sediments from disposal operations may, under certain conditions, have adverse effects on marine animals and plants, by reducing light penetration into the water column affecting phytoplankton and also indirectly the primary consumers (zooplankton). High turbidity levels may result in displacement of fish, marine mammals and seabirds if the changes reduce prey availability. Increased suspended sediments can affect filter feeding organisms, such as shellfish and young fish may also be affected if suspended sediments become trapped in their gills.

8.3.2 The suspended sediment plume created during disposal depends on several factors including the sediments being deposited (size, density and quality of the material); the method of disposal; the hydrodynamic regime in the disposal area (current direction and speed, mixing rate, tidal state); and the existing water quality and characteristics (background suspended sediment levels). The significance of increased suspended sediment levels depends on the background suspended sediment concentrations (SSC) and the sensitivity to changes in turbidity of the species found near the disposal site.

8.3.3 Results from the marine water quality survey undertaken at the disposal site between October and December 2016 show background suspended sediment concentrations are typically 5.5 mg/l, with reported values ranging from <3 mg/l to 14.7 mg/l (for full details see appendix D13.01 of the ES).

8.3.4 Plume dispersion modelling (see appendix D13.12 of the ES) has been used to predict the fate of the disposed material in terms of increases to SSCs above background levels.

8.3.5 During dredging of soft sediments, it is anticipated that the dredger will work the following pattern (with two cycles repeated every 24 hours):

- 2 hours on site to load 3,500m^3 of dredge material;
- 4 hours transit time to the disposal site;
- 2 hours to offload the dredge material; and,
- 4 hours transit time back to the dredge site.

8.3.6 A number of SSC model outputs are presented in the modelling report based on the different sediment partitioning (coarse sand, medium sand, fine sand and fines fractions) and time after disposal event(s) (ES appendix D13.12). The modelling predicted that only the disposal of fine sand and finer fractions would result in elevations of SSC above background levels.

8.3.7 Following a single disposal event, the modelling outputs show that the plume (mostly represented by SSCs that exceeded typical background levels by no more than 10mg/l) moves to the north-east or south-west (depending on state of tide), dispersing to background SSCs after approximately three hours (figure 8-2).

8.3.8 Following the full sediment disposal programme, which has conservatively been modelled to cover disposal every 12 hours continuously for 35 days, SSC is predicted to reduce to background levels within 48 hours (figure 8-3).

8.3.9 The modelling of SSCs from disposal events demonstrates the highly dispersive nature of the disposal site and shows that SSC elevation from disposal, above background levels, would be very temporary. It is predicted that three hours after a single disposal event all suspended sediment would disperse to such a degree that SSCs would be within typical background concentrations, and 48hrs after the final disposal event it is considered that the SSCs would not be discernible from the background environment.

Effects on phytoplankton and zooplankton

8.3.10 Modelling outputs of the SSCs indicated that changes beyond typical background concentrations would be minimal and highly transitory.

8.3.11 Within the comparatively small areas of the receiving water that would show a detectable increase in SSCs, phytoplankton and zooplankton growth may be inhibited. However, this would not have any effect on the abundance and diversity of phytoplankton or zooplankton within the wider environment.

8.3.12 The value of this receptor is low. Any effects on the phytoplankton and zooplankton would be minimal and not be detectable within the wider populations or beyond the range of natural variability. Hence the magnitude of change on phytoplankton and zooplankton is predicted to be negligible and the effect on this receptor from changes to suspended sediments is considered negligible.

Effects on fish and shellfish

8.3.13 Modelling outputs of the SSCs indicated that changes beyond typical background concentrations would be minimal and highly transitory.

8.3.14 The magnitude of change is predicted to be negligible for fish and shellfish receptors given there would be no noticeable effect above typical background concentrations to which fish and shellfish are already tolerant. In addition, mobile fish species would be able to avoid these minimal and temporary changes in SSCs. The value/sensitivity of general fish species is low and conservation/commercial fish species is medium. Hence the effect on all marine fish receptors (including ichthyoplankton and juvenile fish) from changes to SSCs is considered negligible.

Effects on marine mammals

8.3.15 Modelling outputs of the SSCs indicate that changes beyond typical background concentrations would be minimal and highly transitory. Marine mammals often inhabit turbid environments and many utilise sonar to sense the environment around them. There is little evidence that turbidity affects cetaceans directly [RD90]. Pinnipeds are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision.. Studies suggest that the limited available

information indicates that increased turbidity, as a result of dredging, is unlikely to have a substantial direct impact on marine mammals [RD90].

8.3.16 Effects on fish from changes to SSCs, some of which will be prey items for marine mammals, were assessed as negligible.

8.3.17 The value/sensitivity of all marine mammals receptors is high, and the magnitude of change is predicted to be negligible, given there would be no noticeable effect on marine mammal populations, from these minimal and temporary changes in SSCs. The effect on highly mobile marine mammal receptors from changes to SSCs is therefore considered to be negligible.

Effects on seabirds

8.3.18 Modelling outputs of the SSCs indicate that changes beyond typical background concentrations would be minimal and highly transitory. Increased SSC is therefore unlikely to affect diving seabirds when foraging for prey, or their prey species.

8.3.19 The value/sensitivity of target seabird species is high and the value of secondary species is medium. The magnitude of change is predicted to be negligible given there would be no noticeable effect on seabirds or their prey species, from these minimal and temporary changes in SSCs. Hence, the effect on all highly mobile seabird receptors from changes to SSCs is considered negligible.

Effects on infrastructure

8.3.20 There is no infrastructure located within the disposal site, but adjacent to the disposal site there are two proposed tidal energy sites (figure 6-14). The Minesto Ltd Deep Green project has recently obtained a Marine Licence to install one tidal kite immediately south of Holyhead North disposal site, and to the south east of the disposal site, is the proposed West Anglesey Demonstration Zone (WADZ).

8.3.21 Modelling outputs of the SSCs indicate that changes beyond typical background concentrations would be minimal and highly transitory. It is therefore highly unlikely that these developments would be affected by these small and temporary increases in SSCs. The value of the receptor is considered medium and the magnitude of effects is considered negligible. Therefore, the effects to infrastructure features, including the proposed tidal energy developments are assessed as negligible.

Effects on fishing

8.3.22 Modelling outputs of the SSCs indicate that changes beyond typical background concentrations would be minimal and highly transitory.

8.3.23 The sea area of Holyhead North is understood to be used at a low intensity for long-lining, potting and charter angling. Small and temporary increases in SSCs will not directly affect these fishing practices. As noted above, the magnitude of change is predicted to be negligible for fish receptors given there would be no noticeable effect above typical background concentrations, to

which fish are already tolerant. Fish are also mobile species so would be able to avoid these minimal and temporary changes in SSCs. The magnitude of impact on fishing is therefore considered negligible.

8.3.24 The value of fishing is considered medium and the magnitude of the impact would be negligible. The effect on fishing from changes to SSCs is therefore considered negligible.

Effects on nature conservation

8.3.25 The results of the suspended sediment dispersion modelling at Holyhead North indicate that increases above background SSC are only noticeable in close proximity to the disposal site (ES appendix D13.12). Therefore, it is expected that the sediment plume generated by this activity would not reach the Esgair Gemlyn feature of the Cemlyn Bay SAC (located 16 km away). As such, within the HRA an adverse impact on the integrity of the shingle ridge interest feature of Cemlyn Bay SAC is not predicted.

8.3.26 In relation to Atlantic salmon, the area in which increased suspended sediment concentrations will be experienced is very small in the context of migratory pathways, and the effect will be transitory, with dispersion of the suspended sediment to background levels predicted to occur quickly. As a worst case, even if it is assumed that Atlantic salmon avoids all areas of increased suspended sediment concentration, this effect would not represent a barrier to migration. In practice, it is highly unlikely that the behaviour of Atlantic salmon would be influenced by suspended sediment beyond the area where the greatest increases are predicted.

8.3.27 In an unconstrained environment, such as that through which the salmon will be migrating, their ability to detect and avoid areas of elevated suspended solids means that they will avoid areas where conditions were unfavourable, and therefore an adverse effect on site integrity is not predicted.

8.3.28 In relation to marine mammals and seabirds, any potential effects from increased SSCs due to disposal is highly unlikely to result in an adverse effect on the integrity of these features or their prey species.

8.3.29 The value/sensitivity of all nature conservation features is high and the magnitude of effect is predicted to be negligible. As such, the effect on nature conservation from changes to SSCs is considered negligible.

8.4 Smothering of seabed from sediment disposal

8.4.1 Sediments released during disposal may resettle over the seabed affecting the animals and plants that live on and within it. This blanketing or smothering of benthic animals and plants may cause stress, reduced rates of growth or reproduction and in the worst case the effects may be fatal. This could lead to a change/succession of seabed community.

8.4.2 Although mobile organisms such as fish and marine mammals would not be directly impacted by smothering from sediment, it may affect food resource and lead to displacement of fish or mammal species.

8.4.3 Smothering of the seabed could affect marine archaeological features and infrastructure by burying it or disturbing the relationship between the feature/infrastructure and its wider surroundings.

8.4.4 It is proposed as embedded mitigation within the Wylfa Newydd Project to dispose of sediment within the central area of Holyhead North disposal site thus constraining the effects of sediment dispersion, as much as possible, to within the disposal site boundary.

8.4.5 Multibeam data collected by a SEACAMS research project in 2013 and 2014 and interpreted by [RD13] indicates that depths in the middle region of the disposal site exceed 70m. BGS data [RD5] records the seabed in this area as comprising a mix of sandy gravels, thus the sediment would be deposited on an area of seabed comprising of a similar substrate to the material being disposed.

8.4.6 Plume dispersion modelling has been conducted to investigate rates of sediment deposition following disposal of dredged sediment (appendix D13.12). The model shows that deposition of sediment is restricted to certain states of the tide i.e. deposition would not occur for sustained periods in the full tidal cycle. After a single disposal event the model predicted that no area of the seabed receives a deposition of 1cm or more.

8.4.7 The maximum deposition depth predicted is 43cm, covering an area of <0.016km^2. A deposition depth of 30cm or more covers an area of 0.07km^2 and a deposition depth of 5cm or more covers an area of 0.5km^2.

8.4.8 More widely, deposition of 1cm depth or more covers an area of 1.8km^2. This is depicted as a patch of sediment extending 2.8km along its major axis and 0.9km along it minor axis in a broadly oval shape (figure 8-4). The deposition of 1cm or more does not extend beyond the disposal site boundary.

8.4.9 Although figure 8-4 suggests that the depth of sediment on the seabed is maintained on completion of the disposal programme, this is a reflection of short-term tidal processes considered in the modelling. In the longer term, sediment transport processes (rolling, sliding, hopping) would be expected to lead to the gradual dispersal of particles into the wider environment due to the high tidal flows experienced at the site.

Effects on benthic habitats and species

8.4.10 It is intended that disposal of the soft sediment material would take place within the middle of the disposal site where an area covering 1.8km^2. will receive 1cm or more deposition of material. The deposition area is predicted by HABMAP to be inhabited by the community '*Flustra foliacea* and *Hydrallmania falcata* on tide swept circalittoral mixed sediment' [RD14]. Presence of the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx) in this region was also confirmed from some of Horizon's benthic survey sampling sites (HHD_8; HHD_12; HHD_19) (appendix D13.02 of the ES). As a worst case, for the purpose of assessment, it has been assumed that the more sensitive feature (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) dominates the 1.8km^2 deposition area.

8.4.11 To the north-west of the 1.8km^2 deposition area, Horizon's survey at site HHD_16 recorded the biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (SS.SBR); however, applying the assessment criteria for 'reefiness' [RD77] this community was not considered a reef (appendix D13.02of the ES). Despite no record of Sabellariidae reef from the sampling sites nearest to the area of sediment deposition, as a worst case it has been assumed that pockets of this Annex I feature may be present within the footprint of the sediment disposal.

8.4.12 The MarLIN sensitivity review of the habitats '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' and '*Sabellaria spinulosa* on stable circalittoral mixed sediment' states that they are 'not sensitive' to smothering up to 5cm [RD76]; [RD78]. Therefore, the area of seabed predicted to receive between 1-5 cm of deposition (an area of 1.3km^2) has been assessed for the effect of disturbance and deterioration in the benthic community, and the area predicted to receive 5cm or more of sediment deposition (0.5km^2 area) is assessed for the effect of habitat loss. It should, however, be recognised that the communities present may be able to tolerate 5cm or more of deposition, as this level of sedimentation would be achieved over a 35-day period, rather than a one-off event. This would allow the species time to migrate closer to the surface in between each disposal event, meaning that the depth of sediment above them would be less.

Disturbance and deterioration in the benthic community

8.4.13 Flustra is a sand-scoured habitat with the characterising species, *F. folicacea* and *H. falcata* both being tolerant to sediment abrasion and sand scouring [RD79] [RD80]. Given this and the fact that they are not sensitive to smothering of <5cm, the magnitude of effects from disturbance and deterioration of the community from 1-5cm of smothering is therefore assessed as negligible. The value/sensitivity of general seabed communities is low and therefore the effect from disturbance to the community is assessed as negligible.

8.4.14 Sabellaria are acknowledged to be r-strategists (a life strategy which allows a species to deal with the general variations of climate and food supply with a high rate of reproduction). *S. spinulosa* is considered fairly tolerant of disturbance with high rates of recovery [RD81]. The species and associated structures are considered fairly resilient to increased sediment loads, even being able to tolerate smothering for a number of weeks [RD81]. The magnitude of change is therefore predicted to be negligible. Sabellariidae reefs have been assigned a medium value, however, disturbance to the benthic community from 1-5cm of deposition is assessed as negligible.

Habitat loss

8.4.15 Considering the 0.5km^2 area that could result in habitat loss, the HABMAP predictive model [RD14], suggests that approximately 60% of the disposal site (17.27km^2) is covered by the habitat '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' [RD7]. This feature extends way beyond Holyhead North, extending a number of kilometres to the north, south

and east. The benthic survey (appendix D13.022 of the ES) also confirmed the presence of this feature at several locations in the disposal site along with the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx). The *Flustra* community is extensive in this region so the loss of resource would be small when considered in terms of the extent of the same or very similar habitat in the area.

8.4.16 Sabellariidae crusts and, to a lesser extent, reefs are also found throughout the region and are understood to have a medium sensitivity to physical pressure from habitat structure changes [RD76]. As Sabellariidae reef, if present within the sediment disposal footprint, would not represent an isolated feature in the wider region, it anticipated that the short to medium term loss of this habitat would not have a noticeable effect on the integrity of this receptor.

8.4.17 From consideration of the habitats' resilience it is determined that recovery of the *Flustra* community would occur in the short term and the *Sabellaria* community in the short to medium term.

8.4.18 As the loss of these features from the deposition area would not lead to a permanent effect on the integrity or ecological function of the wider area, and recovery within the footprint would occur in the short to medium term, the magnitude of change is predicted to be small.

8.4.19 The *Flustra* habitat has been assigned a low value. As the magnitude of change is small, the effect from loss under the footprint of disposal is therefore assessed as minor.

8.4.20 The Annex I reef feature has been assigned a medium value. Given that the magnitude of change is predicted to be small, the effects from loss under the footprint of disposal is assessed as minor.

Effects on fish and shellfish

8.4.21 It is unlikely that fish species would suffer mortalities due to smothering as most fish are highly mobile. Less mobile shellfish species may result in stress or mortality as a direct result of smothering, however, these infrequent and very limited effects would have no noticeable effect on their populations.

8.4.22 Indirectly, the loss of feeding habitat and refuge could result in some displacement of fish and shellfish. However, recovery of the dominant habitat within the footprint of the sediment disposal (*Flustra* community) would occur in less than two years. Therefore, any loss in the dominant habitats is transitory, occurring over a short-term duration. Considering that those habitats directly affected by the disposal are extensive within this area any displacement of fish would be minimal and short term, with suitable and considerable resource and refuge available in the surrounding area.

8.4.23 Given the above, the magnitude of change to all marine fish receptors, including shellfish, from mortality or displacement is predicted to be negligible, with no noticeable effects on populations of fish, shellfish or fisheries. The value/sensitivity of fish receptors is low for general fish species and medium for species of conservation or commercial importance. Hence the effect is assessed as negligible on all fish and shellfish receptors.

Effects on infrastructure

8.4.24 There is no infrastructure located on the seabed within the disposal site. As the area affected by smothering from sediment disposal of 1cm or more is wholly contained within the disposal site the magnitude of effect of smothering on infrastructure features is assessed as negligible. The sensitivity of infrastructure receptors is medium therefore the effect on infrastructure is assessed as negligible.

Effects on fishing

8.4.25 The sea area of Holyhead North is understood to be used at a low intensity for long-lining, potting and charter angling. Smothering of the seabed in water depths of 60-70m will not directly affect these fishing practices. As noted above, there may be some loss of fish feeding resource causing displacement, however, this is considered to have a negligible effect on all marine fish receptors. The magnitude of effect of smoothing on fishing is therefore assessed as negligible. The sensitivity of fishing is medium therefore the effect on fishing would be negligible.

Effects on the historic environment

8.4.26 No known archaeological remains have been identified within Holyhead North disposal site. As the area affected by smothering from sediment disposal of 1cm or more is wholly contained within the disposal site the magnitude of effect is negligible. The sensitivity of archaeological remains is medium therefore the effect on the historic environment is assessed as negligible.

8.5 Burial of seabed from rock disposal

8.5.1 Loss of seabed habitats and benthic species may occur directly under the footprint of the rock disposal area. This could subsequently result in changes/succession of seabed habitat and community structure.

8.5.2 The disposal of rock material could also cause damage to marine archaeological features or infrastructure if any were to be located in the footprint of the rock disposal.

8.5.3 It is anticipated that rock will be disposed over an ongoing 16-month period as it is produced from the ‘wet excavations’. As embedded mitigation within the Wylfa Newydd Project, it is proposed to dispose of rock within a micro-sited area within the disposal site, to minimise the footprint of impacts.

8.5.4 It is proposed that the micro-sited area would cover approximately 0.375km^2 which would result in raising the seabed within this area by approximately 1m (less than 1.5% of the baseline depth). The micro-sited area for rock disposal would be located on an area of rocky seabed so that it is placed on a substrate that is similar in characteristics to the material being disposed. The rock disposal area would be positioned >0.25km from any known Sabellariidae reef and away from any identified archaeology and infrastructure features. A proposed indicative area for the rock disposal is shown in figure 6-9.

Effects on benthic habitats and species

8.5.5 Benthic survey data (appendix D13.02 of the ES) and BGS substrate mapping [RD5] suggest that the potential rock disposal location shown in figure 6-9 meets the above micro-siting requirements. The seabed within the micro-sited area is understood to comprise a mix of circalittoral rock and coarse gravels, interspersed with boulders with the rocky biotope '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock' (CR.MCR.EcCr.UrtScr). The biotope 'very tide-swept faunal communities' (CR.HCR.FaT) is understood to be present to the north east of the micro-site area. Further to the west and south are 'circalittoral mixed sediment' (SS.SMx.CMx) and '*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock' (CR.HCR.FaT.BalTub) biotopes, respectively. Sabellariidae reef were not recorded at any of these locations and no extensive reef formations are thought to be present within the footprint; however, as a worst case for the purpose of this assessment it has been assumed that pockets of this undesignated Annex I feature may be present.

8.5.6 It is therefore considered that circalittoral rock habitat, some mixed rock coarse sediment habitat and potentially Sabellariidae reef will be lost. The circalittoral rock and Sabellariidae reef habitat represent part of the Annex I 'reef' feature.

8.5.7 Within the wider environment survey data indicates that the seabed substrate is a mix of bedrock, boulders and stony reef. These rocky reef environments are extensive within this region of the Irish Sea, covering approximately 12.33km^2 in Holyhead North alone, and many kilometres to the north and east of the proposed rock disposal area.

8.5.8 The scale of habitat loss is very small in comparison to the availability of rocky reef in the wider region. The rocky seabed that would be lost would be replaced by disposed rock, resulting in a similar substratum. Recolonisation would begin to occur soon after the first disposal event, rather than at the end of the 16 month disposal period. The disposed rock is likely to be recolonised quickly by similar sessile species to those that would be lost, as these are common to the general area. Such a small loss would not have a noticeable effect on the connectivity or ecological function of the wider communities nor reduce the overall biodiversity of the region. It is considered that the loss of rocky habitat resource would be unnoticeable when considered in terms of the extensive rocky habitat adjacent to the footprint.

8.5.9 As with the rocky reef habitat, Sabellariidae aggregations are present throughout the wider area with crusts and, less commonly, reef being recorded at several sites during the benthic surveys (appendix D13.02 of the ES). Sabellariidae aggregations, specifically crusts and reefs, are often representative of a regularly changing community, i.e. they are a step in a cyclical succession, representing an ephemeral rather than stable community [RD75]. The Marine Life Information Network (MarLIN) sensitivity assessment of*S.spinulosa* habitat to physical pressure ('habitat structure changes – removal of substratum') suggests the sensitivity of the *Sabellaria* community to habitat structure change is 'medium' [RD76].

8.5.10 As a reasonable larval supply of Sabellaria is thought to exist in the region, evidenced by the presence of Sabellariidae crusts, and the surrounding environmental conditions would remain the same, it is anticipated that the short to medium term loss of this habitat would not have a noticeable effect on the integrity of this receptor over the wider area, and recolonisation of the seabed would begin to take place in the short to medium term [RD76].

8.5.11 As the loss of these features from the disposal footprints would not lead to a permanent effect on the integrity or ecological function within the wider area, and recovery within the footprint would occur in the short to medium term, the magnitude of change is therefore predicted to be small.

8.5.12 The Annex I reef feature is assigned a medium value and other seabed habitats are assigned a low value. As the magnitude of change is small the effects on subtidal habitats and communities from direct loss under the footprint of disposal is assessed as minor for habitats and communities of conservation importance and negligible for other seabed habitats and communities.

Effects on fish and shellfish

8.5.13 While the mechanism of rock disposal may result in some shellfish mortalities as a direct effect; these infrequent and very limited mortalities would have no noticeable effect on their populations.

8.5.14 Some benthic fish species may suffer mortalities; however, as most fish are highly mobile the effect of direct mortality on fish populations within the rock disposal footprint is considered to be negligible.

8.5.15 Indirectly, the loss of habitat feeding resource and refuge would result in some displacement of fish and shellfish. However, as noted above, recolonisation of rock material is expected to occur in the short to medium term, taking place after each disposal event. Therefore, any loss in the dominant habitats is temporary, occurring over a short-term duration. The habitats directly affected by the disposal are common within the area, and any displacement of fish would be minimal and short term, with suitable and considerable resource and refuge available in the surrounding area.

8.5.16 Given the above, the magnitude of change to all marine fish receptors, including shellfish, from mortality or displacement is predicted to be negligible, with no noticeable effects on populations of fish or fisheries. The value/sensitivity of general fish species is low and for conservation or commercial species it is medium. The effect is therefore assessed as negligible on all marine fish receptors.

Effects on nature conservation

8.5.17 Disposal of rock within the microsite area could cause a potential change or loss of habitat which could affect marine mammal, Atlantic salmon and seabird foraging.

8.5.18 The loss of a small area of feeding or refuge habitat could result in some displacement, however, there are extensive areas of suitable habitat in the

region. Any potential effects associated with a change in or loss of habitat are therefore highly unlikely to result in an adverse effect on the integrity of the relevant designated sites in relation to their conservation objectives for marine mammals, seabirds and Atlantic salmon.

8.5.19 The value of all nature conservation receptors is high, however, as the magnitude of predicted effects are negligible, the effect on nature conservation from loss of seabed is considered negligible.

Effects on infrastructure

8.5.20 Effects from burial will be restricted to within the footprint of the microsite area. As there is no known infrastructure located on the seabed within the disposal site, effects on infrastructure have not been assessed,

Effects on fishing

8.5.21 The sea area of Holyhead North is understood to be used at a low intensity for long-lining, potting and charter angling. Burial of a small area of seabed with 1m of rock in water depths of 60-70m is not expected to directly affect these fishing practices. As noted above, some benthic fish species may suffer mortalities; and there may be some loss of fish feeding resource causing displacement, however, this is considered to have a negligible effect on all marine fish receptors. The magnitude of effect on fishing is therefore assessed as negligible. The sensitivity of fishing is medium therefore the effect on fishing is assessed as negligible.

Effects on the historic environment

8.5.22 Effects from burial will be restricted to within the footprint of the microsite area. As there are no known archaeological remains located on the seabed within the disposal site, the magnitude of effects will be negligible. The sensitivity of archaeological remains is medium therefore the effect on the historic environment is assessed as negligible.

8.6 Changes to physical processes

8.6.1 The deposit of material on the seabed has the potential to change bathymetry and subsequently affect hydrodynamics, which may indirectly affect subtidal communities, seabed infrastructure, or archaeological remains. It is intended that the rock material would be placed in a micro-sited area of the seabed where the seabed would be raised by approximately 1m or less. The placement of this rock on the seabed will create a permanent change to the topography in the micro-sited area and as such consideration of changes to physical processes due to rock disposal has been investigated through modelling.

8.6.2 At the rock disposal location depths range from 60m to 70m. It is considered that at this depth there would be no measurable change on wave climate from increasing the height of the seabed by 1m or less. Changes to wave climate due to rock disposal would not be detectable from baseline variability.

8.6.3 Within Holyhead North, particularly at the depths of the target disposal locations, studies have shown that the bed shear stress is dominated by tidal processes (see ES volume D12). Consideration has been given to the potential changes that the disposal of sediment could elicit on these processes, however, as the deposition of sedimentary material will mostly lead to a temporary increase in seabed height of less than 5cm, and the material will remain mobile. It is therefore considered that the effect on marine receptors from changes to hydrodynamics, as a result of sediment deposition, would be negligible.

8.6.4 As the proposed micro-sited area for rock disposal is outside the predicted area of influence for the sediment deposition no interaction between the rock and sediment disposal is anticipated.

8.6.5 A model simulation has been used to understand and quantify the potential effects of rock disposal on hydrodynamics, specifically tidal flow and therefore sediment transport. This was achieved by reducing model water depth locally by 1m, and locally increasing bed roughness.

8.6.6 The modelling shows that in all instances, water velocity over the rock disposal area itself is reduced, as would be expected. There is evidence of a slight wake (approximately 25% reduction in speed) on the flood tide, although this is limited to the immediate lee of the disposal area, and recovers within 50m from the micro-site. On the ebb, a wake of approximately 15% velocity deficit is apparent over a larger area, recovering within 150m from the micro-site (see appendix A of appendix D13.12 of the ES for modelling plots of near bed velocities).

8.6.7 In the context of the existing bed processes in this area, these highly localised and small changes are considered minimal. The modelling shows that the changes extend 150m from the micro-site, and then only during a short window of the tidal cycle on a spring ebb tide. Over the course of a full tidal cycle (neap to flood) the changes in velocity (both in magnitude and extent) would be considerably smaller than that predicted on a spring ebb tide. Any changes to sediment transport would therefore be highly localised and not measurable beyond the immediate vicinity of the rock disposal area.

8.6.8 Sediment transport process would not be interrupted by the rock disposal area as the critical bed shear stress threshold for movement of fine sediments is 0.18 N m^{-2} and the actual shear stress at the site is between 6-10 N m^{-2}. Therefore, the reduction in current around the rock disposal area of 15% on the flood tide and 25% on the ebb tide would not reduce movement to levels that are near the critical shear stress. Motion will therefore still be initiated and the site would continue to be dispersive for fine sediments.

Effects on benthic habitats and species

8.6.9 The seabed adjacent to the rock disposal micro-site is considered a mix of rocky and stony reef with some coarse sediment. The communities in the area include the biotopes '*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock' (CR.HCR.FaT.BalTub) and '*Urticina felina* and

sand-tolerant fauna on sand-scoured or covered circalittoral rock' (CR.MCR.EcCr.UrtScr) (appendix D13.02 of the ES).

8.6.10 The MarLIN sensitivity assessment for the effect of a change in water flow for these two communities is considered 'not sensitive'. This assessment is based on 'a change in peak mean spring bed flow velocity of between 0.1m/s and 0.2m/s for more than a year', which it is considered that the changes in flow velocity predicted from rock disposal are broadly representative of (appendix D13.12 of the ES).

8.6.11 As a result, the magnitude of change is predicted to be negligible. As a worst case it has been assumed that the benthic habitats represents Annex I 'rocky' reef which is of medium value/sensitivity. The effect from changes to water flow is therefore assessed as negligible.

Effects on infrastructure

8.6.12 There is no infrastructure (cables, pipelines, etc.) located on the seabed within the disposal site. In the wider area, there are two proposed tidal energy sites (figure 6-14). The Minesto Ltd Deep Green project has recently obtained a Marine Licence to install one tidal kite immediately south of Holyhead North disposal site, and to the south east of the disposal site, is the proposed West Anglesey Demonstration Zone (WADZ). Both of these proposed developments are located in the area to take advantage of the natural physical processes.

8.6.13 As changes to hydrodynamics and sediment transport are predicted to be localised to within 150m from the rock micro-site, with all effects contained within the disposal site boundary, the magnitude of effects is therefore assessed as negligible. The sensitivity of infrastructure features, including the proposed tidal energy developments, is medium therefore effects would be negligible.

Effects on the historic environment

8.6.14 No known archaeological remains have been identified within Holyhead North disposal site or the wider archaeological study area. The area predicted to be affected by changes in hydrodynamics is very localised and therefore the magnitude of effects is negligible. The sensitivity of archaeological remains is medium, therefore the effect from changes to physical processes is assessed as negligible.

8.7 Reduction in water depth

8.7.1 The deposit of material on the seabed will reduce water depth, potentially affecting navigation and other uses of the sea such as fishing.

8.7.2 It is intended that the rock material would be placed in a micro-sited area of the seabed where the seabed would be raised by approximately 1m or less. The placement of this rock on the seabed will create a permanent change to the topography at the micro-site in an area where water depths range from

60m to 70m. This represents a reduction in water depth of approximately 1.5%.

8.7.3 The deposition of sedimentary material will mostly lead to less than 0.05m increase in seabed height. This material would be mobile and will disperse over time. This represents a reduction in water depth of 0.08%.

Effects on navigation

8.7.4 Holyhead North is transited by a variety of vessels types including passenger vessels, cargo vessels and high speed craft. [RD57] reports that the average draught of these vessels through the disposal site area was 5.5m. The water depth that will result following the deposition of rock and sediment will therefore provide sufficient underkeel clearance for all vessels. The magnitude of effect is therefore negligible. The sensitivity/value of navigation is medium, therefore it is considered that the effect on navigation from changes to water depth resulting from rock and sediment deposition would be negligible.

Effects on fishing

8.7.5 The sea area of Holyhead North is understood to be used at a low intensity for long-lining, potting and charter angling. A reduction in water depth by approximately 1m in an area where water depth range between 60m-70m is considered to have a negligible magnitude of effect. The value/sensitivity of fishing is medium, therefore the effect on these fishing practices is assessed as negligible.

8.8 Increased vessel movements

8.8.1 Increased vessels movements due to disposal at sea increases the potential for collision risk with other vessels (commercial, recreational and fishing) and vessel strikes on marine mammals. An increase in vessel traffic could also affect the seascape character.

8.8.2 Marine traffic surveys of the disposal site [RD57] indicate that there is currently, on average, 34 vessel transits per day in the summer and 30 unique vessels transits per day in the spring. Passenger vessels accounted for 47.5% of this traffic, cargo vessels 16.15%, and high speed craft 12.85%.

8.8.3 Disposal of capital dredge material from the Wylfa Newydd Project will take place in two stages. Firstly, the soft sediment material would be dredged and disposed. It is anticipated that, as a worst case, this could require transit to the disposal site every 12 hours for a period of 35 days. Following this, the rock material is anticipated to be disposed over an ongoing 16-month period as it is produced from the ‘wet excavations’. These disposal operations are assessed as a worst case to require two vessel movements per day, though it should be noted that disposal would not occur every day, and for much of the construction period there would be no vessel movements per day associated with disposal.

8.8.4 Two vessel transits per day due to disposal activity represents a 5.8% increase in vessel movements in the summer and a 6.6% increase in vessel movements in the spring in the disposal site area.

Effects on marine mammals

8.8.5 Vessel strikes with marine mammals can result in physical injury and, in the worst case, mortality. Marine mammals are relatively robust to potential strikes as they have a thick subdermal layer of blubber which protects their vital organs from minor strikes or collisions [RD82]. Consequently, incidents of mortality or injury of marine mammals caused by vessels are a rare occurrence in UK waters [RD83]. However, a direct strike from a sharp object such as a moving blade has the potential to cause injury to marine mammals.

8.8.6 Marine mammals are generally considered to be agile species possessing quick reflexes, good sensory capabilities and fast swimming abilities [RD84][RD85]. However, juvenile grey seal pups, that are inexperienced in the water, are likely to be more vulnerable to vessel strikes, as are inquisitive species such as bottlenose dolphins, and animals that are distracted by activities such as foraging and social interactions [RD82].

8.8.7 Although all types of vessels may collide with marine mammals, the most lethal and serious injuries are caused by large ships (e.g. 80m or longer) and vessels travelling at speeds faster than 14 knots [RD86].

8.8.8 The number of vessels transiting within the disposal site due to capital dredge disposal operations from the Wylfa Newydd Project (worst case two per day) is small in comparison to the baseline level of marine traffic, and as such represents a small (approximately 6%) increase. Marine mammals have been recorded in low abundance around Holyhead North and therefore the risk of vessel strikes from vessels transiting to and from the disposal site is considered to be of negligible magnitude. The sensitivity of marine mammals is high, therefore the effect is assessed as negligible.

Effects on nature conservation

8.8.9 The shadow HRA concludes that any potential interactions between species and moving vessels during disposal operations are highly unlikely to result in an adverse effect on the integrity of the of the relevant designated sites in relation to their conservation objectives for harbour porpoise, bottlenose dolphin, grey seal and harbour seal.

8.8.10 The value of all nature conservation features is high, and the magnitude of effect is negligible. The effect on nature conservation from vessel movements is therefore considered negligible.

Effects on navigation

8.8.11 During the disposal activities, there would be increased vessel movements to and from Holyhead North. These additional transits would increase the risk of vessel collision between dredge/disposal plant and marine commercial traffic. This type of incident has the potential to occur throughout the vessel's

passage but it is anticipated that it would occur infrequently and would be localised. The magnitude of effect is therefore small. Vessels are assumed to have a medium level of sensitivity due to the ability to react to the situation by manoeuvring to avoid a collision situation. The overall significance of the effect is therefore minor.

8.8.12 During the disposal operation, tug and tow activities may operate within the disposal site. An increase in the number of vessel movements means that there would be an increased likelihood that steering/propulsion failure may occur to tugs and tows as they arrive or depart from the disposal site. Should this occur, a drifting tug and tow could be involved in a collision. Any vessel subject to steering/propulsion failure would show the appropriate lights and shapes, along with a VHF radio broadcast to the Coastguard and all vessels. This would allow for the reaction of other vessel traffic to the situation. It is anticipated that this would occur infrequently throughout the period of the disposal operation, resulting in a small magnitude. Vessels are assumed to have a medium level of sensitivity due to the ability to react to the situation by manoeuvring to avoid a collision situation. The overall significance of the effect is therefore minor.

Effects on recreation

8.8.13 The additional vessel transits associated with the disposal operation increases the risk of vessel collision between disposal vessels and recreational vessel traffic. This type of incident is likely to occur infrequently as recreational vessels typically transit closer to the shore than the disposal site to avoid routes used by commercial vessels and vessels with deeper draughts. The magnitude of effect is therefore small. Vessels are assumed to have a medium level of sensitivity due to the ability to react to the situation by manoeuvring to avoid a collision situation. The overall significance of the effect is therefore minor.

Effects on seascape

8.8.14 NRW MCA 9 Holy Island West and Penrhos Bay; which Holyhead North sits within, is considered to have a low to moderate sensitivity to change caused by offshore industry due to the area's importance and prolonged maritime history [RD65]. As disposal of dredged material will result in a small increase in vessel numbers (approx. 5 - 6.5%) and this will be temporary in nature, only lasting for the duration of the disposal operation, it is considered that the magnitude of effect would be negligible. The value/sensitivity of seascape is low to medium, therefore the overall significance of this effect would be negligible.

8.9 Underwater noise from disposal

8.9.1 Underwater noise can have both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) effects on marine species.

8.9.2 High peak pressure sound levels very close to the source have the potential to cause death or physical injury, with any severe injury potentially leading to death of the exposed animal.

8.9.3 High exposure levels from underwater sound sources can cause auditory injury or hearing impairment, taking the form of a permanent loss of hearing sensitivity (PTS) or a temporary loss in hearing sensitivity (TTS). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The level of impact on an individual is a function of the Sound Exposure Level (SEL) that an individual receives as a result of underwater noise.

8.9.4 Animals may exhibit varying intensities of behavioural response at lower noise levels. These include disorientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment and, in severe cases panic, or stranding, sometimes resulting in injury or death. The response can vary due to exposure level, the hearing sensitivity of the individual, context, previous exposure history or habitation, motivation and ambient noise levels (e.g. [RD87]).

8.9.5 The potential effects of underwater noise are dependent on the noise source characteristics, the receptor species, distance from the sound source and noise attenuation within the environment.

8.9.6 The following activities associated with disposal at Holyhead North are considered as sources of noise and vibration:

- Vessel movements; and
- Dredged material disposal.

8.9.7 Appendix D13.09 of the ES presents the methodology for, and findings of, the underwater noise modelling undertaken for the Wylfa Newydd Project, including an explanation of the metrics used. The modelling determines the distance from a noise source that physical injury or lethal effects, auditory injury (either permanent or temporary), and behavioural effects and predicted to occur. The results are based on the worst case scenario for each of the activities using the thresholds and criteria summarised in appendix D13.09.

Dredged material disposal

8.9.8 Underwater noise generated from disposal at sea is difficult to predict and, therefore, as a precautionary approach, the maximum modelled impact range for cutter suction dredging has been used as a proxy in the underwater noise assessment.

8.9.9 Dredging produces continuous, broadband sound. Sound Pressure Levels (SPLs) can vary widely, with, for example, dredger type, operational stage or environmental conditions (e.g. sediment type, water depth, salinity and seasonal phenomena such as thermoclines). These factors will also affect the

propagation of sound from dredging activities and along with ambient sound already present, will influence the distance at which sounds can be detected.

8.9.10 The modelling shows that there is no potential risk of physical injury for harbour porpoise, bottlenose dolphin, grey seal and harbour seal as a result of underwater noise from cutter suction dredging operations (and therefore disposal), as noise levels do not reach levels which could result in any physical injury to marine mammals. The maximum predicted range for PTS is <1m for harbour porpoise (high-frequency cetacean), <1m for bottlenose dolphin (mid-frequency cetacean) and 5m for grey and harbour seals, based on the worst case scenario for cutter suction dredging operations.

8.9.11 The maximum predicted range for TTS in harbour porpoise is 4m based on the worst case scenario for cutter suction dredging operations.

8.9.12 This is consistent with reviews of published sources of underwater noise during dredging activity (e.g. [RD88],[RD89],[RD90]), which indicate that the sound levels that marine mammals may be exposed to during dredging activities are usually below auditory injury thresholds or PTS exposure criteria (as defined in [RD87]). However, TTS cannot be ruled out if marine mammals are exposed to noise for prolonged periods [RD90], although marine mammals remaining in close proximity to such activities for long periods of time is unlikely. Therefore, the potential risk of any auditory injury in marine mammals as a result of dredging activity is highly unlikely.

8.9.13 The maximum predicted range for behavioural avoidance based on the precautionary criteria from [RD91] is up to 1.8km for harbour porpoise (high-frequency cetacean), 130m for bottlenose dolphin (mid-frequency cetacean) and 500m for grey and harbour seals, based on the worst case scenario for cutter suction dredging operations (appendix D13.09 of the ES).

8.9.14 The predicted maximum range for minor behavioural effect in harbour porpoise based on the criteria from [RD93] is 99m, based on the worst case scenario for cutter suction dredging.

8.9.15 The noise levels produced by dredging activity could overlap with the hearing sensitive and communication frequencies used by marine mammals [RD90]. However, species such as harbour porpoise have a relatively poor sensitivity below 1kHz and are less likely to be affected by masking, although for seals there could be the potential of masking communication, especially during the breeding season [RD90].

8.9.16 The predicted noise impact ranges of cutter suction dredging for fish are less than those for marine mammals. The maximum predicted range for recoverable injury for fish with swim bladders involved in hearing is 2m. The maximum predicted range for TTS in fish with swim bladders involved in hearing is 13m for cutter suction dredging operations (appendix D13.09 of the ES).

Vessel movements

8.9.17 There will be an increase in the number of vessels at Holyhead North disposal site and vessel movements between the Wylfa Newydd Development Area and the disposal site. The underwater noise assessment is based on large vessels

and it assumed that the vessels are travelling at a speed of approximately 10 knots. It is assumed that two disposal events will occur during each 24 hour period.

8.9.18 The dredging works are predicted to last for a duration of approximately 17-18 months. There will be a predicted peak of 60 vessels per month (120 two-way movements) for disposal of soft sediments and a peak of 10 vessels per month (20 two-way movements) for disposal of rock.

8.9.19 Most noise from vessels is likely to be lower frequency, associated with large, slow moving vessels and the use of dynamic positioning systems.

8.9.20 There is no potential risk of physical injury for harbour porpoise, bottlenose dolphin, grey seal and harbour seal as a result of underwater noise from vessel movements, as modelling shows that noise would not reach levels that could result in any physical injury to marine mammals (Appendix D13.09 of the ES).

8.9.21 The maximum predicted range for PTS is less than 1m for harbour porpoise (high-frequency cetacean), bottlenose dolphin (mid-frequency cetacean) and for both grey and harbour seals, for movements of large and medium sized vessels.

8.9.22 The maximum predicted range for behavioural avoidance based on the precautionary criteria from [RD91] for harbour porpoise is up to 1.7km for large vessels and 500m for medium sized vessels (high-frequency cetacean), and less than 1m for bottlenose dolphins (mid-frequency cetacean) and both grey and harbour seals for medium and large sized vessels, based on the worst case scenario for vessel movements.

8.9.23 The predicted maximum range for minor behavioural effect in harbour porpoise based on the criteria from [RD93] is 60m for large vessels and 10m for medium sized vessels, based on the worst case scenario for vessel movements.

8.9.24 The predicted noise levels for vessels were compared with the baseline noise levels collected in 2013 and 2014 to inform the underwater noise modelling. When using the average baseline level measured across all days and all transects (115.2dB re 1µPa (RMS)) the predicted vessel noise drops below this level at 2.4km for medium vessels and 4.4km for large vessels (ES appendix D13.09 of the ES).

8.9.25 The predicted noise impact ranges of large and medium vessel movements for fish are less than those for marine mammals. The maximum predicted range for recoverable injury for fish with swim bladders involved in hearing is <1m for both large and medium sized vessels. The maximum predicted range for TTS in fish with swim bladders involved in hearing is 4m for large vessels and <1m for medium sized vessels.

Effects on fish and shellfish

Disposal of dredged material

8.9.26 Disposal of dredged material would occur over a number of months as an intermittent activity.

8.9.27 The modelling shows that the risk of mortality resulting from dredging/disposal, is low, with potential effects of a temporary, recoverable injury being restricted to within 2m of the works (using hearing specialists as a worst case).

8.9.28 Behavioural effects are more likely, with the range of avoidance extending out to kilometres from the source. It is likely this would result in temporary displacement of fish species away from the area, although there are numerous other similar habitats of high quality within the vicinity that could support fish communities throughout the duration of the works.

8.9.29 It is considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. The value/sensitivity for fish is low for general species and medium for commercial or conservation species. Therefore, the effect of underwater noise from disposal of dredged material is considered to be negligible for all fish receptors.

Vessel movements

8.9.30 The modelling shows that noise levels generated by vessels are low. The modelled ranges of effects generated from vessel noise does not have the potential to result in fatality or permanent injury to fish, with TTS being limited to within 4m of the vessel itself for large vessels and 1m for medium vessels (appendix D13.06 of the ES).

8.9.31 However, the modelling does show that it is likely that the noise generated from vessel movements would result in temporary localised behavioural response, manifested as a displacement of fish species away from the area.

8.9.32 There are numerous other suitable habitats within the vicinity that could support fish communities throughout the duration of the works. It is therefore considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. The value/sensitivity of fish receptors is medium for species of commercial or conservation importance and low for general species. The effect of underwater noise from vessel movements is therefore considered to be negligible for all fish and shellfish receptors.

Effects on marine mammals

Disposal of dredged material

8.9.33 During disposal operations the modelling shows there is no potential risk of physical injury to marine mammals.

8.9.34 The risks of PTS and TTS are localised to the noise source and therefore it is very unlikely to result in injury. Modelling results show that PTS would occur

within 1m of the source for bottlenose dolphin and for harbour porpoise, and within 5m for seals.

8.9.35 Behavioural effects will result over larger distances, however, marine mammals are highly mobile species which would be able to avoid the area of impact.

8.9.36 The marine mammals baseline suggests bottlenose dolphin, harbour porpoise and seals are present in small numbers in the disposal site. Therefore, the magnitude of effect is negligible. The value/sensitivity of marine mammals is high, however given the magnitude, the effect on marine mammals is considered negligible.

Vessel movements

8.9.37 The impact ranges based on criteria for [RD92] and [RD93] show that PTS and TTS from vessel movements is considered unlikely.

8.9.38 The impact on behaviour is likely to be manifested as avoidance. Marine mammals are highly mobile species and therefore avoidance of the area is unlikely to be an issue. In addition, the baseline information suggests that marine mammals present in low numbers in the area where the noise effects of the disposal will be felt.

8.9.39 The magnitude of effect is considered to be negligible as a result of the localised nature of any effect and the low abundance of marine mammals in the area. The value/sensitivity of marine mammals is high, therefore the effect on marine mammals is considered negligible.

Effects on nature conservation

8.9.40 The shadow HRA concludes that any potential effects from underwater noise during construction and operation on all designated sites with marine mammal features are highly unlikely to result in an adverse effect on the integrity of the of the relevant designated sites in relation to their conservation objectives for harbour porpoise, bottlenose dolphin, grey seal and harbour seal.

8.9.41 Based on the noise modelling results, the shadow HRA assumes that Atlantic salmon will avoid the worst of the noise and noise would not represent a barrier to migration. Hence an adverse effect on site integrity is not predicted because few salmon will be in the area where harm may occur (because it is a small area and the baseline surveys do not indicate the presence of salmon in this location), which is at some distance from most spawning rivers.

8.9.42 The value of al nature conservation features is high, however, given the negligible magnitude of effects, the effect on nature conservation from underwater noise is considered negligible.

8.10 Cumulative disposal operations

8.10.1 The disposal of material from the Wylfa Newydd Project could have cumulative impacts with other disposal operations at Holyhead North. There is currently one marine licence that permits disposal at Holyhead North. This is for Stena

Line Ports to dispose of up to 99,000 tonnes per year of maintenance dredged material from Holyhead Port. This disposal operation has been ongoing for a number of years.

8.10.2 There are currently no other disposal licences for this site, however, it is anticipated that there will be a future requirement for the disposal of maintenance dredged material from the Wylfa Newydd Project; and it is understood that Holyhead Port may undertake a reclamation project that could include capital dredging in the future. The disposal requirements and timing of these works are currently unknown so they have not been considered cumulatively with the Wylfa Newydd Project. However, the implications of disposal from the capital dredge for the Wylfa Newydd Project on the future function and capacity of Holyhead North disposal site is considered in section 8.11.

8.10.3 It is possible that disposal of material from the Wylfa Newydd Project could overlap with disposal of maintenance dredged material from Holyhead Port. Disposal from multiple operations at the same time could have greater impacts on marine receptors than those assessed solely for the Wylfa Newydd Project.

8.10.4 As disposal from Holyhead Port maintenance dredge would be of silty sediment material, consideration is given to whether there would be any additional change from cumulative suspended sediment concentrations.

8.10.5 It is not considered necessary to cumulatively assess the effects of smothering or changes to the dynamics of fine sediment settling due to rock sheltering, as it is understood that due to the fine silty nature of the material disposed from Holyhead Port it would predominantly disperse within the water column and does not accumulate on the seabed at the disposal site. Any material that were to be deposited would quickly be resuspended and transported due to the dynamic nature of the site. This is evidenced by Horizon's benthic survey and BGS data [RD5] characterising the seabed substrate in the south-east corner of Holyhead North disposal site, where dredge arisings from Holyhead port have typically been disposed, as rocky substrate, suggesting that there is no build-up of dredged material.

8.10.6 The levels of chemical contaminants in dredge sediments are considered by the regulator on a case by case basis for each marine licence application. It is assumed that any operation permitted to dispose at Holyhead North would have levels of contamination in the sediment that would not cause concern to the marine environment. As such changes in water chemistry are not considered further.

8.10.7 As the Holyhead Port licence is for the disposal of maintenance dredged material it is understood that this would comprise silty dispersive sediment material. As such, cumulative impacts from rock disposal burial, changes in water depth and changes in physical process/hydrodynamics from changes in bathymetry have been scoped out of cumulative assessment.

Suspended sediment concentrations

8.10.8 To assess the potential cumulative effects of suspended sediments from the capital dredge of the Wylfa Newydd Project and Holyhead Port maintenance dredge, a scenario was modelled. As a worst case this was based on the release of 1,568m^3 of fines per day from the Wylfa Newydd Project and 2,500 m^3 per release from the Port. These values are based on the dredging methods and capacity of the disposal vessels used for each operation. It has been assumed that 21 disposals would be required for the Port to dispose of their total licensed amount (99,000 tonnes). As such, the simulations assume that disposal from the port would occur every four hours until 21 releases have taken place. Disposal from the Port of Holyhead takes place close to the eastern margin of Holyhead North; conversely the Horizon sediment disposal has been modelled based on each disposal event taking place approximately within the middle of the disposal site. Although distance between the disposal events from the two dredging operations would likely be much greater than 1km, this separation distance has been assumed for the modelling.

8.10.9 The modelling results show that the effect of the Wylfa Newydd Project disposal was not readily discernible from that of the much larger port releases (figure 8-5), and while the area of increased suspended sediment concentrations associated with the port release appears large when compared with the Horizon disposal plots, they are nonetheless comparable to the typical background sediment concentrations (ranging from 3mg/l – 14.7mg/l). It is therefore considered that the proposed cumulative disposal of material would not result in a readily detectable increase in SSCs above background concentrations and any increase would be temporary (appendix D13.12 of the ES).

Effects on marine receptors

8.10.10 In the unlikely event that both disposal operations would be coincident, given that the cumulative increase in SSCs would not result in a readily noticeable change from the baseline, the effect on all receptors is assessed as negligible.

8.11 Future function and capacity of the site

8.11.1 The assessment of potential adverse effects for the disposal of capital dredged material from the Wylfa Newydd Project concludes that all impacts would be minor or negligible. All effects would be very localised and most would be temporary. All receptors are expected to recover from effects in the short-medium term.

8.11.2 The only permanent change that will result from the disposal operation is a negligible reduction in water depth (of approximately 1m or less) and negligible and very localised changes in hydrodynamics that would not interrupt sediment transport.

8.11.3 Due to the dynamic environment and depth of water that the disposal site is located within, disposed sediment material does not build up on the seabed over time as it is continually resuspended. As such the 1m reduction in water depth and the predicted changes to hydrodynamics would not affect the

function and capacity of the disposal site to receive fine maintenance dredged material, such as that from the Wylfa Newydd Project and Holyhead Port in the future.

8.11.4 Future capital dredge projects may require the disposal of larger sand and gravel size fractions of material in line with previous capital dredge requirements, discussed in section 5.3, that could accumulate on the seabed. Once deposited, sand and gravelly material would be expected to gradually disperse into the wider environment due to bed load saltation (rolling, sliding, hopping) of the sediment particles due to tidal flows. It is anticipated that the very localised changes in water depth and hydrodynamics, affecting only a very small area of the disposal site, would have a negligible effect on these processes and therefore a negligible effect on the function and capacity of the disposal site. To ensure that these dispersive processes continue uninterrupted it is recommended that in future, coarse material is not disposed within the rock micro-site area, to prevent it from becoming trapped within the rock and accumulating.

8.11.5 Due to the large size (3.45x2.4nm) and depth of water (ranging from 35-96m) at Holyhead North, the disposal of rock material from the Wylfa Newydd Project is expected to have a negligible effect on the capacity of the site to receive rock material again in the future.

8.11.6 It is therefore concluded that the disposal of capital dredge material from the Wylfa Newydd Project both alone and cumulatively will have a negligible effect on the future function and capacity of Holyhead North disposal site.

9 Conclusions

9.1.1 Characterisation of the disposal site, Holyhead North, was requested by NRW to determine the effects of disposing of capital dredged material from the Wylfa Newydd Project. As this is an existing and open disposal site, it was agreed with NRW that this characterisation would focus on supplementing existing information about the site and assessing the effects that are outside of the 'normal' use of the disposal site i.e. disposal of rock material, and a larger volume of sediment material.

9.1.2 The assessment of potential adverse effects from disposing of capital dredged material at Holyhead North from the Wylfa Newydd Project investigated the following sources of effects:

- Release of contaminants;
- Increased suspended sediment levels;
- Burial of the seabed from rock;
- Smothering of the seabed from sediment;
- Changes to physical processes from mounding on the seabed;
- Reduction in water depth;
- Increased vessel movements; and
- Underwater noise.

9.1.3 Potential effects were considered on the following receptors: phytoplankton and zooplankton, benthic habitats and species, fish and shellfish, marine mammals, seabirds, fishing, infrastructure, recreation, navigation, historic environment and seascape character where applicable. A summary of the conclusions of the assessment are provided in table 9-1.

9.1.4 The assessment concludes that effects on all receptors from the disposal of material from the Wylfa Newydd Project will be minor or negligible.

Table 9-1 Summary of potential effects

Source	Receptor	Value/ sensitivity	Magnitude	Assessment of effect
Release of contaminants	Phytoplankton and zooplankton	Low	Negligible	Negligible
	Fish and shellfish (general)	Low	Negligible	Negligible
	Fish and shellfish (conservation/ commercial importance)	Medium	Negligible	Negligible
	Marine mammals	High	Negligible	Negligible
	Seabirds (target species)	High	Negligible	Negligible

Source	Receptor	Value/ sensitivity	Magnitude	Assessment of effect
	Seabirds (secondary species)	Medium	Negligible	Negligible
	Benthic habitats and species (general)	Low	Negligible	Negligible
	Benthic habitats and species (conservation importance)	Medium	Negligible	Negligible
	Nature conservation	High	Negligible	Negligible
Increased suspended sediment (SSC)	Phytoplankton and zooplankton	Low	Negligible	Negligible
	Fish and shellfish (general)	Low	Negligible	Negligible
	Fish and shellfish (conservation/ commercial importance)	Medium	Negligible	Negligible
	Marine mammals	High	Negligible	Negligible
	Seabirds (target species)	High	Negligible	Negligible
	Seabirds (secondary species)	Medium	Negligible	Negligible
	Nature Conservation	High	Negligible	Negligible
	Infrastructure	Medium	Negligible	Negligible
	Fishing	Medium	Negligible	Negligible
Burial of the seabed from rock	Benthic habitats and species (general)	Low	small	Negligible
	Benthic habitats and species (conservation importance)	Medium	small	Minor

Source	Receptor	Value/ sensitivity	Magnitude	Assessment of effect
	Fish and shellfish (general)	Low	Negligible	Negligible
	Fish and shellfish (conservation/ commercial importance)	Medium	Negligible	Negligible
	Nature conservation	High	Negligible	Negligible
	Fishing	Medium	Negligible	Negligible
	Historic environment (non-designated, unknown assets)	Medium	Negligible	Negligible
Smothering of the seabed by sediment	Benthic habitats and species (general)	Low	Small	Negligible
	Benthic habitats and species (conservation importance)	Medium	Small	Minor
	Fish and shellfish (general)	Low	Negligible	Negligible
	Fish and shellfish (conservation/ commercial importance)	Medium	Negligible	Negligible
	Infrastructure	Medium	Negligible	Negligible
	Fishing	Medium	Negligible	Negligible
	Historic environment (non-designated, unknown assets)	Medium	Negligible	Negligible
Changes to physical processes	Benthic habitats and species (conservation importance)	Medium	Negligible	Negligible
	Infrastructure	Medium	Negligible	Negligible
	Historic environment (non-	Medium	Negligible	Negligible

Source	Receptor	Value/ sensitivity	Magnitude	Assessment of effect
	designated, unknown assets)			
Reduction in water depth	Navigation	Medium	Negligible	Negligible
	Fishing	Medium	Negligible	Negligible
Increased vessel movements	Marine mammals	High	Negligible	Negligible
	Navigation	Medium	Small	Minor
	Recreation	Medium	Small	Minor
	Nature conservation	High	Negligible	Negligible
	Seascape	Low - Medium	Negligible	Negligible
Underwater noise	Marine mammals	High	Negligible	Negligible
	Nature conservation	High	Negligible	Negligible
	Fish and shellfish (general)	Low	Negligible	Negligible
	Fish and shellfish (conservation/ commercial importance)	Medium	Negligible	Negligible

9.1.5 The cumulative effects of disposal from the Wylfa Newydd Project and all disposal operations utilising the site was also considered. This assessment identified that there is currently only one Marine Licence that permits disposal at Holyhead North. This is held by Stena Line ports for the disposal of 99,000 tonnes per annum of maintenance dredged material from Holyhead Port. Stena Line Ports have been disposing of this material at this location for many years.

9.1.6 The only source of effect that was considered to have a cumulative impact for these two projects was suspended sediment concentrations. The disposal of material from Holyhead Port releases larger volumes of material at any one time than the proposed disposal of sediment from the Wylfa Newydd Project, and the associated sediment plume from Holyhead Port is much greater than that of the Wylfa Newydd Project. The modelling shows that the cumulative increase in SSCs would not result in a readily noticeable change above background levels. The effect on marine receptors from cumulative SSCs is therefore assessed as negligible.

9.1.7 Future capacity and function of the disposal site has been assessed as the disposal of rock material will result in a permanent change to the seabed

bathymetry which will result in a reduction of water depth of approximately 1m in the micro-site area where the rock material will be disposed. Due to the large size and depth of Holyhead North and its dispersive nature, the disposal of both sediment and rock material from the Wylfa Newydd Project is expected to have a negligible effect on the function and capacity of the site to receive material in the future.

9.1.8 It is therefore concluded that the disposal of capital dredge material from the Wylfa Newydd Project both alone and cumulatively will have a negligible/minor effect on marine receptors and a negligible effect on the future function and capacity of Holyhead North disposal site. Holyhead North is therefore deemed to have suitable characteristics to receive the capital dredge material from the Wylfa Newydd Project.

10 References

Table 10-1 Schedule of references

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Appendix 1-1 Scoping of the site characterisation report - NRW Permitting Service comments

Topic Area	Comment	Horizon Response	Report Section Number
General Comments	Bulking Factors - use of 1.8 for rock and 1.4 silts instead of 1.4 and 1.1 as has been used	There is some confusion in the NRW response between bulking factors and specific gravity. The bulking factors and specific gravity used are referenced in table 5-1	Section 5.1
Coastal Processes	Re-use of material is for rock only as soft material should remain in the marine environment otherwise it would be considered a loss to the Sediment Budget Source. Where the report discusses re-use it should clearly state that rock is being referred to and not soft sediments	This has been noted and reference to re-use is only made in relation to rock material	Section 5.2 (and elsewhere where relevant in the document)
Coastal Processes	Amount of material to be stated in m^3 and tonnes	This has been done where applicable	e.g. table 5-1
Coastal Processes	INNS work undertaken by NRW to be referenced	This has been used and referenced in the report where applicable	e.g. Paragraph 6.4.29
Coastal Processes	References listed to be made available if requested	Noted	N/A
Coastal Processes	Settling thickness of soft sediment needs to be modelled as well as rock material	Smothering of seabed from soft sediment material settling has been modelling and included in the report	Section 8.4
Coastal Processes	Discussion on comparative impact of feasible lower quantities of rock disposal, and if these could make a significant change to the conclusions	Only a discussion on the possible worst case rock disposal was included, as lower quantities of rock disposal would not have changed the outcome of the assessment	N/A

Topic Area	Comment	Horizon Response	Report Section Number
Coastal Processes	Different block characteristics of the rock should be considered	modelling was carried out to assess the potential for changes to hydrodynamics and therefore any changes to sediment processes that the disposed rock would have on the seabed following the immediate completion of the disposal activities. This was achieved by reducing model depth locally by 1m, and locally increasing bed roughness to simulate the increased roughness length of the disposal area due to the presence of the rock.	Section 8.6
Coastal Processes	Consideration of whether disposal could significantly reduce the suitability of the affected area for future application in terms of wave heights, current velocities etc.	Consideration of changes to water depth, waves and currents have been provided in the report.	Section 8.6
	The rock layer could potentially provide a sheltering environment in which future sediment disposal is more easily trapped than at present, altering the finer sediment dispersal characteristics of the disposal site	The results of the modelling show that the rock material will only result in an increase in seabed by 1m, which will not have an impact on waves, but may decrease tidal current velocities by 10-20% (flood and ebb respectively) - as the currents are significantly over the threshold for sediment motion it is not expected that the rock layer would cause a sheltering effect enough to cause changes to the dispersive nature of the disposal site	Section 8.6
Coastal Processes	Scoping out of changes to wave action across the site due to water depth	Information about the characteristics to the water column is provided in section 6.3	Section 6.3
Coastal Processes	Modelling schedule and outputs are appropriate/suitable	Noted	N/A

Topic Area	Comment	Horizon Response	Report Section Number
Coastal Processes	The assessment should also consider the implication of disposal of rock material in terms of other infrastructure and highlight where potential mitigation measures should be utilised	Changes to hydrodynamics and reduction of water depth have both been assessed for impacts to infrastructure, historic environment, navigation and fishing where applicable. However, no mitigation measures were considered necessary.	Sections 8.6 and 8.7
Coastal Processes	Cumulative impacts with maintenance dredge material from Stena Line Ports and the Project area	A cumulative assessment is included in the report	Section 8.10
Coastal Processes	No maintenance dredging is considered within this document and will therefore need to be considered later	Noted	N/A
Benthic Ecology	Consultees are concerned that Horizon are using previous investigation and assessments which were concerned with entirely soft sediments to justify scoping out impact from rock disposal at the site which is not dispersive and will become a permanent feature	The report includes consideration of smothering and crushing from rock disposal. It should also be noted that disposal of rock will be in a rocky micro-sited area	Section 8.4
Benthic Ecology	Location of sampling locations for site specific survey are within the disposal area	Horizon survey extents extended up to 1.6km from the disposal location, and all relevant previous data collected was used for the assessment where possible.	Section 6.4
Benthic Ecology	Presence of *Sabellaria spinulosa* within the disposal site - consultees consider that the impacts of development or activities on 'undesignated' Annex 1 habitat outside SACs should be assessed and adverse effects minimised or mitigated as far as possible.	Impacts to *Sabellaria spinulosa* are considered where applicable in the assessment.	Section 8.4, 8.5
Benthic Ecology	Pre-construction surveys to further identify the micro-sited area for rock disposal	Pre-construction surveys are not covered in the site characterisation report and will need to be further discussed.	N/A

Topic Area	Comment	Horizon Response	Report Section Number
Benthic Ecology	Reference for smothering of benthic communities not provided	Text amended and references provided as relevant to the assessment	Section 8.4
Fisheries	Applicant should make use of all available fishing activity data including VMS, surveillance	Sources of fishing data utilised included UK Sea Fisheries Statistics, the Sea Fishing Atlas for Wales, ICES landing data, NRW and Cefas projects, and vessel activities data reported in the Project's NRA and that for the Minesto Project.	Section 6.6
Fisheries	Data from Charter Angling boats that fish in the area should be included	Data sources include the Fish Map Mon project and Sea Fishing Atlas for Wales which engaged with both the commercial and recreational fishing industries	Section 6.6.2 – 6.6.6
Fisheries	ICES data should be included for Irish Sea and Bristol Channel	ICES data included where applicable	Section 6.6
Fisheries	Survey data needs to include relevant information (e.g. date/time stamps), including limitations	Detailed information on the survey methods used to collect the baseline fish data is presented in the fish and fisheries appendix of the Wylfa Newydd ES	N/A
Fisheries	Assessment on the potential effects of dredge disposal in relation to fish and shellfish should consider the following: Impacts of increased SSC concentrations on eggs, larvae, juvenile and adult fish and shellfish; Smothering of benthic habitat and shellfish beds by settlement of suspended sediment; and Potential release of contamination within sediment, and subsequent uptake by fish and other marine organisms	All these potential impacts have been assessed	Sections: 8.3; 8.5; and 8.2

Topic Area	Comment	Horizon Response	Report Section Number
Fisheries	Contamination analysis in material to be dredged should be assessed in relation to fish and fish ecology	Chemical contamination has been compared to Cefas Action Levels and the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (ISQG and PEL)	Section 8.3
Fisheries	Report should include a detailed account of fish species present in the area, and an assessment of the potential impacts of dredge disposal on fish and shellfish (all desk-based)	Fish species are outlined in Section 6.4 and potential impacts are assessed where applicable in Section 8.	Section 6.4 Section 8.2 Section 8.3 Section 8.4 Section 8.5 Section 8.9
Seabirds	Omission of ESAS/WWT data that NRW supplied	These data sources have been used to define the baseline environment	Section 6.4
Marine Mammals	Cross-check of data with those used in other Horizon documentation	This report utilises the information presented in the Marine mammals appendix of the Wylfa Newydd Environmental Statement (D13.06)	Section 6.4.54
Marine Mammals	In terms of impact pathways, disturbance/displacement to marine mammals need to be considered	Impacts to marine mammals have been assessed in the report	Section 8.2 Section 8.3 Section 8.4 Section 8.8 Section 8.9
Chemical Characteristics	Chemical data from Stena Line maintenance dredge is available online on request	Chemical analysis data from other projected that have disposed at Holyhead Deep/Holyhead North was requested from Cefas and has been utilised in the report	Section 7.3

Topic Area	Comment	Horizon Response	Report Section Number
		Noted but not utilised as samples were analysed from the areas to be dredged and from the disposal site for the purposes of this Project	
Navigation	Bathymetry survey to be undertaken post disposal	Noted	N/A
Navigation	Proposed site encroaches into The Skerries traffic Separation Scheme	Noted in report	Section 6.6
Other Sea Users	Any impacts of the proposal on the licenced activity from Holyhead Port (Stena Line) should be considered in the report	Cumulative impacts and future function and capacity of the disposal site have been assessed in the report	Section 8.10 Section 8.11
Other Sea Users	Potential capital dredge from Holyhead Port should be included in potential in-combination assessments	This is included in the cumulative assessment as recommended	Section 8.10

Appendix 1-2 DOffGI sediment chemical analysis results

Trace Metals

Laboratory Sample Number	Sample Description	%	units mg/kg							
		Total Solids	AL1 : 20 AL2 : 100	AL1 : 0.4 AL2 : 5	AL1 : 40 AL2 : 400	AL1 : 40 AL2 : 400	AL1 : 0.3 AL2 : 3	AL1 : 20 AL2 : 200	AL1 : 50 AL2 : 500	AL1 : 130 AL2 : 800
			Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
2016/31571	BH1237_0.00-0.30_ES1	85	4.6	0.14	21	12.3	<0.027	21.2	4.2	57.5
2016/31572	BH1236_0.00-0.40_ES1	73.6	5.17	0.2	14.1	16	0.04	16.7	5.24	81.7
2016/31573	BH1236_1.50-1.70_ES2	81.2	4.01	0.07	27.3	18.1	<0.033	32.2	9.7	57.9
2016/31574	BH1202_0.00-0.50_ES1	76.9	9.16	0.1	7.31	6.95	<0.033	9.92	6.5	36.8
2016/31575	BH1202_1.00-1.50_ES2	89.1	11.3	0.43	15.3	20	<0.028	27.7	19.9	49.4
2016/31576	BH1202_2.00-2.40_ES3	90.5	11.9	0.32	13	11	<0.021	20.7	5.36	50.5
2016/31577	BH1214_0.00-0.50_ES3	75.5	8.01	0.09	17.5	31.6	0.18	15.8	11.1	163.9
2016/31578	BH1229_0.00-0.50_ES2	80.7	8.2	0.06	13	18.8	0.05	17.2	5.68	121.3
2016/31579	BH1228_0.00-0.32_ES1	86.8	4.83	0.07	12.4	24.3	<0.031	17.7	1.51	105
2016/31580	BH1215_0.00-0.70_ES2	96.5	0.92	0.05	6.99	14.7	<0.025	8.81	0.45	40.9
2016/31581	BH1238_0.00-0.30_ES1	79.2	6.37	0.08	13.8	10.6	<0.032	18.6	39.6	68.8
2016/31582	BH1203_0.00-0.30_ES4	80.7	6.41	0.07	9.34	2.8	<0.031	6.7	6.49	26.3
2016/31583	BH1203_1.00-1.30_ES5	83.3	4.88	0.06	8.76	8.17	<0.028	7.86	4.75	28.3
2016/31584	BH1203_2.00-2.30_ES10	93.7	4.13	0.08	8.26	12.9	0.05	12.4	3.54	49.4
2016/31585	BH1234-ENV_0.00-0.50_ES1	76.4	5.76	0.1	19.5	7.97	<0.032	16.7	4.31	45.2
2016/31586	BH1234-ENV_1.00-1.50_ES2	82.2	4.84	0.07	14.9	14.1	<0.027	23.3	3.9	60.9
2016/31587	BH1234-ENV_2.00-2.50_ES3	84	5.63	0.18	14.2	14.4	<0.029	20.2	5.99	55.6
2016/31588	BH1235-ENV_0.00-0.40_ES1	77.1	5.74	0.09	14.5	6.05	<0.028	13.1	4.45	41.1
2016/31589	BH1235-ENV_1.20-1.40_ES2	83.4	4.01	0.08	13	11.5	<0.025	13.7	3.07	44.7
2016/31590	BH1210_0.00-0.50_ES2	92.4	1.82	0.07	52.6	103	<0.025	27.1	20.2	154

Organotins

Laboratory Sample Number	Sample Description	units mg/kg	
		AL1 : 0.1 AL2 : 1	AL1 : 0.1 AL2 : 1
		DBT*	TBT*
2016/31571	BH1237_0.00-0.30_ES1	<0.001	<0.001
2016/31572	BH1236_0.00-0.40_ES1	<0.001	<0.001
2016/31573	BH1236_1.50-1.70_ES2	<0.001	<0.001
2016/31574	BH1202_0.00-0.50_ES1	<0.001	<0.001
2016/31575	BH1202_1.00-1.50_ES2	<0.001	<0.001
2016/31576	BH1202_2.00-2.40_ES3	<0.001	<0.001
2016/31577	BH1214_0.00-0.50_ES3	<0.001	<0.001
2016/31578	BH1229_0.00-0.50_ES2	<0.001	<0.001
2016/31579	BH1228_0.00-0.32_ES1	<0.001	<0.001
2016/31580	BH1215_0.00-0.70_ES2	<0.001	<0.001
2016/31581	BH1238_0.00-0.30_ES1	<0.001	<0.001
2016/31582	BH1203_0.00-0.30_ES4	<0.001	<0.001
2016/31583	BH1203_1.00-1.30_ES5	<0.001	<0.001
2016/31584	BH1203_2.00-2.30_ES10	<0.001	<0.001
2016/31585	BH1234-ENV_0.00-0.50_ES1	<0.001	<0.001
2016/31586	BH1234-ENV_1.00-1.50_ES2	<0.001	<0.001
2016/31587	BH1234-ENV_2.00-2.50_ES3	<0.001	<0.001
2016/31588	BH1235-ENV_0.00-0.40_ES1	<0.001	<0.001
2016/31589	BH1235-ENV_1.20-1.40_ES2	<0.001	<0.001
2016/31590	BH1210_0.00-0.50_ES2	<0.001	<0.001

PCBs

atory Sample Number	Units ug/kg	AL1 : 0.02 AL2 : 0.2 mg/kg																								AL1 : 20 AL2 : 200 ug/kg
	Sample Description	CB#28	CB#52	CB#101	CB#118	CB#153	CB#138	CB#180	CB#31	CB#105	CB#128	CB#149	CB#170	CB#183	CB#187	CB#18	CB#44	CB#47	CB#49	CB#66	CB#110	CB#158	CB#141	CB#151	CB#156	CB#194	SUM
2016/31571	BH1237_0.00-0.30_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31572	BH1236_0.00-0.40_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31573	BH1236_1.50-1.70_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31574	BH1202_0.00-0.50_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31575	BH1202_1.00-1.50_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31576	BH1202_2.00-2.40_ES3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31577	BH1214_0.00-0.50_ES3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31578	BH1229_0.00-0.50_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31579	BH1228_0.00-0.32_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31580	BH1215_0.00-0.70_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31581	BH1238_0.00-0.30_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31582	BH1203_0.00-0.30_ES4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31583	BH1203_1.00-1.30_ES5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31584	BH1203_2.00-2.30_ES10	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31585	BH1234-ENV_0.00-0.50_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31586	BH1234-ENV_1.00-1.50_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31587	BH1234-ENV_2.00-2.50_ES3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31588	BH1235-ENV_0.00-0.40_ES1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31589	BH1235-ENV_1.20-1.40_ES2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0
2016/31590	BH1210_0.00-0.50_ES2	0.236	<0.2	1.23	2.37	1.45	1.94	0.75	<0.2	1.31	0.528	1.02	0.481	<0.2	0.26	<0.2	<0.2	<0.2	<0.2	0.336	1.69	0.274	0.4	<0.2	0.441	<0.2	14.716

PAHs

Laboratory Sample Number (LSN)	Sample Description	Units mg/kg	Units ug/kg AL1 : 100 AL2: None																				
		THC (Total Hydrocarbon Content)	Naphthalene*	methyl naphthalenes*	dimethyl naphthalenes*	trimethyl naphthalenes*	Acenaphthylene*	Acenapthene*	Fluorene*	Phenanthrene*	Anthracene*	methyl phenanthrene*	Fluoranthene*	Pyrene*	Benz[a]anthracene*	Chrysene*	Benzo[b]fluoranthene*	Benzo[k]fluoranthene*	Benzo[e]pyrene*	Benzo[a]pyrene*	Perylene*	Indeno[1,2,3-cd]pyrene*	Benzo[g,h,i]perylene*	Dibenz[a,h]anthracene*
2016/31571	BH1237_0.00-0.30_ES1	8.4	0.37	0.923	1.23	6.1	<0.100	0.337	0.414	1.9	0.315	5.71	1.52	1.14	2.07	0.545	1.83	<0.100	0.631	0.526	<0.100	0.402	0.587	0.143
2016/31572	BH1236_0.00-0.40_ES1	14.5	6.92	44.5	62.2	80.3	<0.100	0.334	1.58	9	0.964	25	2.36	1.72	2.7	1.61	3.2	0.375	1.2	1.02	0.419	0.481	0.729	0.277
2016/31573	BH1236_1.50-1.70_ES2	6.82	1.15	3.8	4.03	5.27	<0.100	0.122	0.208	5	0.161	9.9	1.97	1.56	2.33	2.05	7.55	0.712	6.34	1	0.412	1.47	5.03	0.919
2016/31574	BH1202_0.00-0.50_ES1	6.51	2.53	5.41	4.74	7.54	<0.100	0.27	0.735	3.03	0.344	22	3.34	2.37	2.68	1.11	2.76	0.858	1.44	1.2	0.411	1.03	1.04	0.229
2016/31575	BH1202_1.00-1.50_ES2	3.17	7.57	14.6	10.9	15.3	<0.100	0.2	2.42	5.88	0.194	12.8	1.8	1.85	3.2	1.19	3.81	<0.100	1.98	0.703	0.31	0.54	1.07	0.295
2016/31576	BH1202_2.00-2.40_ES3	1.87	2.1	3.1	1.13	2.85	<0.100	0.134	0.485	1.75	<0.100	3.43	0.631	0.516	2.29	0.567	1.42	<0.100	0.505	0.142	0.274	<0.100	0.298	<0.100
2016/31577	BH1214_0.00-0.50_ES3	52.6	61.6	130	105	97.6	2.01	96.1	83.4	230	12.9	87.6	332	207	88.9	83.5	158	82.1	74.3	106	19.3	94.5	10.9	48.3
2016/31578	BH1229_0.00-0.50_ES2	9.4	0.477	1.43	1.97	3.21	<0.100	0.252	0.324	1.9	0.368	4.47	3.31	2.29	2.79	2.08	2.68	1.42	1.36	1.54	0.378	1.3	1.06	0.264
2016/31579	BH1228_0.00-0.32_ES1	1.63	0.456	1.37	2.05	3.2	<0.100	0.119	0.22	1.18	0.217	5.5	1.7	0.99	1.69	0.68	1.32	0.538	0.818	0.688	0.164	0.906	0.598	0.144
2016/31580	BH1215_0.00-0.70_ES2	<0.100	<0.100	<0.100	<0.100	0.813	<0.100	<0.100	<0.100	<0.100	<0.100	1.68	<0.100	<0.100	1.86	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2016/31581	BH1238_0.00-0.30_ES1	87.5	27.1	154	218	350	0.189	3.23	8.63	24.1	6.33	119	9.79	10.3	6.2	6.35	7.09	2.12	5.64	6.56	0.69	3.34	5.72	0.712
2016/31582	BH1203_0.00-0.30_ES4	5.88	0.574	1.2	2.02	4.83	<0.100	0.138	0.375	1.75	0.404	4.13	2.27	1.22	2.26	1.14	1.74	0.684	0.965	0.808	0.294	0.774	0.681	0.191
2016/31583	BH1203_1.00-1.30_ES5	1.64	1.3	1.15	0.663	1.49	<0.100	0.101	0.25	1.34	0.145	1.76	1.02	0.702	1.97	<0.100	1	0.152	0.322	0.239	0.255	0.156	0.201	<0.100
2016/31584	BH1203_2.00-2.30_ES10	5.67	0.402	0.38	<0.100	0.82	<0.100	<0.100	0.138	1.13	0.113	3.02	0.727	0.428	3.2	<0.100	0.586	<0.100	0.226	<0.100	0.119	<0.100	0.284	<0.100
2016/31585	BH1234-ENV_0.00-0.50_ES1	7.64	0.735	2.43	14.8	31.9	<0.100	0.197	0.799	4.38	0.579	12.8	2.34	1.82	4.08	1.13	3.42	0.731	1.3	1.07	2.44	0.665	0.918	0.229
2016/31586	BH1234-ENV_1.00-1.50_ES2	2.78	2.55	14.6	14.5	18.3	<0.100	0.196	0.372	3.29	0.163	6.73	1.36	1.29	8.18	2.01	6.46	<0.100	0.982	0.313	0.128	0.186	0.647	0.32
2016/31587	BH1234-ENV_2.00-2.50_ES3	2.73	1.56	2.53	2.28	9.51	<0.100	0.111	0.332	3.38	<0.100	4.22	1.43	1.27	3.79	1.79	6.83	<0.100	1.23	0.204	<0.100	0.208	0.556	0.328
2016/31588	BH1235-ENV_0.00-0.40_ES1	8.61	1.71	4.86	6.39	11.4	0.141	0.239	0.626	2.68	0.532	8.48	4.21	3.44	3.64	1.91	4.15	1.55	2.27	2.28	0.925	2.73	2.19	0.599
2016/31589	BH1235-ENV_1.20-1.40_ES2	1.02	0.738	0.939	0.463	18.9	<0.100	<0.100	0.197	1.51	<0.100	2.39	0.866	0.842	3.99	0.935	2.43	<0.100	0.577	<0.100	<0.100	0.125	0.305	0.159
2016/31590	BH1210_0.00-0.50_ES2	15.1	3.42	33.3	34.8	18.7	1.69	50.1	14.9	116	14.7	41.6	246	166	79.6	58.7	62.8	34.3	37.1	62.8	12.8	45.9	29.5	8.6

TOC

Laboratory Sample Number	Sample ID	Total organic carbon #*
2016/31571	BH1237_0.00-0.30_ES1	0.1
2016/31572	BH1236_0.00-0.40_ES1	0.13
2016/31573	BH1236_1.50-1.70_ES2	0.14
2016/31574	BH1202_0.00-0.50_ES1	0.42
2016/31575	BH1202_1.00-1.50_ES2	0.34
2016/31576	BH1202_2.00-2.40_ES3	0.11
2016/31577	BH1214_0.00-0.50_ES3	0.16
2016/31578	BH1229_0.00-0.50_ES2	0.08
2016/31579	BH1228_0.00-0.32_ES1	0.13
2016/31580	BH1215_0.00-0.70_ES2	No TOC measured - gravel.
2016/31581	BH1238_0.00-0.30_ES1	0.52
2016/31582	BH1203_0.00-0.30_ES4	0.11
2016/31583	BH1203_1.00-1.30_ES5	0.05
2016/31584	BH1203_2.00-2.30_ES10	No TOC measured - gravel.
2016/31585	BH1234-ENV_0.00-0.50_ES1	0.09
2016/31586	BH1234-ENV_1.00-1.50_ES2	0.13
2016/31587	BH1234-ENV_2.00-2.50_ES3	0.14
2016/31588	BH1235-ENV_0.00-0.40_ES1	0.54
2016/31589	BH1235-ENV_1.20-1.40_ES2	0.06
2016/31590	BH1210_0.00-0.50_ES2	0.13

PSA

Sample Laboratory Number	Sample ID	Visual Description	Gravel % (> 2mm particle size)	Sand % (> 0.063mm to < 2mm particle size)	Silt/clay % (< 0.063mm particle size)
2016/31571	BH1237_0.00-0.30_ES1	Slightly muddy, sandy gravel	53	44	3
2016/31572	BH1236_0.00-0.40_ES1	Slightly muddy, gravelly, shelly sand.	9	83	8
2016/31573	BH1236_1.50-1.70_ES2	Thick, sticky, brown gravelly mud(clay?).	12	13	76
2016/31574	BH1202_0.00-0.50_ES1	Slightly muddy, shelly, sandy gravel.	74	25	1
2016/31575	BH1202_1.00-1.50_ES2	Sandy, gravelly mud containing broken shell fragments.	32	17	51
2016/31576	BH1202_2.00-2.40_ES3	Slightly muddy, sand/gravel.	46	49	6
2016/31577	BH1214_0.00-0.50_ES3	Slightly muddy, shelly, sandy gravel.	50	45	5
2016/31578	BH1229_0.00-0.50_ES2	Slightly muddy, slightly shelly, sandy gravel.	56	38	6
2016/31579	BH1228_0.00-0.32_ES1	Brown, slightly muddy, sandy gravel (grey shale?).	70	18	12
2016/31580	BH1215_0.00-0.70_ES2	Gravel (grey shale?) - no TOC/PSA - description only.	No PSA - gravel.	0	0
2016/31581	BH1238_0.00-0.30_ES1	Slightly muddy, sandy gravel containing broken shell fragments.	62	34	4
2016/31582	BH1203_0.00-0.30_ES4	Sand containing some broken shell fragments.	0	96	4
2016/31583	BH1203_1.00-1.30_ES5	Gravelly sand.	37	62	1
2016/31584	BH1203_2.00-2.30_ES10	Gravel (grey shale?) - no TOC/PSA - description only.	No PSA - gravel.	0	0
2016/31585	BH1234-ENV_0.00-0.50_ES1	Slightly muddy, gravelly sand containing broken shell fragments.	28	67	6
2016/31586	BH1234-ENV_1.00-1.50_ES2	Slightly muddy, sandy gravel containing broken shell fragments.	42	55	3
2016/31587	BH1234-ENV_2.00-2.50_ES3	Slightly muddy, gravelly sand containing broken shell fragments.	26	69	5
2016/31588	BH1235-ENV_0.00-0.40_ES1	Slightly muddy, sandy gravel containing broken shell fragments.	37	55	8
2016/31589	BH1235-ENV_1.20-1.40_ES2	Slightly muddy, sandy gravel containing broken shell fragments.	47	46	7
2016/31590	BH1210_0.00-0.50_ES2	Slightly sandy gravel.	93	7	0

Appendix 1-3 DOffGI sediment radionuclide analysis results

UKAS TESTING 1011

amec foster wheeler

Analytical Report for Horizon Nuclear Power

Radiometric and Radiochemical Analysis of Wylfa Rock and Soil Samples

The applicability of UKAS accreditation to this report is detailed in Section 5.1

Amec Foster Wheeler Reference:	206352-0000-DM00-RPT-0001
Issue Number:	01
Issue Date:	08 December 2016

1 Job Details

1.1 Scope of Work

Eight sediment and rock core samples were received. The scope of work involved the radiometric and radiochemical analysis of the samples as detailed in the quotation reference TRP-2016-3839.

1.2 Samples Received

A description of the samples received is provided in Table 1-1.

Table 1-1: Description of the samples received

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Receipt Date at Laboratory
L160331-1	BH1230 0.0-0.5M	SEDIMENT	18/08/2016	26/08/2016
L160331-2	BH1232 0.0-0.5M	SEDIMENT	18/08/2016	26/08/2016
L160331-3	BH1235 0.0-0.4M	SEDIMENT	18/08/2016	26/08/2016
L160331-4	BH1236 0.6-0.8M	SEDIMENT	18/08/2016	26/08/2016
L160331-5	BH1238 0.0-0.3M	SEDIMENT	18/08/2016	26/08/2016
L160331-6	BH1230 3.45-3.55	ROCK	18/08/2016	26/08/2016
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	12/10/2016
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	12/10/2016

1.3 Sample Receipt Date

See section 1.2 above.

1.4 Details of Subcontractors

Calcium-45, carbon-14 and nickel-63 testing was subcontracted to:

GAU Radioanalytical,
National Oceanography Centre,
Southampton, European Way,
Southampton, SO14 3ZH

Sulfur-35 testing was subcontracted to:

Environmental Scientifics Group,
Unit 12, Moorbrook,
Southmead Industrial Estate,
Didcot, Oxfordshire, OX11 7HP

2 Sample Preparation

2.1 Sample Preparation (Amec Foster Wheeler)

Each sample was received split across three separate containers. One was forwarded to GAU Radioanalytical and one to Environmental Services Group, with the third retained for analysis by Amec Foster Wheeler.

For analysis undertaken at Amec Foster Wheeler, a portion of the sample was dried in a drying cabinet and ground to pass a 1 mm screen. Estimates of moisture content are provided in the results table (Appendix 1). It should be noted that the moisture content values are not formal determinations of moisture content by drying to constant weight at >100°C, but a measure of the moisture content on drying to a visibly dry material suitable for grinding.

Aliquots of the dried and ground material were submitted for measurement by high-resolution gamma spectrometry and gross alpha/beta analysis.

All other analyses were undertaken on acid digests produced by dissolution of aliquots of the dried and ground sample using a combination of mineral acids, including hydrofluoric acid.

2.2 Sample Preparation (GAU and ESG)

Summaries of GAU and ESG's sample preparation procedures are provided in their analytical reports (Appendices 2 and 3).

3 Analytical Methods

3.1 High-Resolution Gamma Spectrometry

A known amount of the sample was transferred to an appropriate container to produce a standard counting geometry prior to measurement by high-resolution gamma spectrometry. The high-resolution gamma spectrometry was conducted using high-purity germanium detectors, coupled to computerized multi-channel analysers, with peak search and peak shape functions and validated radionuclide library. System calibration is undertaken for standardized geometries using a nationally traceable “mixed gamma” reference solution, in the energy range 60 keV - 1836 keV (References 1 and 2).

3.2 Gross Alpha/Beta

A subsample of the prepared material was finely ground. A known mass was spread as an even layer on a stainless steel planchet with the help of a dilute solution of adhesive alcohol. The solvent was removed by evaporation and the planchet was then counted on a Berthold LB770 or Protean MPC9604 low background gas proportional counter. The counter was calibrated with americium-241 for gross alpha determination and potassium-40 for gross beta determination (Reference 3).

3.3 Iron-55

Iron was separated from an aliquot of the prepared sample solution by solvent extraction using di-isopropyl ether. The purified iron fraction was decolourised, and the iron-55 content was measured by liquid scintillation counting. Iron-55 of known activity concentration was used to determine the counting efficiency. Stable iron measurements, before and after the analytical procedure, were used to monitor the chemical recovery (Reference 4).

3.4 Strontium-90

Strontium was separated from an aliquot of the prepared sample solution by ion-exchange followed by extraction chromatography using a commercially available strontium-specific resin. The strontium-90 in the purified fraction was measured by liquid scintillation counting following a known ytttium-90 ingrowth period. The counting efficiency was determined using a calibration curve of efficiency versus time, together with the time elapsed between separation and counting in order to account for yttrium-90 ingrowth. The chemical recovery was estimated by measurement of stable strontium before and after chemical separation (Reference 5).

3.5 Americium-241 and Curium Isotopes (^{242}Cm, $^{243/244}$Cm)

Americium and curium were isolated from an aliquot of the prepared sample solution by ion-exchange chromatography and extraction chromatography. The purified americium and curium were electrodeposited onto a stainless-steel disc, which was then measured by alpha spectrometry. Americium-243 was used as an internal standard for the procedure (Reference 6).

3.6 Plutonium isotopes (^{238}Pu, $^{239/240}$Pu, ^{242}Pu) and ^{241}Pu

Plutonium was isolated from the sample solution by anion-exchange chromatography. The purified plutonium was then split into two fractions. One fraction was processed for electro-deposition onto a stainless-steel disc, which was then measured by alpha spectrometry. The other fraction was processed for measurement by liquid scintillation counting to determine plutonium-241. The plutonium-241 counting efficiency was determined using plutonium-241 of known activity concentration. Plutonium-236 was used as an internal standard and chemical recovery monitor for the procedure (Reference 6).

3.7 Carbon-14 (by GAU Radioanalytical)

See the GAU analytical report in Appendix 2 for details of the analytical method.

3.8 Calcium-45 (by GAU Radioanalytical)

See the GAU analytical report in Appendix 2 for details of the analytical method.

3.9 Nickel-63 (by GAU Radioanalytical)

See the GAU analytical report in Appendix 2 for details of the analytical method.

3.10 Sulfur-35 (by ESG)

See the ESG analytical report in Appendix 3 for details of the analytical method.

4 Results

Results are reported in full in the table in Appendix 1. Results are referenced to the analysis dates listed in the table.

Carbon-14 and tritium results are reported in Bq/g of as-received sample.

Sulfur-35 results are reported in Bq/kg dry weight.

All other radiometric/radiochemical results are reported in Bq/g dry weight.

5 Quality Assurance

5.1 Quality system and applicability of UKAS accreditation

Analytical Services operates a quality management system to the requirements of BS EN ISO/IEC 17025:2005 and BS EN ISO 9001:2008.

The following analyses described in this report are UKAS accredited for samples submitted and analysed:

- high-resolution gamma spectrometry (see Note 1);
- gross alpha/beta analysis of sediments;
- iron-55;
- strontium-90;
- americium-241 and curium isotopes (Cm-242 and Cm-243/244);
- plutonium isotopes (Pu-238, Pu-239/240 and Pu-241);
- carbon-14 analysis of sediments undertaken by GAU Radioanalytical;
- nickel-63 analysis of sediments undertaken by GAU Radioanalytical; and
- sulfur-35 analysis of sediments undertaken by ESG.

Gross alpha/beta, nickel-63 and sulfur-35 analysis of rocks, and calcium-45 analysis of rocks and sediments, are outside of the scope of the laboratories' UKAS accreditations.

Note 1. Pb-210 and I-129 fall outside the UKAS accredited calibration range for high-resolution gamma spectrometry; therefore any results for these nuclides presented in this report are not UKAS accredited.

Any comments, opinions and interpretations expressed in Section 6 of this report are outside the scope of UKAS accreditation.

5.2 Statement of uncertainties

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor *k*=2, providing a coverage probability of approximately 95%. For UKAS accredited methods, the uncertainty evaluation has been carried out in accordance with UKAS requirements.

5.3 Quality assurance and quality control procedures

The samples were processed in the environmental suite of laboratories.

5.3.1 High-Resolution Gamma Spectrometry

The gamma spectrometers are calibrated annually. The efficiency and energy calibrations are checked on a weekly basis.

5.3.2 Quality Control (QC) Sample Results

The results of quality control samples run alongside the samples for the radiochemical analysis methods are tabulated below. The acceptability of the quality control results was assessed using:

- the zeta score. A *PASS* verdict results from the zeta score being in the range -2.0 to 2.0. A *WARNING* verdict results when (-3.0 < zeta score < -2.0) or (2.0 < zeta score < 3.0). A *FAIL* verdict results when zeta is either less than -3.0 or greater than 3.0, or following two consecutive *WARNING* verdicts (Reference 7).

- the Laboratory Control Sample Percent (LCS%), calculated as follows:

$$LCS\% = 100 * \frac{Result}{Assigned\ value}$$

  A pass verdict results from the LCS% being within the range 75% to 125%.

Test	QC ID	LCS Type	Zeta Score	Zeta Pass/Fail	LCS %	LCS % Pass/Fail	% Chemical recovery
Am-241	Q-Am-7	Aqueous	-0.27	Pass	99.18	Pass	41.54
Am-241	Q-Am-7	Aqueous	-0.54	Pass	98.28	Pass	36.18
Fe-55	PM19743 Dil4	Aqueous	2.88	Warning (i)	123.57	Pass	88.34
Fe-55	PM19743 Dil4	Aqueous	1.36	Pass	109.93	Pass	87.15
Gross alpha	BP Soil	Solid	-0.60	Pass	91.68	Pass	N/A (ii)
Gross alpha	BP Soil	Solid	-0.94	Pass	87.57	Pass	N/A
Gross beta	BP Soil	Solid	1.14	Pass	107.54	Pass	N/A
Gross beta	BP Soil	Solid	-0.90	Pass	94.88	Pass	N/A
Tritium	Q-H3-38	Solid	0.68	Pass	105.29	Pass	N/A
Tritium	Q-H3-38	Solid	0.11	Pass	100.83	Pass	N/A
Pu-239/240	Q-Pu-2	Aqueous	1.65	Pass	104.39	Pass	93.92
Pu-239/240	Q-Pu-2	Aqueous	2.18	Warning (i)	106.52	Pass	67.28
Pu-241	Q-Pu-2	Aqueous	-1.05	Pass	87.52	Pass	93.92
Pu-241	Q-Pu-2	Aqueous	-0.19	Pass	97.43	Pass	67.28
Sr-90	Q-Sr-13	Aqueous	-0.89	Pass	95.31	Pass	93.38
Sr-90	Q-Sr-13	Aqueous	-0.92	Pass	95.18	Pass	93.34

(i) Further investigation is only initiated where two consecutive zeta-score WARNING verdicts are obtained, as per our accredited QA procedures. For the WARNING verdicts observed for Fe-55 and Pu QC samples, all the preceding and subsequent QC zeta-scores yielded PASS verdicts.

(ii) N/A indicates not applicable. For gross alpha and gross beta determination, the LCS% is equivalent to the % chemical recovery.

6 Comments

6.1 General

The results reported refer to the samples received at the laboratory and it is assumed that any subsamples analysed are representative of the samples provided.

7 References

1. Amec Foster Wheeler Analytical Services, Operational Manual OM GSSP Issue 05 *Gamma Spectrometry Sample Preparation.*
2. Amec Foster Wheeler Analytical Services, Operational Manual OM GS Issue 09 *Gamma Spectrometer Systems.*
3. Amec Foster Wheeler Analytical Services, Operational Manual OM ABTS Issue 08 *Gross Alpha and Gross Beta in Water and Solid Samples: Thick Source Method.*
4. Amec Foster Wheeler Analytical Services, Operational Manual OM Fe-55 Issue 05 *Determination of Iron-55 in Digested/Leached Solids and Waters by Liquid Scintillation Counting.*
5. Amec Foster Wheeler Analytical Services, Operational Manual OM Sr-90 Issue 08 *Determination of Strontium-90 in Water and Digested Solid Samples.*
6. Amec Foster Wheeler Analytical Services, Operational Manual OM ACT Issue 04 *Determination of Actinides in Waters and Selected Solid Samples.*
7. BS ISO 13528:2005, *Statistical Methods for Use in Proficiency Testing by Interlaboratory Comparisons* (2005).

8 Appendices

Appendix 1 – Results Table (9 pages)

Appendix 2 – GAU Analytical Report reference GAU3614 (Issue 1) detailing the calcium-45, carbon-14 and nickel-63 analysis (6 pages)

Appendix 3 – ESG Analytical Report reference RT6392 detailing the sulfur-35 analysis (4 pages)

Appendix 1 - Results

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Am-241	0.00109	±	0.00040	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00041	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.00029	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	80	±	9	Bq/kg
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ac-228	0.0226	±	0.0037	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ag-110m		<	0.00089	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Am-241		<	0.0024	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-212	0.0216	±	0.0096	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-214	0.0183	±	0.0058	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ce-144		<	0.0054	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-58		<	0.00059	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-60		<	0.0019	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-134		<	0.00082	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-137	0.00303	±	0.00074	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-152		<	0.0017	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-154		<	0.00073	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-155		<	0.0034	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-129		<	0.0034	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-131		<	0.00061	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-133		<	0.00037	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	K-40	0.488	±	0.036	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Mn-54		<	0.0012	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Nb-95		<	0.0011	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Np-237		<	0.0032	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-233		<	0.00083	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-234m		<	0.11	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-210		<	0.028	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-212	0.0198	±	0.0020	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-214	0.0142	±	0.0024	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ra-226		<	0.050	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ru-106		<	0.0082	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-124		<	0.00055	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-125		<	0.0034	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Te-123m		<	0.00078	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Th-234	0.046	±	0.022	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Tl-208	0.0081	±	0.0014	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	U-235		<	0.0029	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Zn-65		<	0.0021	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.195	±	0.064	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.532	±	0.051	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Iron-55	01/10/2016	Fe-55		<	0.069	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Moisture Content	19/09/2016	Moisture content	9.6			%
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.20	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0015	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-239/240	0.00179	±	0.00076	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Strontium-90	06/10/2016	Sr-90		<	0.0061	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Total Tritium by Pyrolysis	16/09/2016	Total Tritium		<	0.022	Bq/g
L160331-1	BH1230 0.0-0.5m	SEDIMENT	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.11			
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Am-241		<	0.0014	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00099	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.0014	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	100	±	11	Bq/kg
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ac-228	0.0312	±	0.0057	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ag-110m		<	0.00088	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Am-241		<	0.0034	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Bi-212	0.0281	±	0.0095	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Bi-214	0.0223	±	0.0075	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ce-144		<	0.0016	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Co-58		<	0.00068	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Co-60		<	0.0013	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Cs-134		<	0.00057	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Cs-137	0.00244	±	0.00087	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-152		<	0.0013	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-154		<	0.00094	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-155		<	0.0051	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-129		<	0.0018	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-131		<	0.0011	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-133		<	0.00061	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	K-40	0.582	±	0.041	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Mn-54		<	0.0014	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Nb-95		<	0.00056	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Np-237		<	0.0035	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pa-233		<	0.00069	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pa-234m		<	0.066	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-210		<	0.021	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-212	0.0286	±	0.0024	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-214	0.0184	±	0.0025	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ra-226	0.025	±	0.012	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ru-106		<	0.012	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Sb-124		<	0.00057	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Sb-125		<	0.0030	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Te-123m		<	0.00055	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Th-234	0.038	±	0.023	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Tl-208	0.0095	±	0.0015	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	U-235	0.00122	±	0.00056	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Zn-65		<	0.0030	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.351	±	0.078	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.589	±	0.058	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Iron-55	01/10/2016	Fe-55		<	0.066	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Moisture Content	19/09/2016	Moisture content	4.5			%
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.16	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0016	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-239/240	0.00132	±	0.00067	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Strontium-90	06/10/2016	Sr-90		<	0.0064	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Total Tritium by Pyrolysis	17/09/2016	Total Tritium		<	0.022	Bq/g
L160331-2	BH1232 0.0-0.5m	SEDIMENT	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.05			
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Am-241	0.00121	±	0.00042	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00056	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.00070	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	140	±	15	Bq/kg
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ac-228	0.0218	±	0.0030	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ag-110m		<	0.00054	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Am-241		<	0.0027	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-212	0.0225	±	0.0076	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-214	0.0236	±	0.0059	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ce-144		<	0.037	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-58		<	0.0019	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-60		<	0.0025	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-134		<	0.00063	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-137	0.00296	±	0.00060	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-152		<	0.0018	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-154		<	0.00050	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-155		<	0.0030	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-129		<	0.0040	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-131		<	0.00082	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-133		<	0.00094	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	K-40	0.439	±	0.031	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Mn-54		<	0.0016	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Nb-95		<	0.00068	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Np-237		<	0.0031	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-233		<	0.0043	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-234m		<	0.078	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-210		<	0.030	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-212	0.0198	±	0.0018	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-214	0.0147	±	0.0024	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ra-226	0.024	±	0.012	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ru-106		<	0.020	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-124		<	0.00074	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-125		<	0.0016	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Te-123m		<	0.00050	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Th-234	0.033	±	0.017	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Tl-208	0.0074	±	0.0012	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	U-235	0.00118	±	0.00054	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Zn-65		<	0.0034	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.273	±	0.066	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.452	±	0.047	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Iron-55	02/10/2016	Fe-55		<	0.034	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Moisture Content	19/09/2016	Moisture content	11			%
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.29	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0020	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-239/240	0.00163	±	0.00085	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Strontium-90	06/10/2016	Sr-90	0.0083	±	0.0081	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Total Tritium by Pyrolysis	17/09/2016	Total Tritium		<	0.021	Bq/g
L160331-3	BH1235 0.0-0.4m	SEDIMENT	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.14			
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Am-241		<	0.00013	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00036	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.00014	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	90	±	9	Bq/kg
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ac-228	0.0349	±	0.0046	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ag-110m		<	0.00039	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Am-241		<	0.0017	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Bi-212	0.0281	±	0.0085	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Bi-214	0.0190	±	0.0060	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ce-144		<	0.057	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Co-58		<	0.0016	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Co-60		<	0.0011	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Cs-134		<	0.00043	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Cs-137		<	0.00086	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-152		<	0.00070	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-154		<	0.0012	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Eu-155		<	0.0036	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-129		<	0.0036	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-131		<	0.00086	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	I-133		<	0.0014	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	K-40	0.647	±	0.041	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Mn-54		<	0.0011	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Nb-95		<	0.00086	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Np-237		<	0.0056	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pa-233		<	0.0018	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pa-234m		<	0.088	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-210		<	0.025	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-212	0.0297	±	0.0023	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Pb-214	0.0191	±	0.0022	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ra-226	0.0285	±	0.0091	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Ru-106		<	0.020	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Sb-124		<	0.00085	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Sb-125		<	0.0027	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Te-123m		<	0.00067	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Th-234	0.025	±	0.018	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Tl-208	0.0092	±	0.0022	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	U-235	0.00138	±	0.00045	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	07/10/2016	Zn-65		<	0.0025	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.395	±	0.083	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.756	±	0.067	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Iron-55	02/10/2016	Fe-55		<	0.058	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Moisture Content	19/09/2016	Moisture content	12			%
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.14	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0015	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-239/240		<	0.0012	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Strontium-90	07/10/2016	Sr-90		<	0.0092	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Total Tritium by Pyrolysis	17/09/2016	Total Tritium		<	0.024	Bq/g
L160331-4	BH1236 0.6-0.8m	SEDIMENT	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.14			
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Am-241	0.00098	±	0.00039	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00042	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.00031	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	70	±	8	Bq/kg
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ac-228	0.0241	±	0.0035	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ag-110m		<	0.00054	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Am-241		<	0.0029	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-212	0.0196	±	0.0093	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-214	0.0147	±	0.0073	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ce-144		<	0.0014	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-58		<	0.0011	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-60		<	0.0012	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-134		<	0.00082	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-137	0.00483	±	0.00082	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-152		<	0.0017	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-154		<	0.00071	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-155		<	0.0035	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-129		<	0.0028	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-131		<	0.00073	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-133		<	0.00059	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	K-40	0.415	±	0.031	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Mn-54		<	0.0022	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Nb-95		<	0.00095	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Np-237		<	0.0036	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-233		<	0.00074	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-234m		<	0.11	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-210		<	0.027	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-212	0.0202	±	0.0019	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-214	0.0125	±	0.0020	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ra-226		<	0.021	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ru-106		<	0.014	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-124		<	0.00083	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-125		<	0.0048	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Te-123m		<	0.00089	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Th-234	0.043	±	0.020	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Tl-208	0.00669	±	0.00097	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	U-235		<	0.0012	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Zn-65		<	0.0039	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.276	±	0.068	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.479	±	0.048	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Iron-55	02/10/2016	Fe-55		<	0.043	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Moisture Content	19/09/2016	Moisture content	11			%
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.15	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0014	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Plutonium	11/10/2016	Pu-239/240		<	0.0014	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Strontium-90	07/10/2016	Sr-90		<	0.0075	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Total Tritium by Pyrolysis	28/09/2016	Total Tritium		<	0.022	Bq/g
L160331-5	BH1238 0.0-0.3m	SEDIMENT	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.17			
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Americium/Curium	14/10/2016	Am-241		<	0.00057	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Americium/Curium	14/10/2016	Cm-242		<	0.00061	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Americium/Curium	14/10/2016	Cm-243/244		<	0.0011	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Sulfur-35 (by ESG)	18/08/2016	S-35	90	±	9	Bq/kg
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ac-228	0.0274	±	0.0062	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ag-110m		<	0.00078	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Am-241		<	0.0030	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-212	0.033	±	0.011	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Bi-214	0.0204	±	0.0067	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ce-144		<	0.0073	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-58		<	0.00078	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Co-60		<	0.00094	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-134		<	0.00065	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Cs-137		<	0.0011	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-152		<	0.0016	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-154		<	0.0010	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Eu-155		<	0.0036	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-129		<	0.0024	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-131		<	0.0010	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	I-133		<	0.0012	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	K-40	0.595	±	0.040	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Mn-54		<	0.0023	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Nb-95		<	0.0011	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Np-237		<	0.0033	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-233		<	0.0025	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pa-234m		<	0.11	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-210		<	0.019	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-212	0.0262	±	0.0022	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Pb-214	0.0190	±	0.0045	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ra-226	0.0222	±	0.0096	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Ru-106		<	0.011	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-124		<	0.00052	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Sb-125		<	0.0040	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Te-123m		<	0.00081	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Th-234		<	0.028	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Tl-208	0.0091	±	0.0015	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	U-235	0.00108	±	0.00047	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	High Resolution Gamma Spectrometry	06/10/2016	Zn-65		<	0.0020	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.3	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.04	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Gross Alpha (as Am-241)	20/09/2016	Gross Alpha (as Am-241)	0.322	±	0.074	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Gross Beta (as K-40)	20/09/2016	Gross Beta (as K-40)	0.704	±	0.064	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Iron-55	02/10/2016	Fe-55		<	0.11	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Moisture Content	19/09/2016	Moisture content	0.049			%
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Plutonium-241	08/10/2016	Pu-241		<	0.14	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Plutonium	11/10/2016	Pu-238		<	0.0025	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Plutonium	11/10/2016	Pu-239/240		<	0.0016	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Strontium-90	07/10/2016	Sr-90		<	0.0060	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Total Tritium by Pyrolysis	28/09/2016	Total Tritium		<	0.023	Bq/g
L160331-6	BH1230 3.45-3.55m	ROCK	18/08/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.00			
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Am-241		<	0.00061	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Cm-242		<	0.00070	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Cm-243/244		<	0.0011	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Sulfur-35 (by ESG)	11/10/2016	S-35	60	±	6	Bq/kg
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ac-228	0.0448	±	0.0054	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ag-110m		<	0.00077	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Am-241		<	0.0017	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Bi-212	0.042	±	0.011	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Bi-214	0.0250	±	0.0087	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ce-144		<	0.069	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Co-58		<	0.00091	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Co-60		<	0.0012	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Cs-134		<	0.00087	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Cs-137		<	0.0012	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-152		<	0.0016	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-154		<	0.00070	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-155		<	0.0040	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-129		<	0.0018	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-131		<	0.0014	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-133		<	0.0014	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	K-40	0.754	±	0.049	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Mn-54		<	0.0014	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Nb-95		<	0.00065	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Np-237		<	0.0042	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pa-233		<	0.0023	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pa-234m		<	0.16	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-210		<	0.036	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-212	0.0409	±	0.0031	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-214	0.0214	±	0.0029	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ra-226	0.031	±	0.013	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ru-106		<	0.016	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Sb-124		<	0.00085	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Sb-125		<	0.0022	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Te-123m		<	0.00091	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Th-234		<	0.043	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Tl-208	0.0129	±	0.0015	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	U-235	0.00150	±	0.00059	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Zn-65		<	0.0012	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.1	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.03	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Gross Alpha (as Am-241)	18/10/2016	Gross Alpha (as Am-241)	0.438	±	0.088	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Gross Beta (as K-40)	18/10/2016	Gross Beta (as K-40)	0.858	±	0.053	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Iron-55	29/10/2016	Fe-55		<	0.075	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Moisture Content	21/10/2016	Moisture content	0.62			%
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Plutonium-241	30/10/2016	Pu-241		<	0.17	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Plutonium	30/10/2016	Pu-238		<	0.0016	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Plutonium	30/10/2016	Pu-239/240		<	0.00064	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Strontium-90	04/11/2016	Sr-90		<	0.0081	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Total Tritium by Pyrolysis	25/10/2016	Total Tritium		<	0.017	Bq/g
L160402-1	BH1215 5.20-5.50m	ROCK	11/10/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.01			
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Am-241		<	0.00042	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Cm-242		<	0.00060	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Americium/Curium	03/11/2016	Cm-243/244		<	0.00072	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Sulfur-35 (by ESG)	11/10/2016	S-35	90	±	9	Bq/kg
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ac-228	0.0400	±	0.0040	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ag-110m		<	0.00079	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Am-241		<	0.0028	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Bi-212	0.0465	±	0.0095	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Bi-214	0.0224	±	0.0052	Bq/g

Laboratory Reference	Client Reference	Sample Type	Sampling Date	Analysis	Reference Date	Determinand	Result			Units
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ce-144		<	0.0038	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Co-58		<	0.0021	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Co-60		<	0.0013	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Cs-134		<	0.00068	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Cs-137		<	0.00084	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-152		<	0.0018	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-154		<	0.0013	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Eu-155		<	0.0042	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-129		<	0.00077	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-131		<	0.00097	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	I-133		<	0.00062	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	K-40	0.781	±	0.050	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Mn-54		<	0.0012	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Nb-95		<	0.00097	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Np-237		<	0.0034	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pa-233		<	0.0017	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pa-234m		<	0.29	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-210		<	0.025	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-212	0.0382	±	0.0029	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Pb-214	0.0221	±	0.0034	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ra-226	0.0236	±	0.0085	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Ru-106		<	0.011	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Sb-124		<	0.00082	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Sb-125		<	0.0086	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Te-123m		<	0.00083	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Th-234	0.052	±	0.024	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Tl-208	0.0125	±	0.0015	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	U-235	0.00114	±	0.00042	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	High Resolution Gamma Spectrometry	26/10/2016	Zn-65		<	0.0013	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Calcium-45 (by GAU)	18/10/2016	Ca-45		<	0.2	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Carbon-14 (by GAU)	18/10/2016	C-14		<	0.01	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Nickel-63 (by GAU)	18/10/2016	Ni-63		<	0.03	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Gross Alpha (as Am-241)	18/10/2016	Gross Alpha (as Am-241)	0.396	±	0.079	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Gross Beta (as K-40)	18/10/2016	Gross Beta (as K-40)	0.813	±	0.051	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Iron-55	30/10/2016	Fe-55		<	0.094	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Moisture Content	21/10/2016	Moisture content	0.15			%
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Plutonium-241	30/10/2016	Pu-241		<	0.18	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Plutonium	30/10/2016	Pu-238		<	0.0015	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Plutonium	30/10/2016	Pu-239/240		<	0.00092	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Strontium-90	04/11/2016	Sr-90		<	0.0094	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Total Tritium by Pyrolysis	25/10/2016	Total Tritium		<	0.017	Bq/g
L160402-2	BH1219 13.55-13.70m	ROCK	11/10/2016	Wet/Dry Ratio	18/10/2016	Wet/Dry Ratio	1.00			

GAU Radioanalytical Laboratories

UKAS TESTING 2758

Report

^{14}C, ^{45}Ca and ^{63}Ni analysis in eight solid samples

Sample IDs: L160331-1, L160331-2, L160331-3, etc…

Amec Foster Wheeler Nuclear UK Ltd

Customer	Amec Foster Wheeler Nuclear UK Ltd 305 Bridgewater Place Birchwood Park Warrington Cheshire WA3 6XG
Customer purchase order number	PO0008684-1 201394-AA-0003
GAU job / report number	GAU3614 (Issue 1)
Date samples received	18th October 2016
Report date	5th December 2016
Report produced by	Dr. Pawel Gaca (Senior Radiochemist, GAU-Radioanalytical)
Signed	
Report authorised by	Prof Phil Warwick (Deputy Director, GAU-Radioanalytical)
Signed	

COMMERCIAL IN CONFIDENCE

Report Summary

This report has been produced for Amec Foster Wheeler Nuclear UK Ltd and is commercial in confidence.

This report contains all results for job GAU3614.

Summary of reports issued for Job GAU3614

Report	Issue Date	Report content / Modification log
GAU3614 (Issue 1)	5th December 2016	All results for job GAU3614

Methodology

Sample Receipt

Eight sediment and rock samples were received by GAU-Radioanalytical on **18th October 2016** in good condition.

Sample Preparation

^{14}C analysis

Samples were analysed as received.

^{63}Ni analysis

Samples were dried at 105°C (overnight), ground using a TEMA mill prior to taking a sub-sample for analysis.

^{45}Ca analysis

The dried samples were further ignited at 900°C. A sub-sample of the ignited fraction was used for analysis.

^{14}C (GAU/RC/2022: Accredited to ISO/IEC 17025:2005)

An aliquot of the sample was progressively combusted to 900°C in a silica work tube using air/O_2 combustion/carrier gas. The combustion products were passed over a Pt-alumina catalyst and heated to 800°C to ensure the complete conversion of ^{14}C to $^{14}CO_2$. The $^{14}CO_2$ was then trapped in Carbontrap bubblers. The ^{14}C collected in the bubblers was measured using a Quantulus ultra-low level liquid scintillation counter.

^{45}Ca in solid samples (GAU/RC/2045)

An aliquot of the sample was removed for ^{41}Ca/^{45}Ca analysis and spiked with Ca carrier solution. The sub-sample was fused with lithium metaborate and the resulting glass dissolved and purified by Ca precipitation and extraction chromatography. The final purified fraction was measured using a Quantulus ultra-low level liquid scintillation counter. Recovery was determined via ion chromatographic measurement of stable Ca in the samples prior to and after the purification procedure.

^{63}Ni in solid samples (GAU/RC/2023: Accredited to ISO/IEC 17025:2005)

A sub-sample was spiked with stable Ni. Nickel was then separated by precipitation and further purified using a combination of extraction and ion exchange chromatography. Nickel-63 activity was determined by liquid scintillation counting. Chemical recovery was determined through the measurement of stable Ni prior to and following the chemical purification.

Limits of Detection

Limits of detection for radiochemical analyses are quoted as defined by Currie, 1968.

References

Currie L.A. (1968). Limits of qualitative detection and quantitative determination. *Analytical Chemistry, **40 (3),** 586-593.*

Samples and Results

Notes
No deviant samples identified.

Summary of samples

GAU ID	Customer ID	Sample type	Wet/dry ratio
GAU3614/1	L160331-1	Sediment	1.11
GAU3614/2	L160331-2	Sediment	1.05
GAU3614/3	L160331-3	Sediment	1.14
GAU3614/4	L160331-4	Sediment	1.14
GAU3614/5	L160331-5	Sediment	1.17
GAU3614/6	L160331-6	Rock	1.00
GAU3614/7	L160402-1	Rock	1.01
GAU3614/8	L160402-2	Rock	1.00

^{14}C*, ^{45}Ca, ^{63}Ni*

GAU ID	^{14}C*	+/-	^{45}Ca	+/-	^{63}Ni*	+/-
GAU3614/1	<0.01	-	<0.1	-	<0.04	-
GAU3614/2	<0.01	-	<0.1	-	<0.04	-
GAU3614/3	<0.01	-	<0.1	-	<0.04	-
GAU3614/4	<0.01	-	<0.1	-	<0.04	-
GAU3614/5	<0.01	-	<0.1	-	<0.04	-
GAU3614/6	<0.01	-	<0.3	-	<0.04	-
GAU3614/7	<0.01	-	<0.1	-	<0.03	-
GAU3614/8	<0.01	-	<0.2	-	<0.03	-
GAU3614/STD	N/A	N/A	49	3	71	7

*Indicates results obtained with accredited method.
Results for ^{14}C are quoted in Bq/g (as received).
Results for ^{45}Ca and ^{63}Ni are quoted in Bq/g (dry).
Uncertainties are based on combined standard uncertainties, coverage factor k=2 S.D.
Reference date: 18/10/2016

Expected QC standards concentrations (decay-corrected to the reference date):
^{45}Ca: 52.9 +/- 0.3 Bq/g
^{63}Ni: 71.9 +/- 0.7 Bq/g
Because of the analytical technique, no ^{14}C QC standard is run routinely alongside the samples. The pyrolisers' performance is periodically checked to determine the efficiency of the analysis.

End of Report

ESG
Environmental Scientifics Group

Test Report: **RT6392**

Analysis of Sediment and Rock samples for S-35

Prepared for Adrian Clacher

Amec Foster Wheeler Nuclear UK

December 2016

Analysis of Sediment and Rock samples for S-35

Customer: Adrian Clacher
Amec Foster Wheeler Nuclear UK Ltd
305 Bridgewater Place
Birchwood Park
Warrington
Cheshire, WA3 6XG

Testing Facility: ESG
Unit 12
Moorbrook
Southmead Industrial Park
Didcot
Oxon
OX11 7HP

Laboratory Reference:	RT6392
Customer Reference:	L160331-1
Quote Number:	ENR-ANU-8728
Samples Received:	18 October 2016
Condition:	Ambient/Satisfactory
Analysis Completed:	06 December 2016
Report Author:	
Author's name:	Gary Shaw
Job Title:	Senior Analyst
Approved by:	
Date:	7/12/16
Approver's name:	Trevor Harding
Job Title:	Senior Analyst
Report Date:	07 December 2016

UKAS TESTING
1015

Introduction

Eight sediment and rock samples were received from Amec Foster Wheeler on 18 October 2016. The samples were received in good condition. Accompanying instructions indicated the analysis required.

Sample Summary

Customer Reference	Laboratory Reference	Laboratory Determined Matrix	UKAS Accredited
L160331-1	RT6392	Sediment	YES
L160331-2	RT6393	Sediment	YES
L160331-3	RT6394	Sediment	YES
L160331-4	RT6395	Sediment	YES
L160331-5	RT6396	Sediment	YES
L160331-6	RT6397	Rock	NO
L160402-1	RT6398	Rock	NO
L160402-2	RT6399	Rock	NO

Experimental

The samples were prepared and analysed using the method summarised below.

Measurement of S-35 in aqueous samples, dried silts, sediments, soils, vegetation, fish and milk samples

The measurement of 35S activity in aqueous and solid environmental samples. The sample is oxidized by ashing in a muffle furnace in the presence of Benedict's reagent, which ensures the retention of volatile sulphur compounds. The residue is dissolved in dilute hydrochloric acid and interferences such as 90Sr removed by precipitation of carbonates. The sulphur is precipitated as barium sulphate by the addition of barium chloride. The barium sulphate is isolated by centrifugation and mixed with water and Instagel scintillant. The gel formed is counted on a liquid scintillation counter calibrated for the measurement of 35S.

Results

Results are presented in the following table. Result uncertainties for each analysis are stated in the results tables or beneath the tables where applicable.

Results for the samples are expressed as $Bq.kg^{-1}$ of dried and homogenised samples.

The results in this test report relate only to the items tested. This test report must not be reproduced except in full, without written approval of the laboratory. Any opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

UKAS TESTING
1015

Analysis of Sediment and Rock samples for S-35

Customer Reference	Laboratory Reference	Sulphur-35
L160331-1	RT6392	80 ±9
L160331-2	RT6393	100 ± 11
L160331-3	RT6394	140 ± 15
L160331-4	RT6395	90 ± 9
L160331-5	RT6396	70 ± 8
L160331-6	RT6397*	90 ± 9
L160402-1	RT6398*	60 ± 6
L160402-2	RT6399*	90 ± 9

Notes:

1. Results are presented as $Bq.kg^{-1}$ of dried and homogenised samples.
2. Uncertainties are quoted at 2SD based on expanded uncertainties.
3. An asterisk "*" indicates that the sample matrix/analysis is not covered under the UKAS of the laboratory with UKAS 1015.

UKAS TESTING
1015

Appendix 1-4 Figures

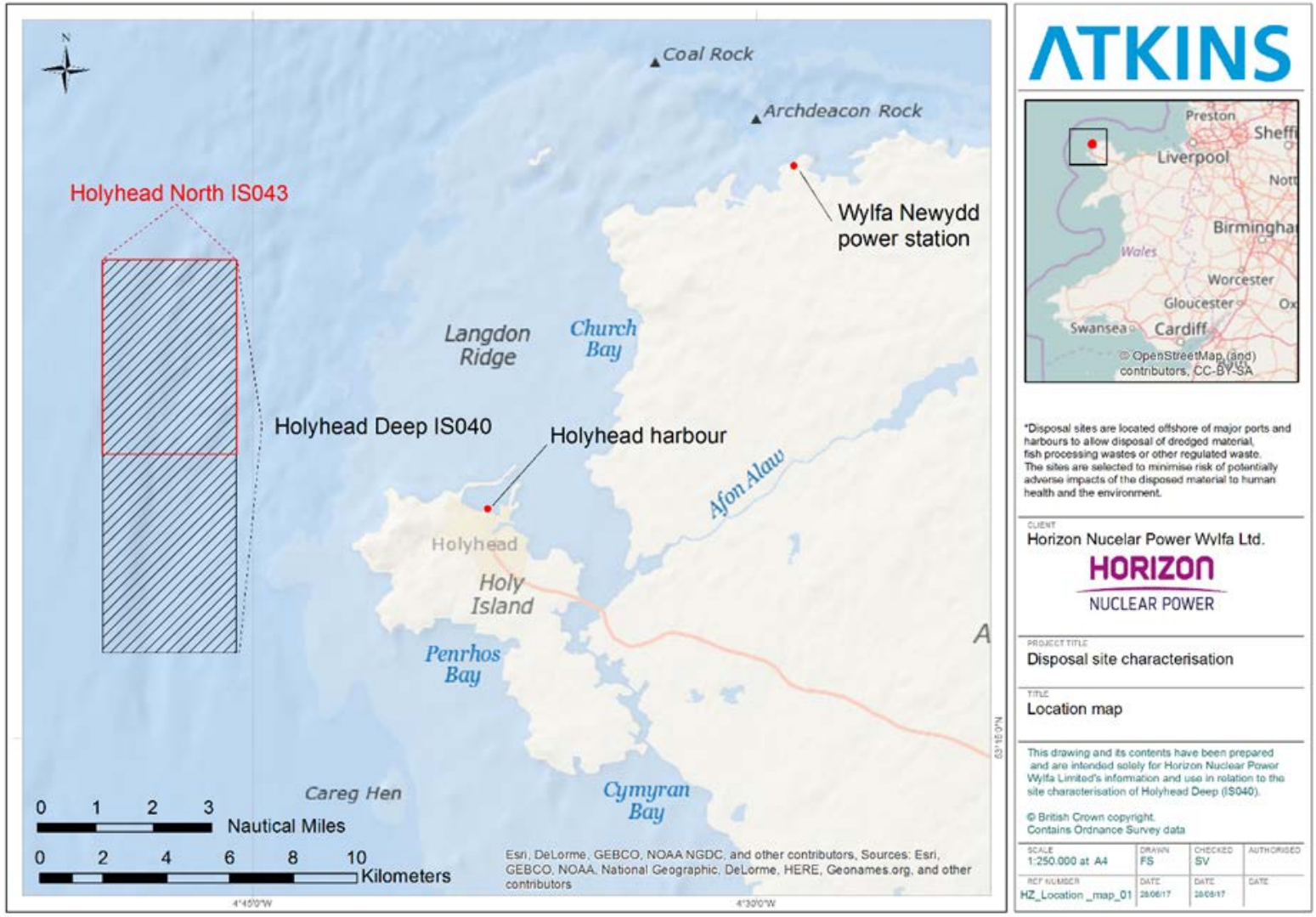

Figure 2-1 Location map of the Wylfa Newydd Project

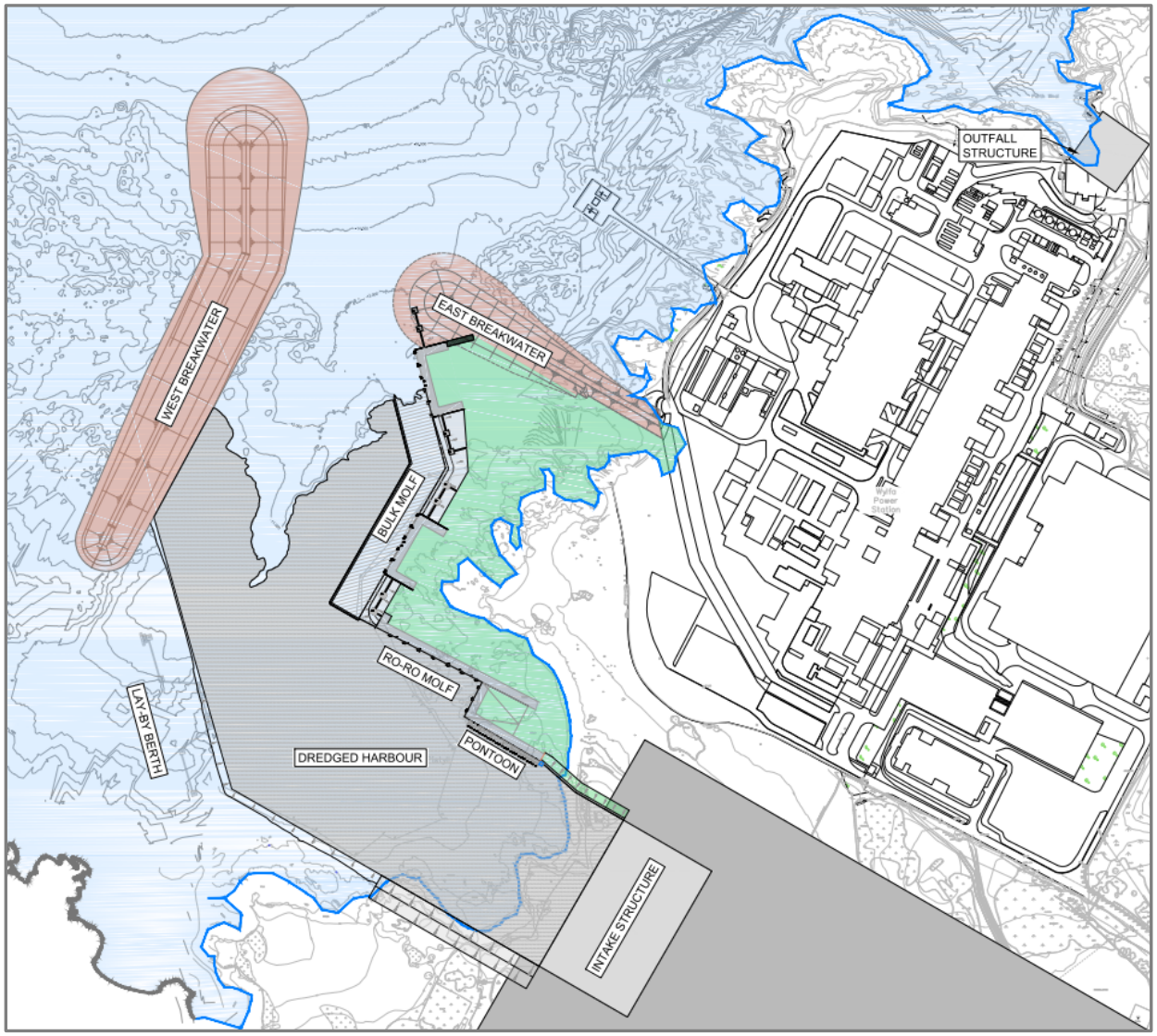

Figure 2-2 Schematic of the Wylfa Newydd Project marine works

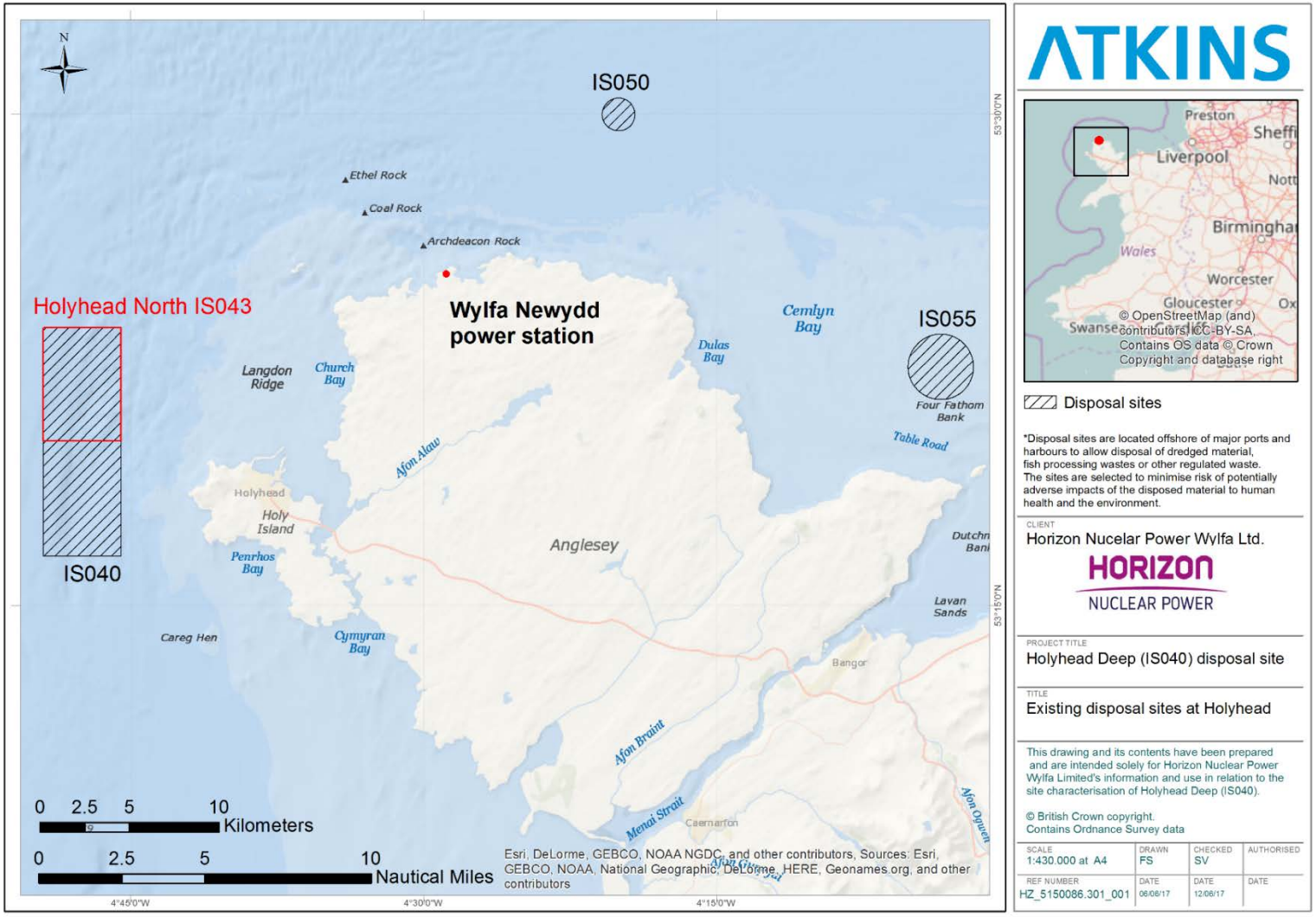

Figure 5-1 Disposal sites near to the Wylfa Newydd Development Area

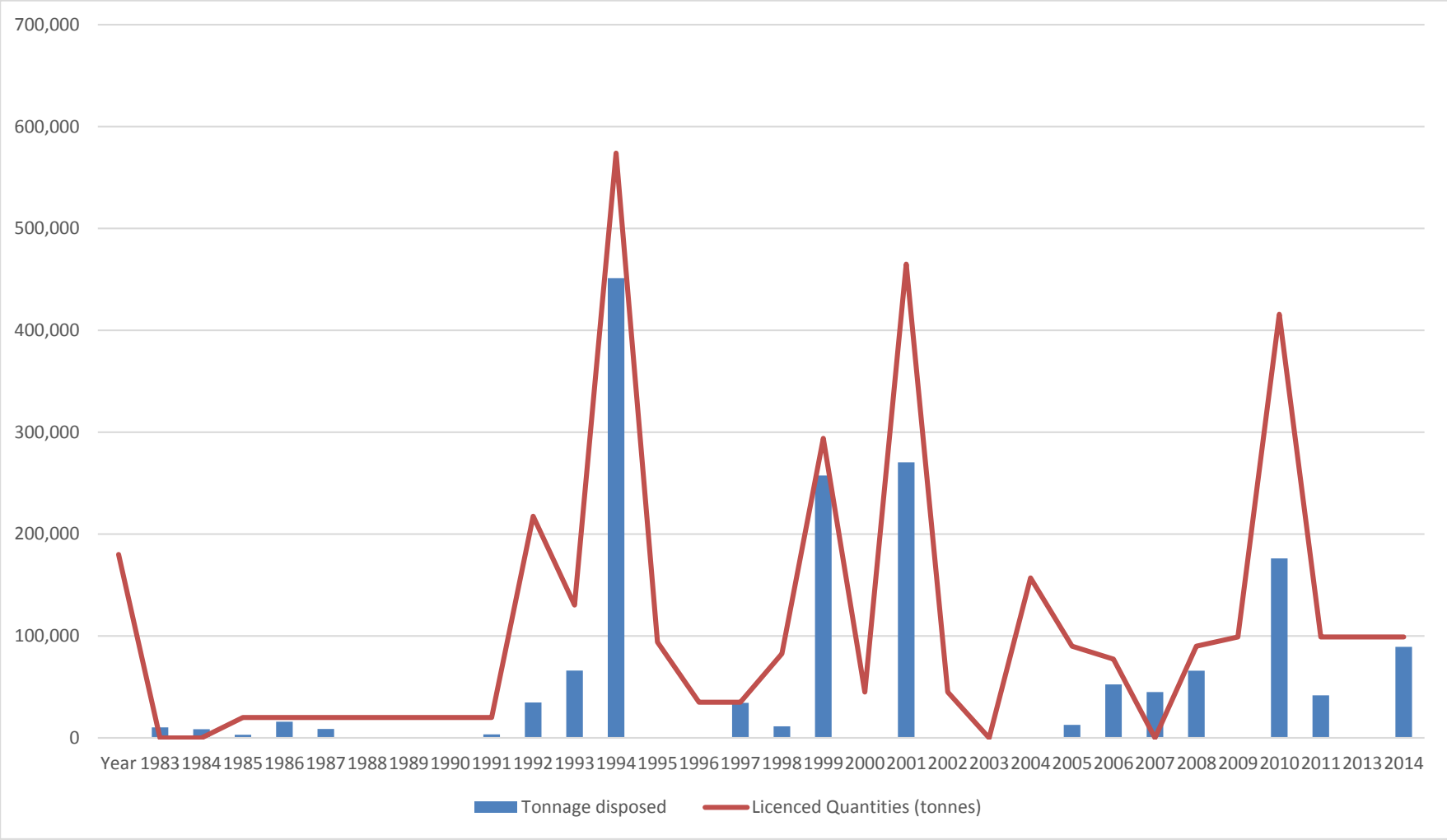

Figure 6-1 Holyhead Deep licensed and disposed quantities of material 1983-2015

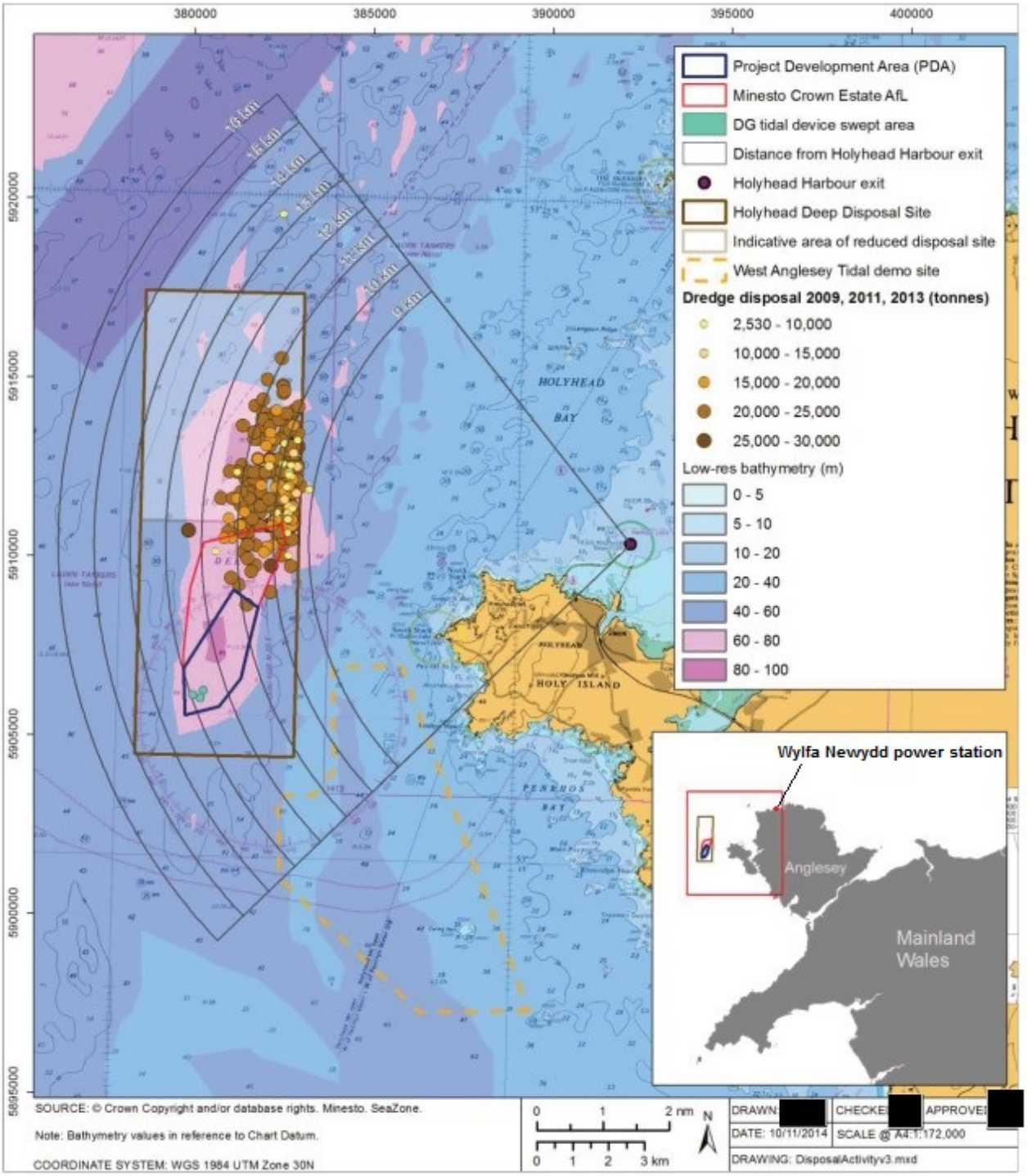

Figure 6-2 Holyhead Port dredged sediment disposal locations [RD7]

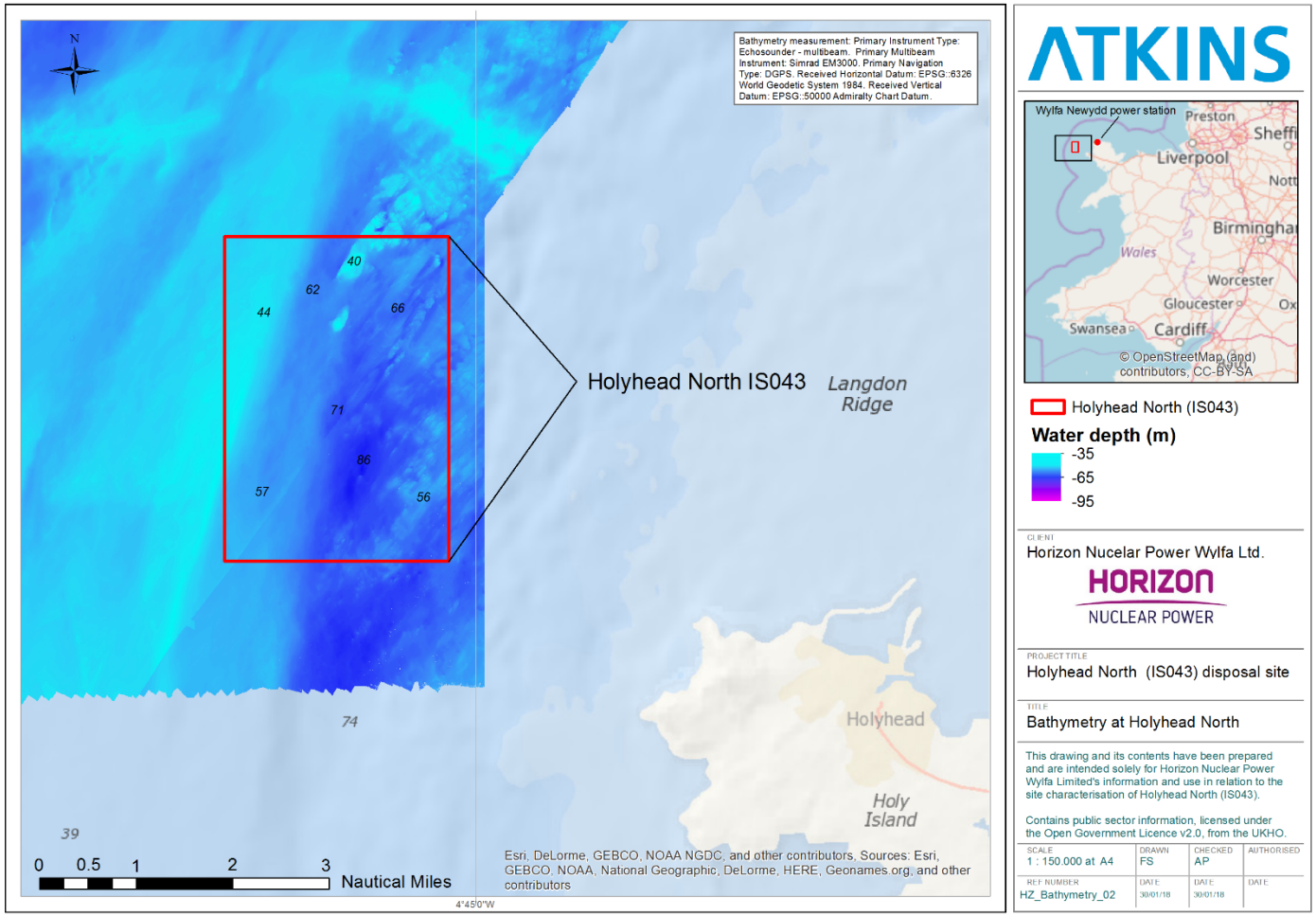

Figure 6-3 Bathymetry at Holyhead North disposal site

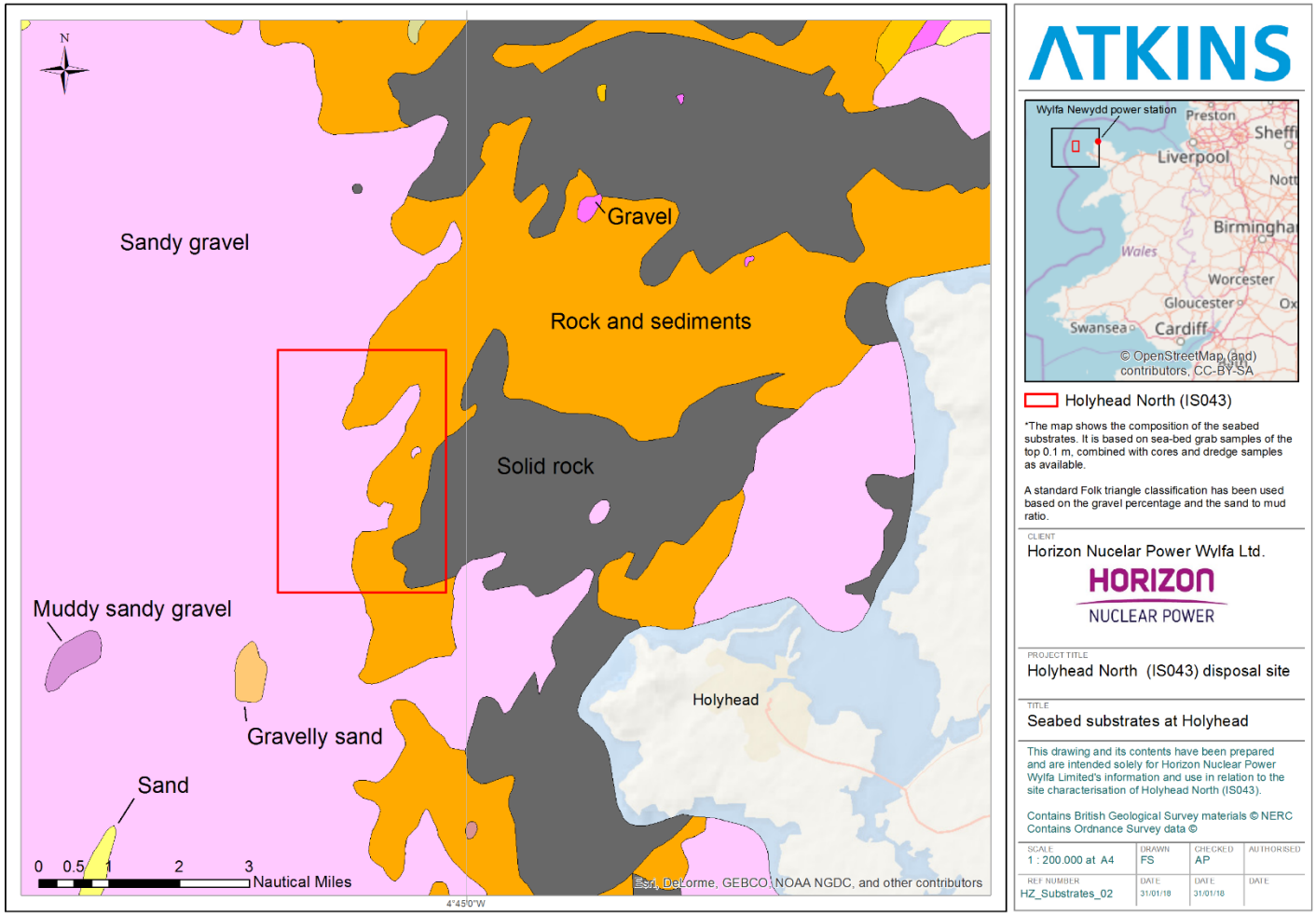

Figure 6-4 Seabed substrate of Holyhead North disposal site

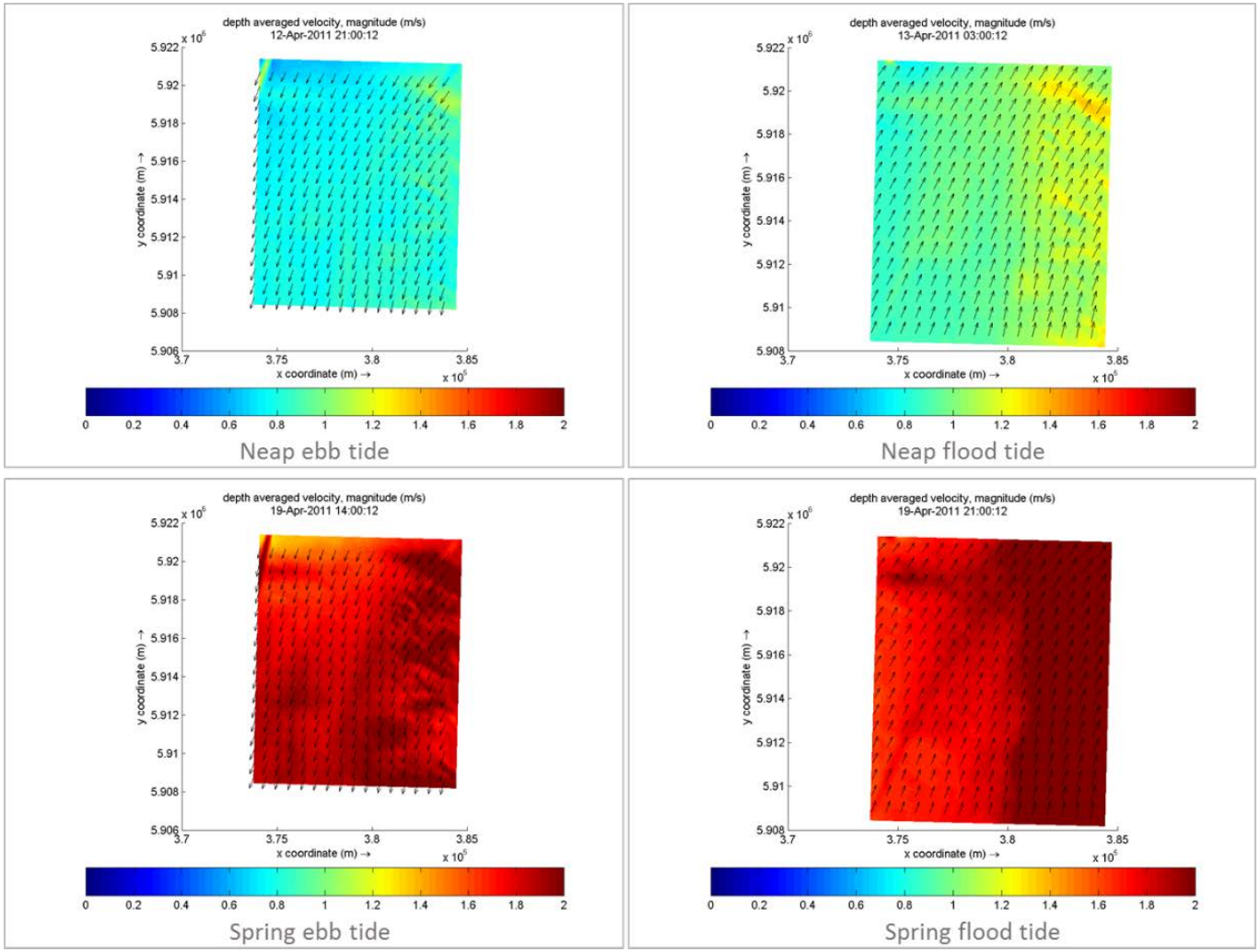

Figure 6-5 Holyhead North disposal site current velocities

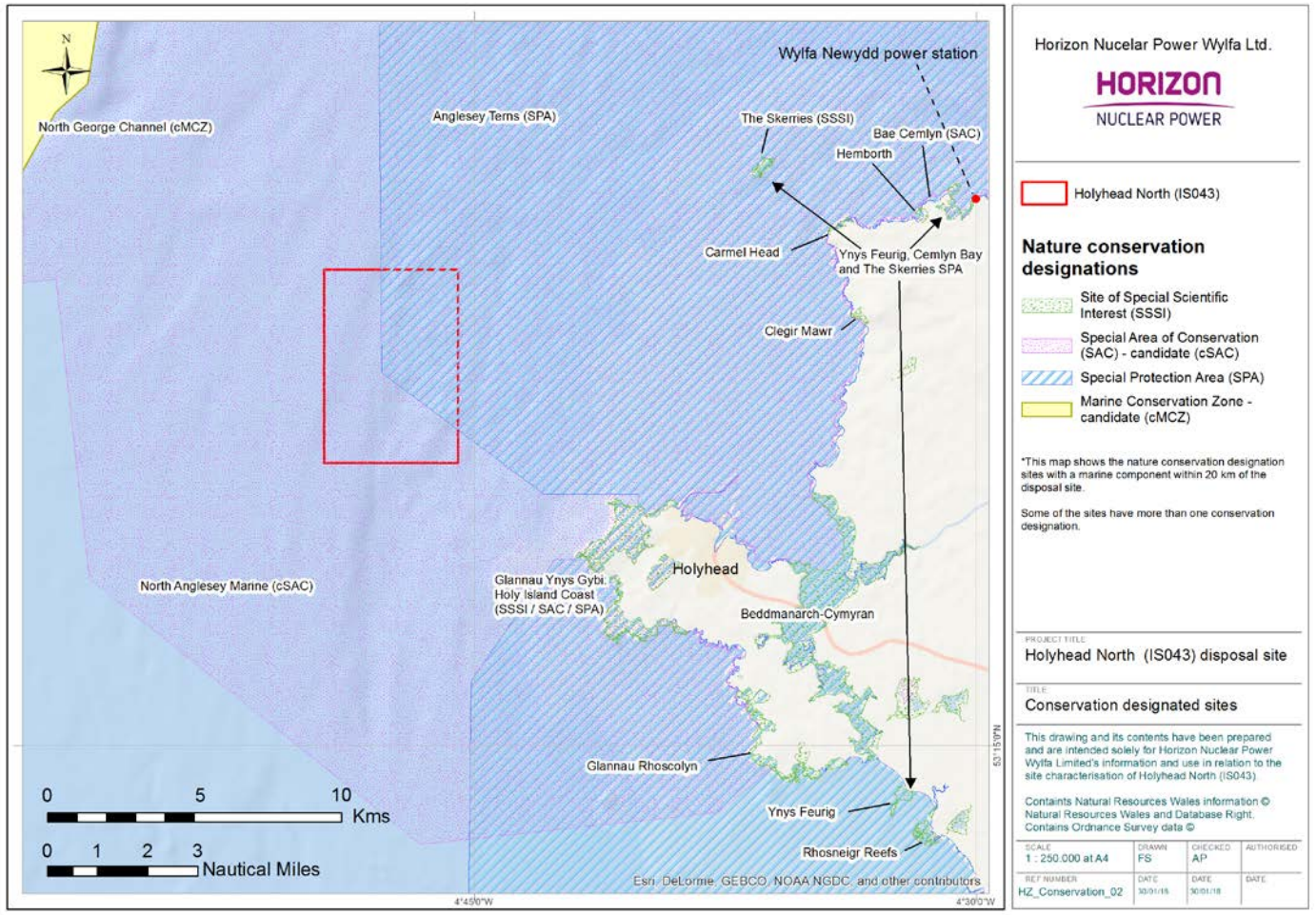

Figure 6-6 Designated conservation sites within 20km of Holyhead North disposal site

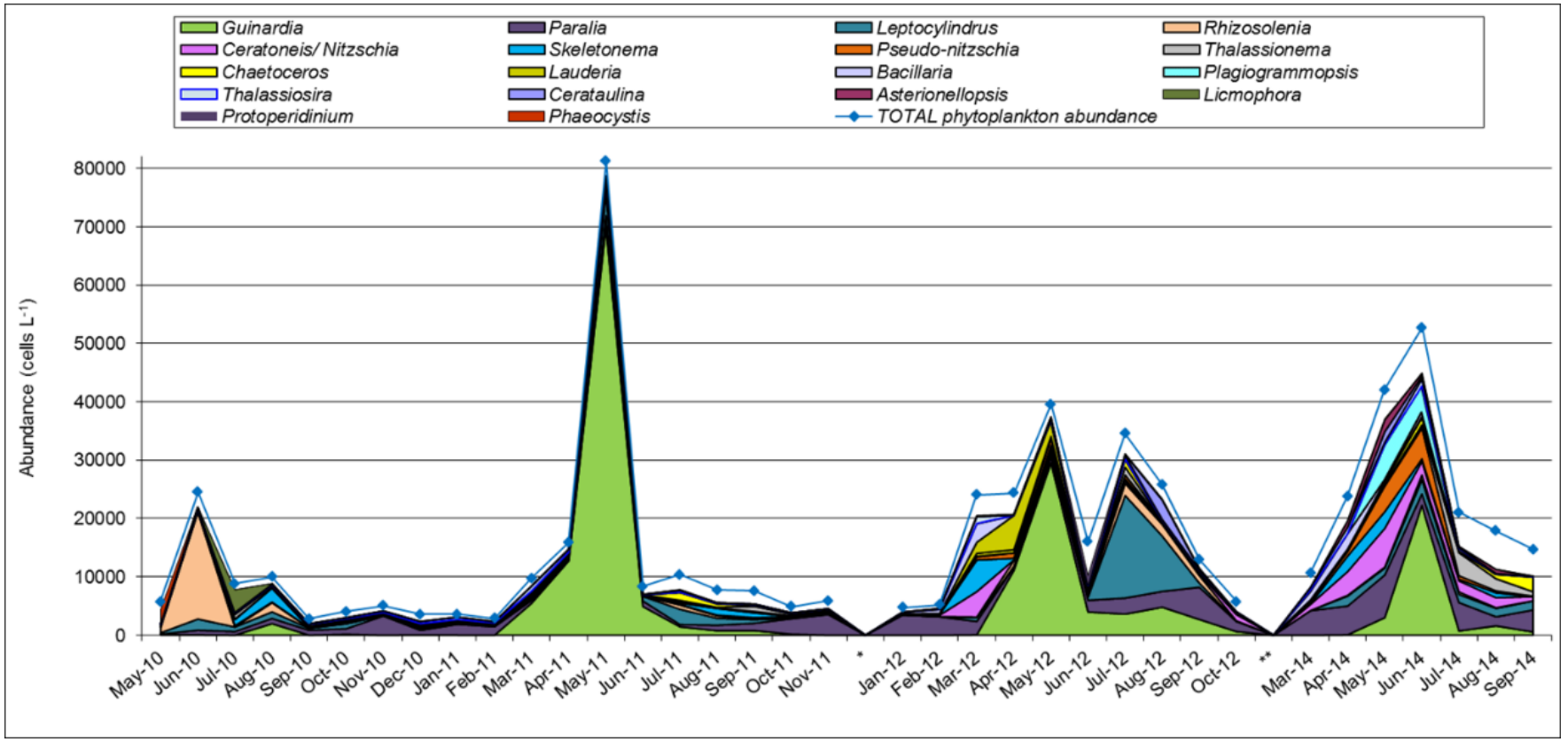

Figure 6-7 Main phytoplankton genera contributing to total phytoplankton abundance

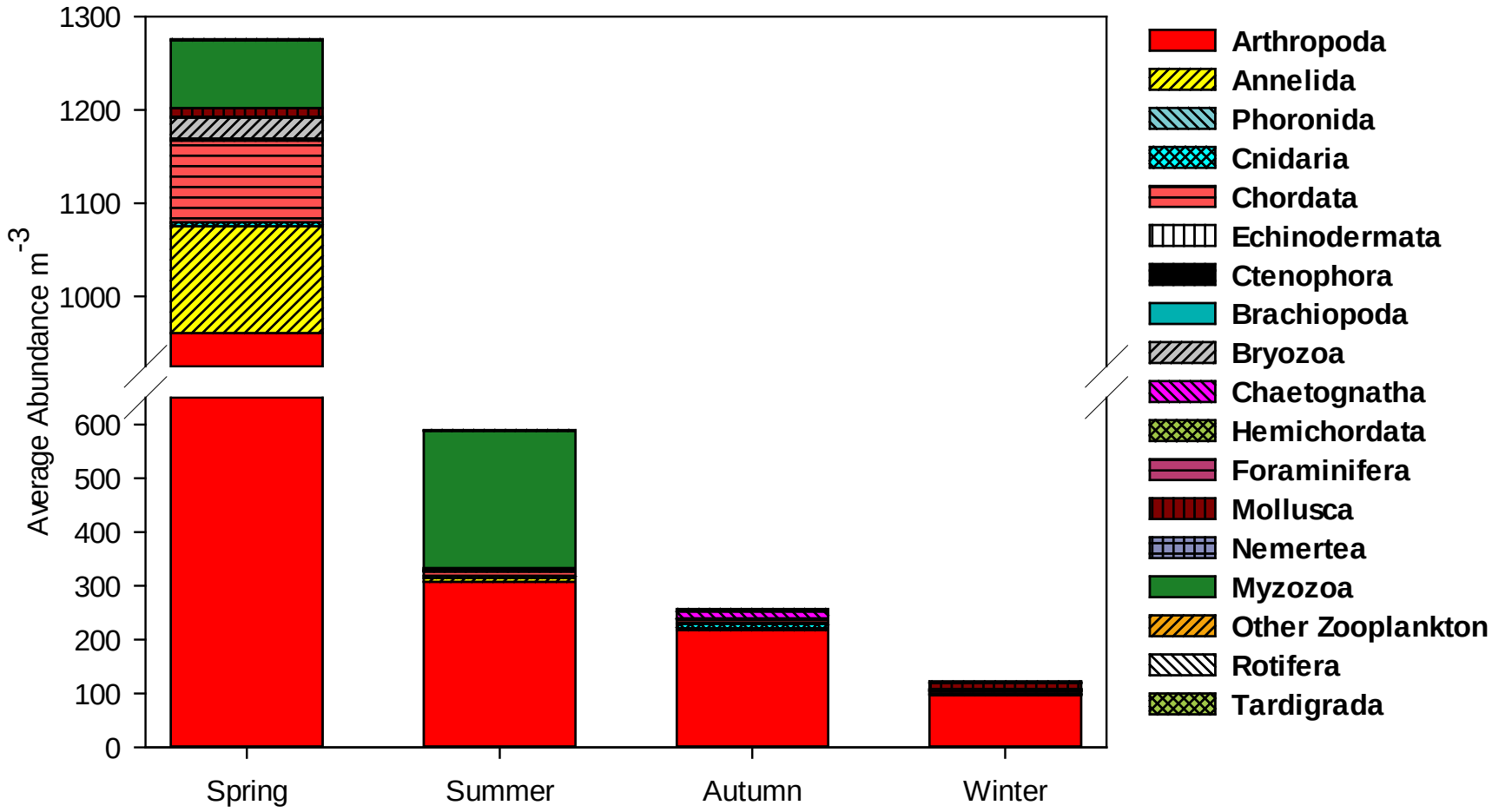

Figure 6-8 Seasonal representation by phylum of zooplankton recorded in surveys between May 2010 and June 2014

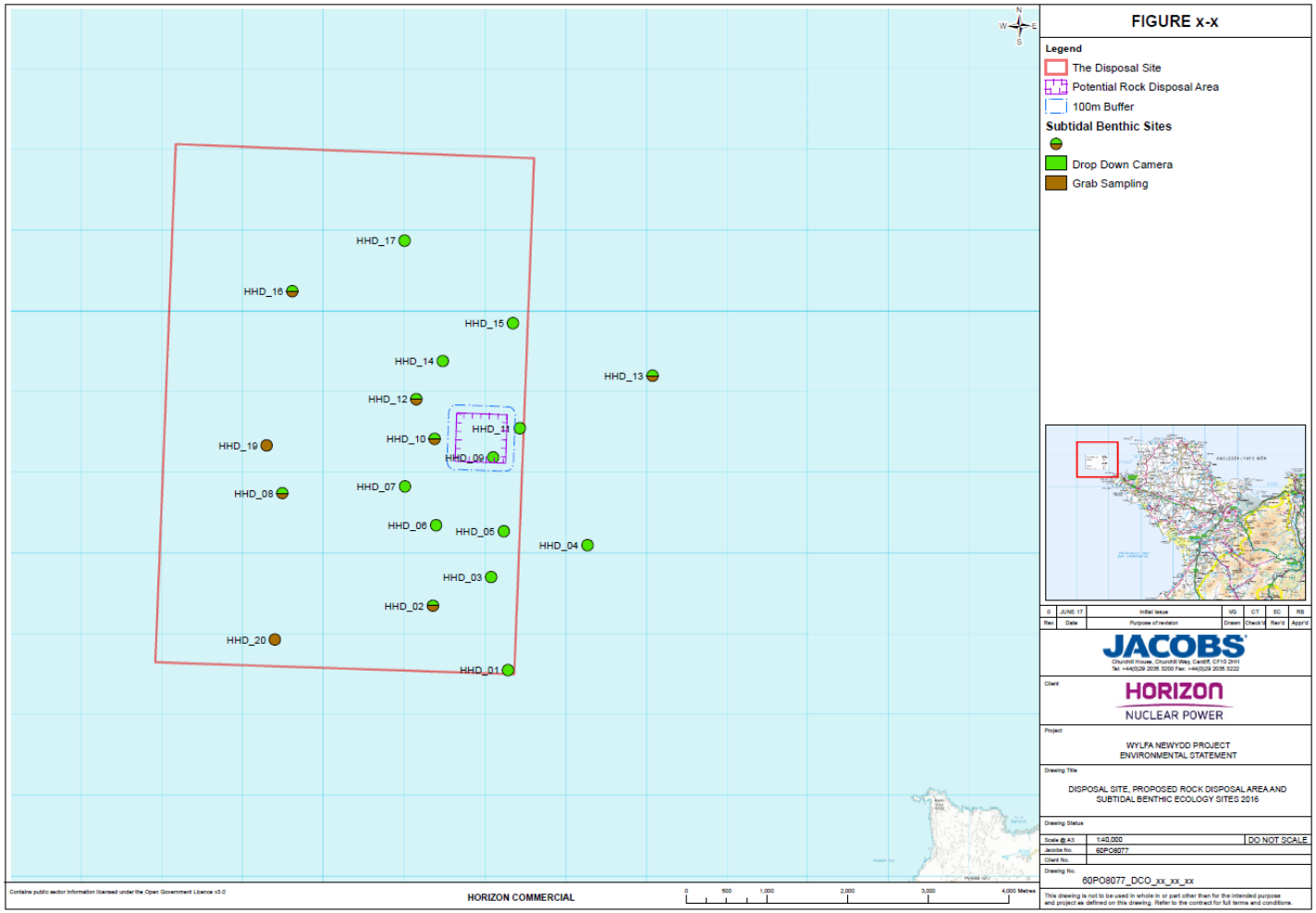

Figure 6-9 Holyhead North disposal site survey sampling stations

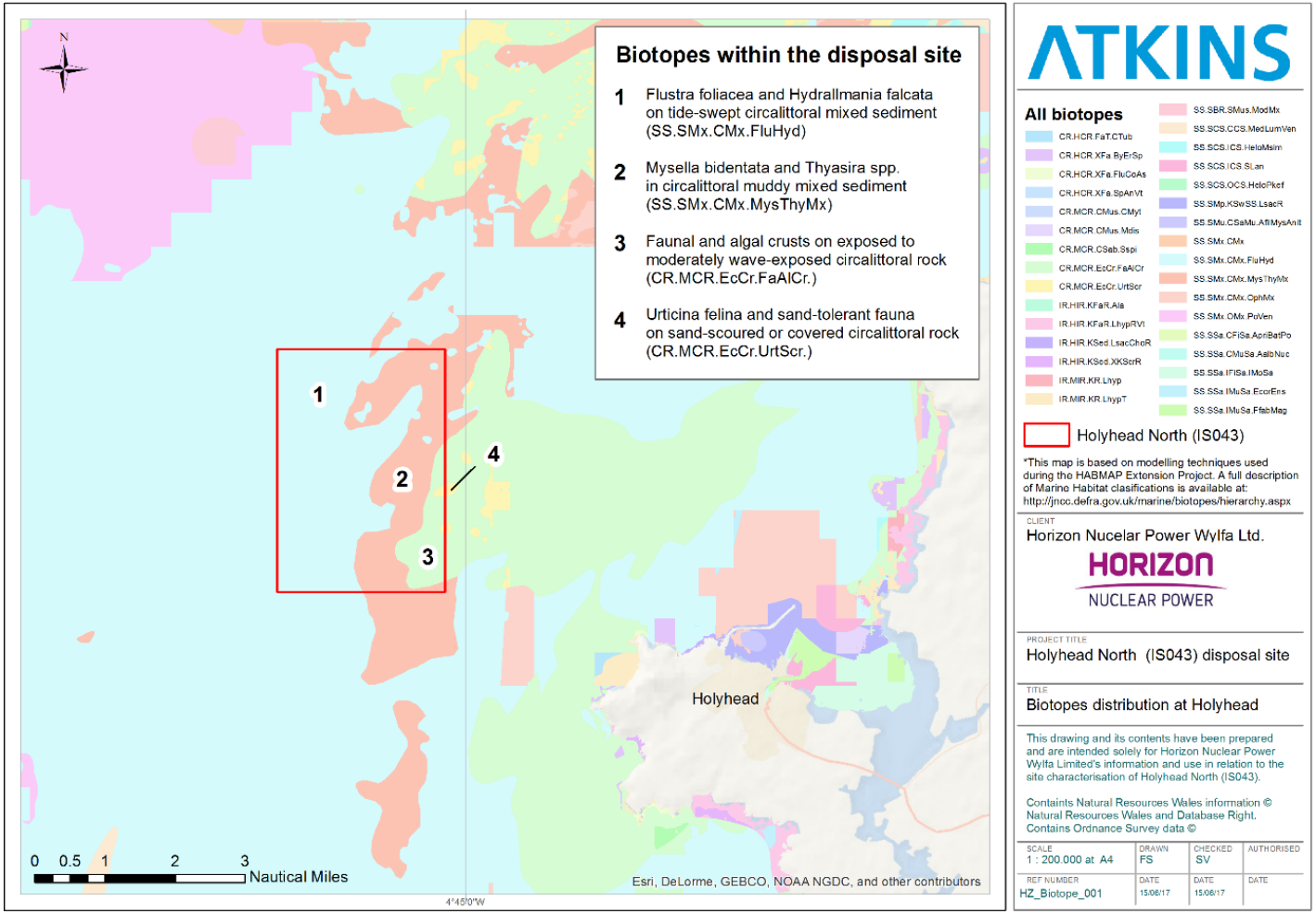

Figure 6-10 HABMAP predicted biotopes in Holyhead North disposal site

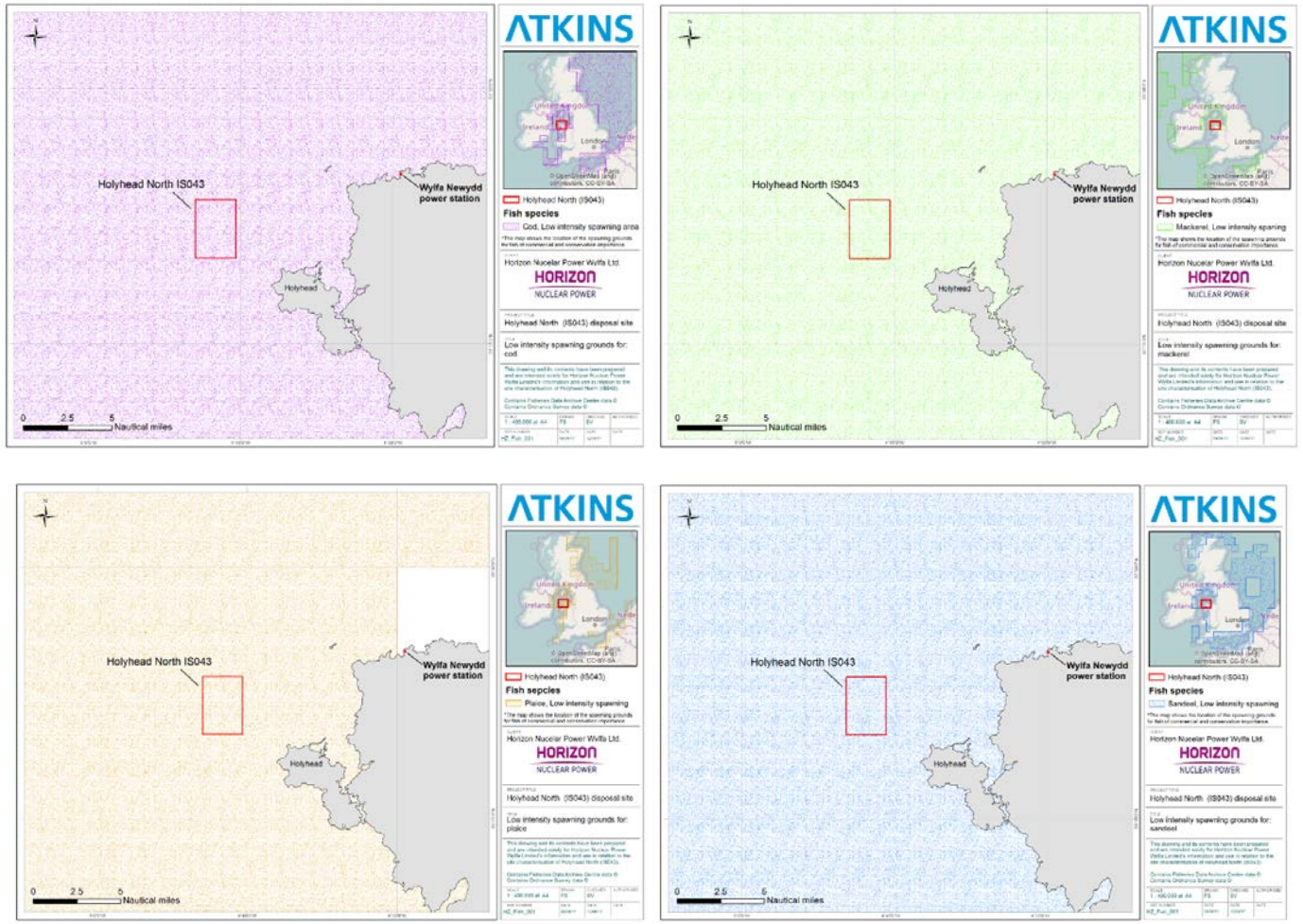

Figure 6-11 Spawning grounds for cod, mackerel, plaice and Sandeel [RD22]

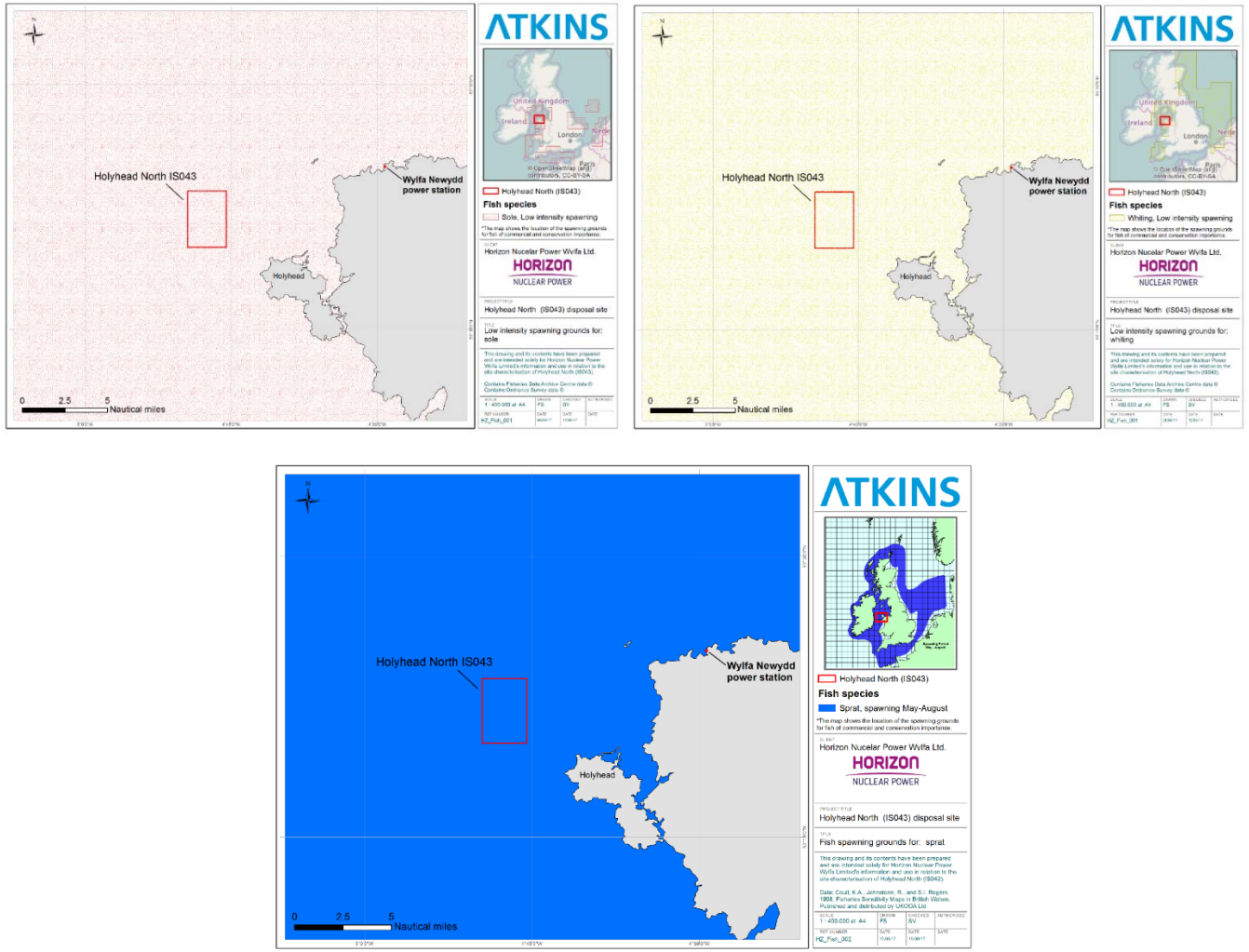

Figure 6-12 Spawning grounds for sole and whiting [RD22] and spawning ground for sprat [RD21]

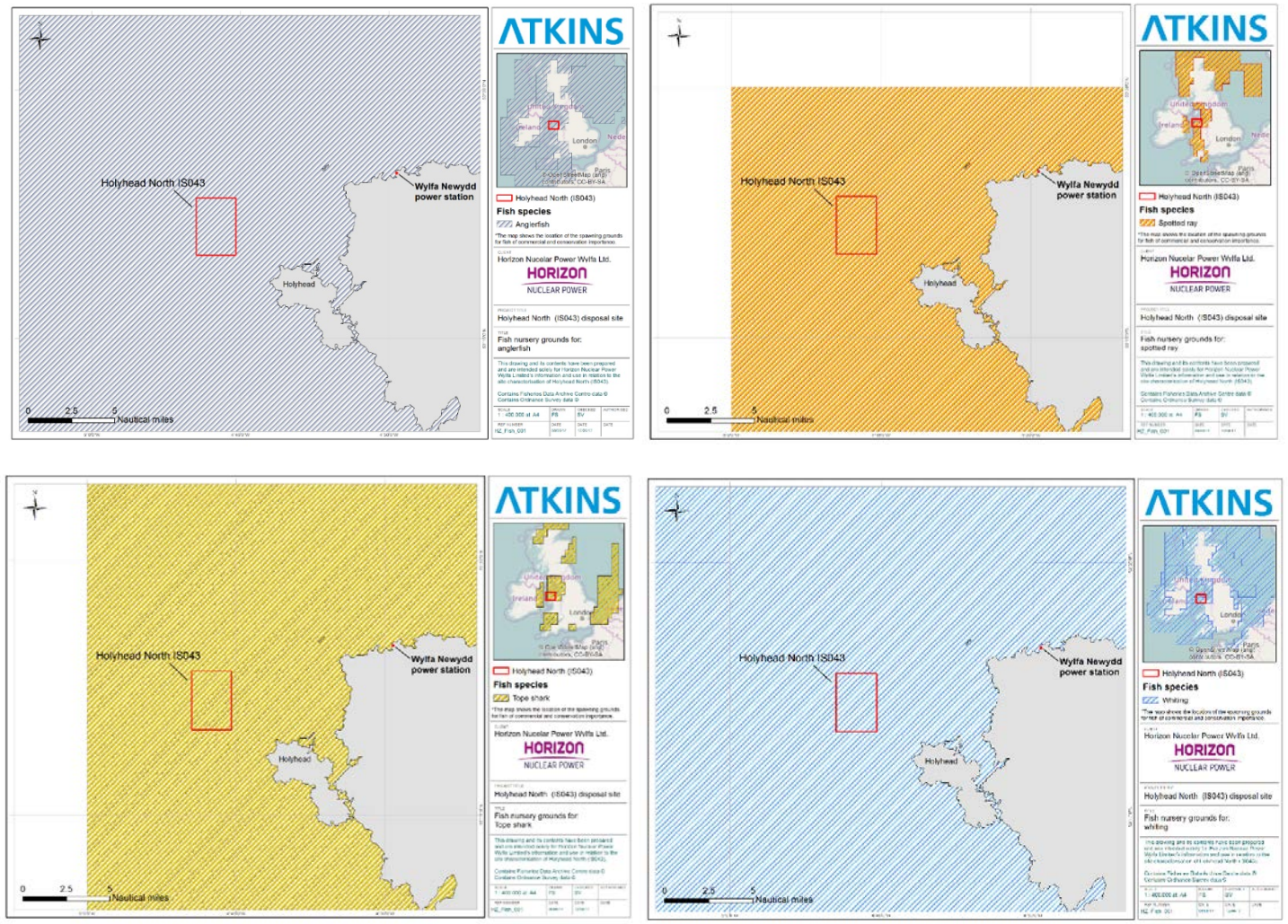

Figure 6-13 Nursery grounds for anglerfish, spotted ray, tope shark and whiting [RD22]

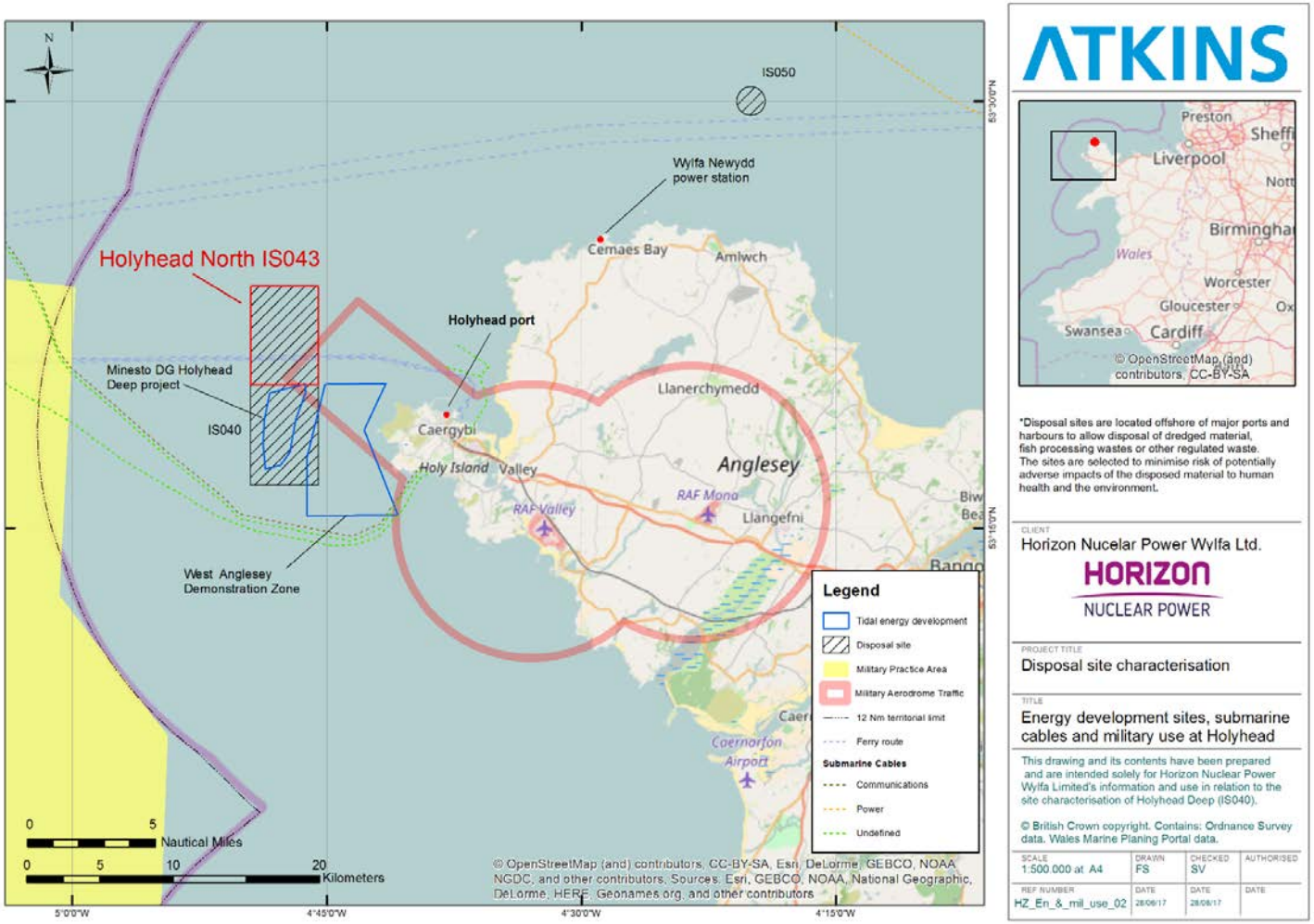

Figure 6-14 Infrastructure near to Holyhead North disposal site

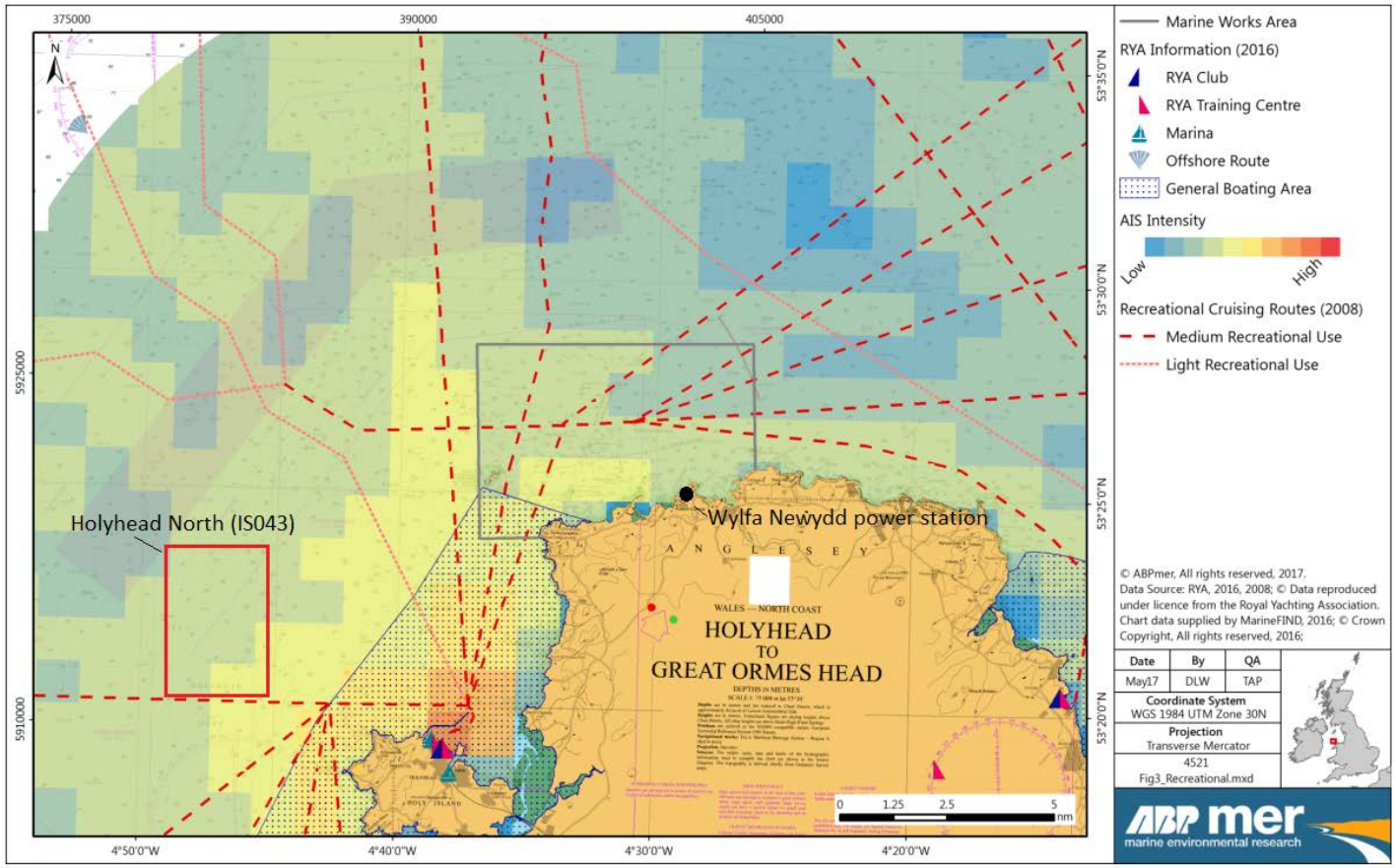

Figure 6-15 RYA recreational boating[1]

[1] This figure has been produced by ABPmer for the Wylfa Newydd Navigation Risk Assessment and has been reproduced and adapted for use in this report.

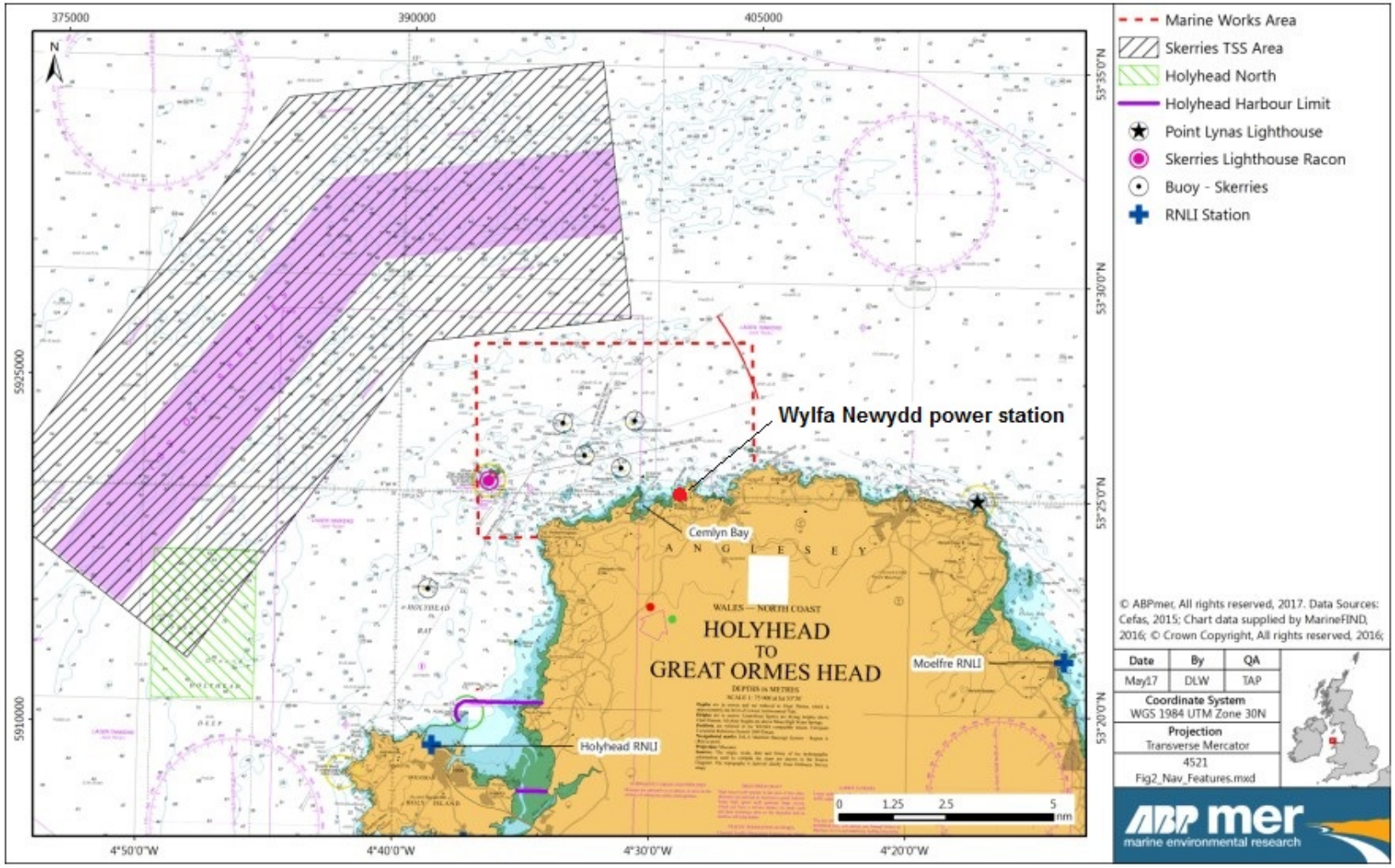

Figure 6-16 Navigation features[1]

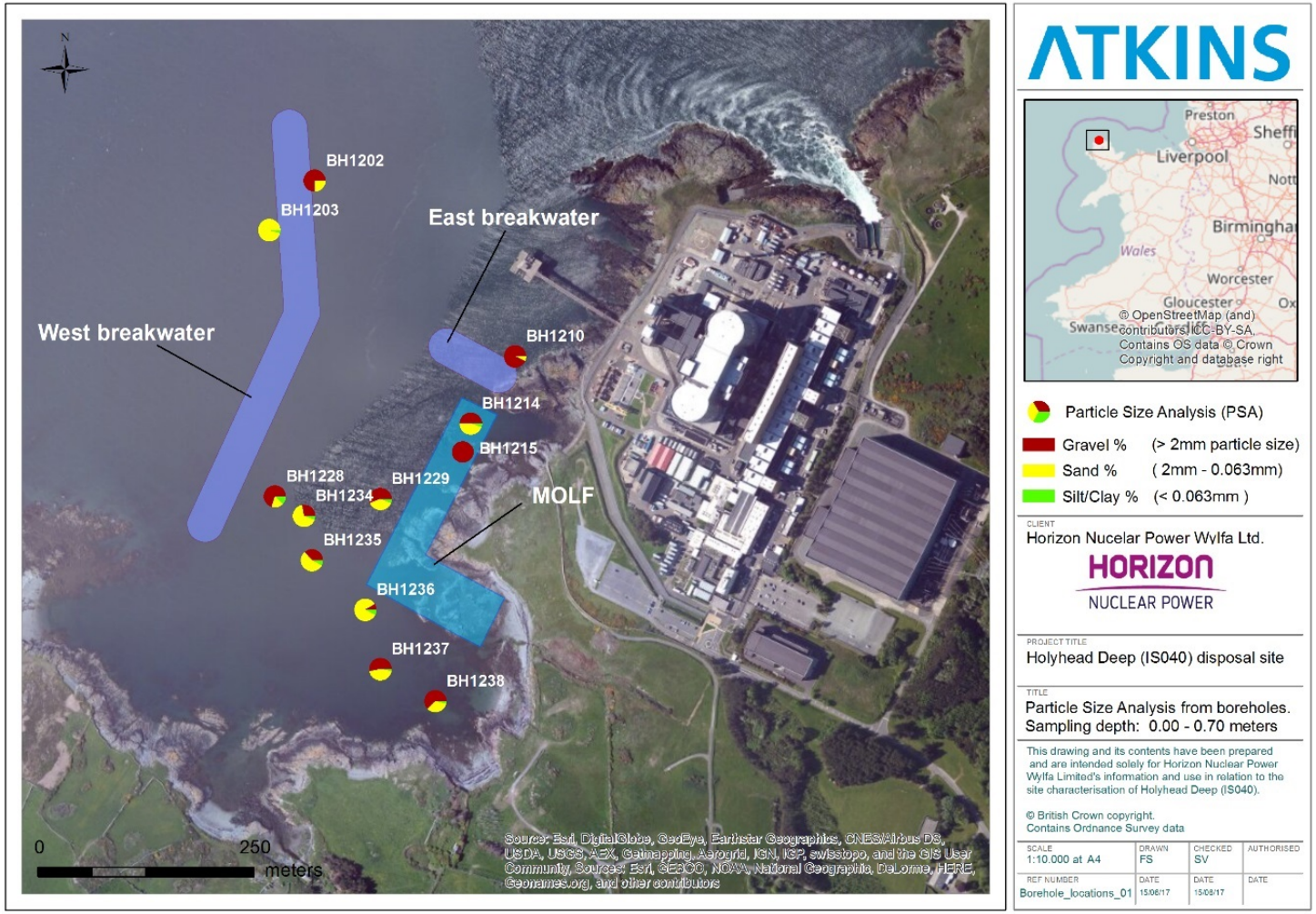

Figure 7-1 Particle size analysis results from 0-0.7m depth samples

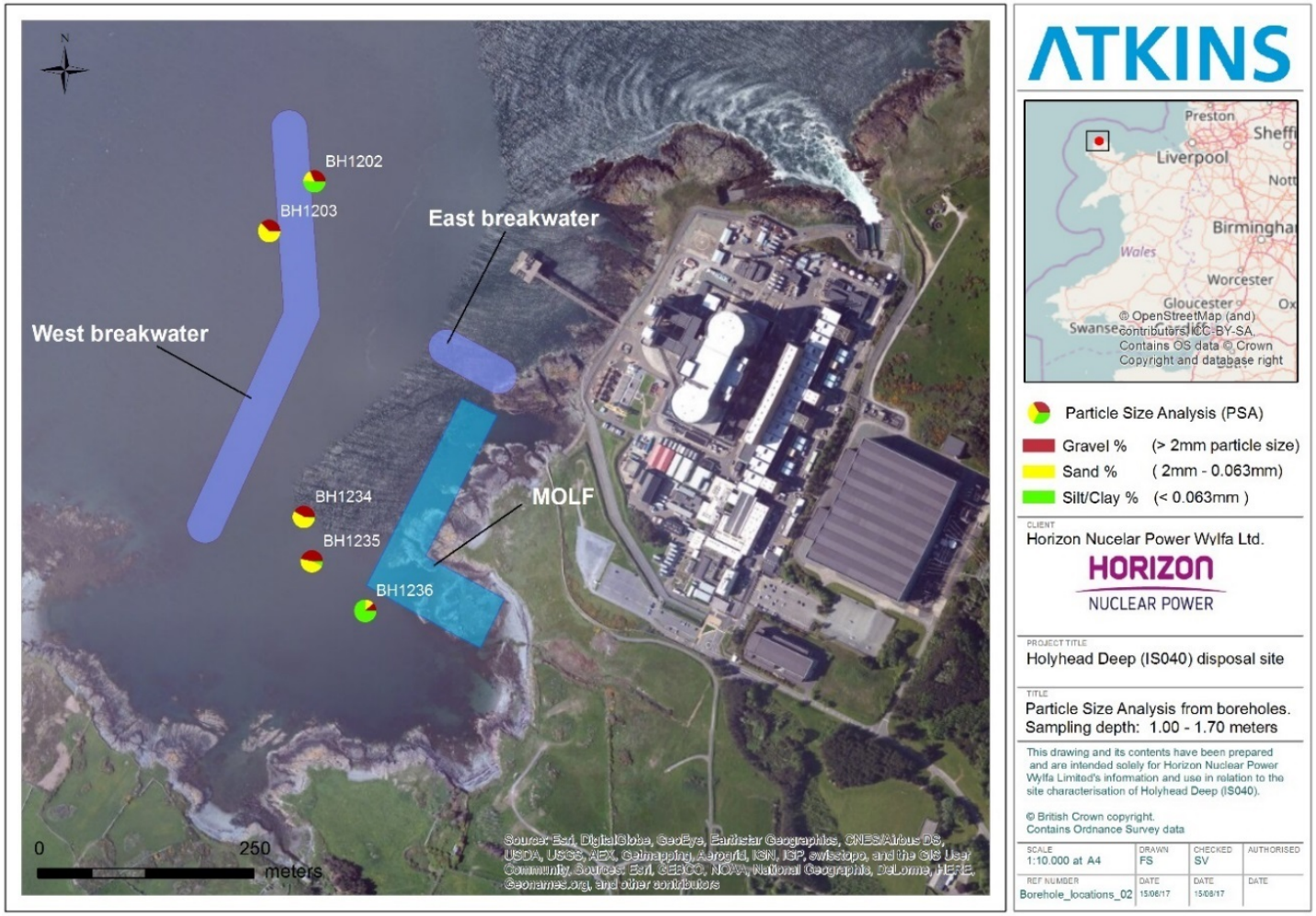

Figure 7-2 Particle size analysis results from 1-1.7m depth samples

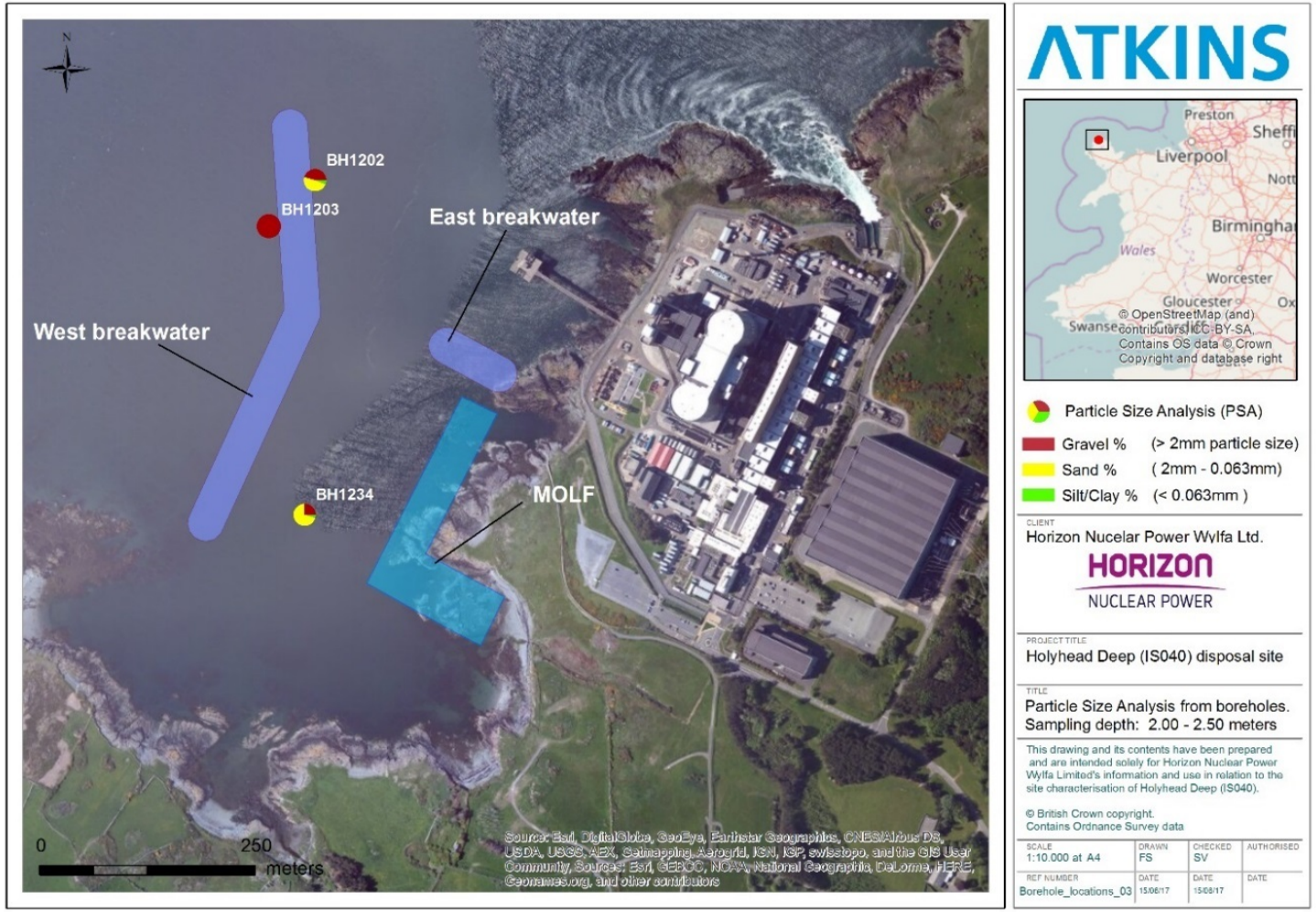

Figure 7-3 Particle size analysis results from 2-2.5m depth samples

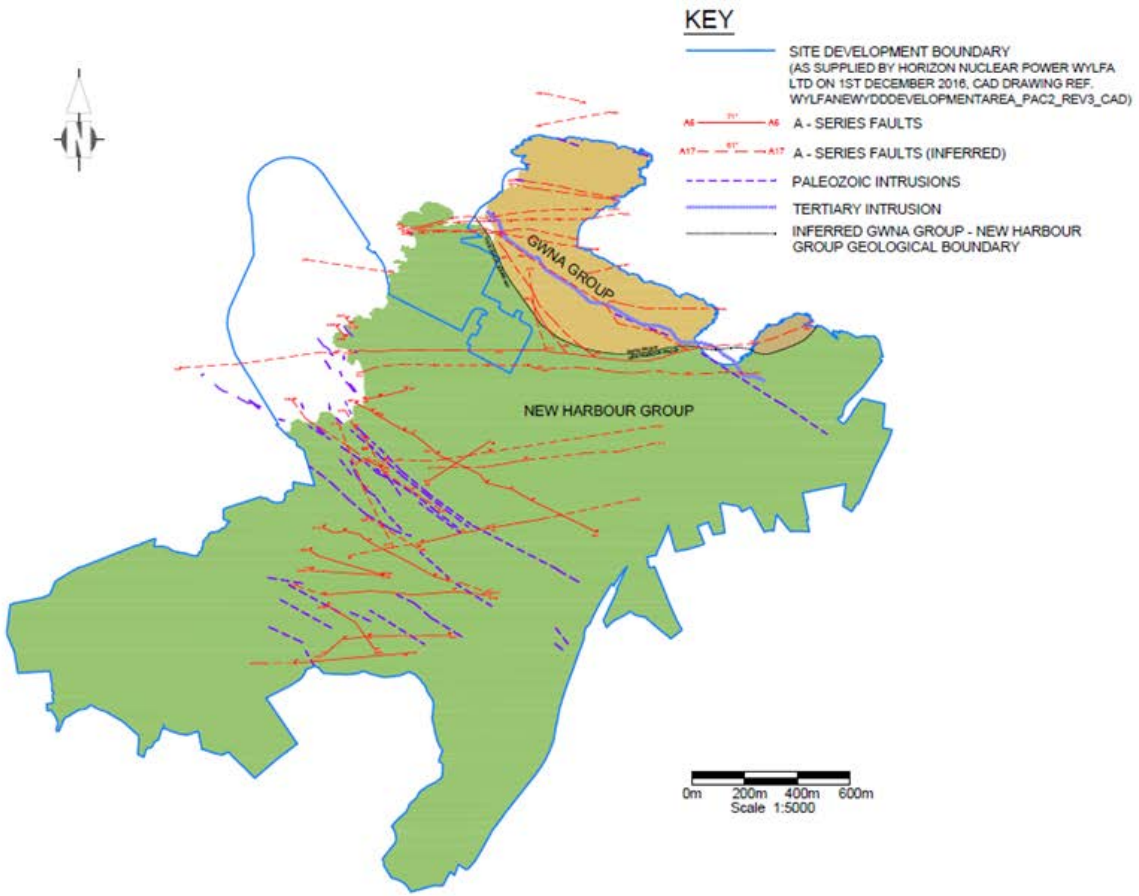

Figure 7-4 Wylfa Newydd Development Area site geology

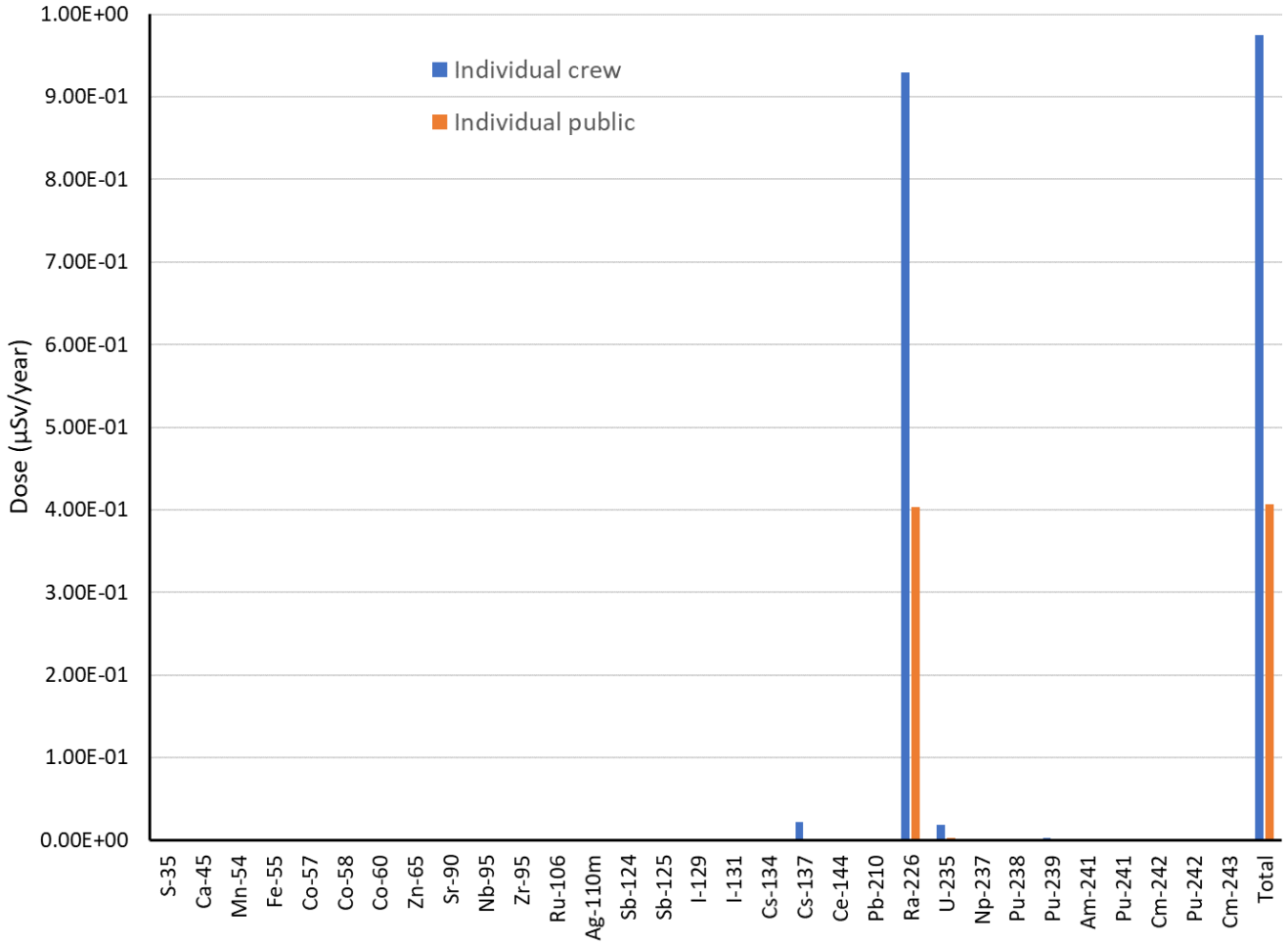

Figure 7-5 Assessment of dose to individual members of crew and the public arising from disposal of dredged sediment from the Wylfa Newydd Development Area

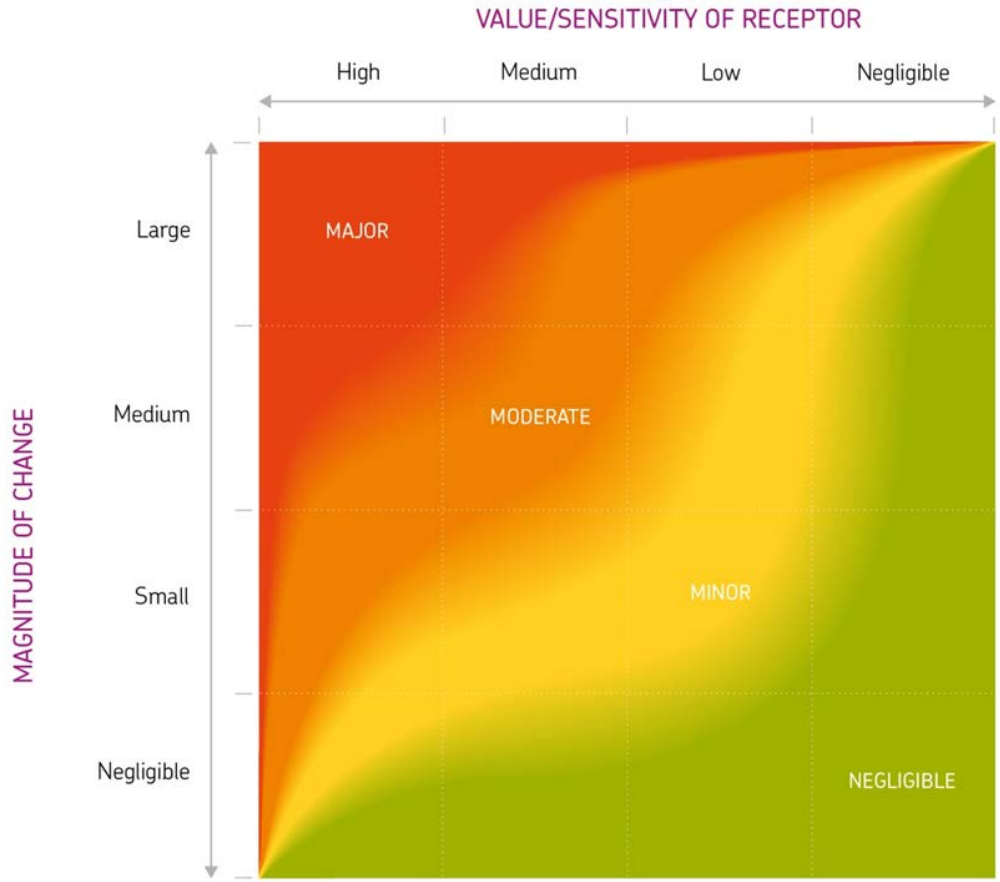

Figure 8-1 Scale for significance of effect [RD70]

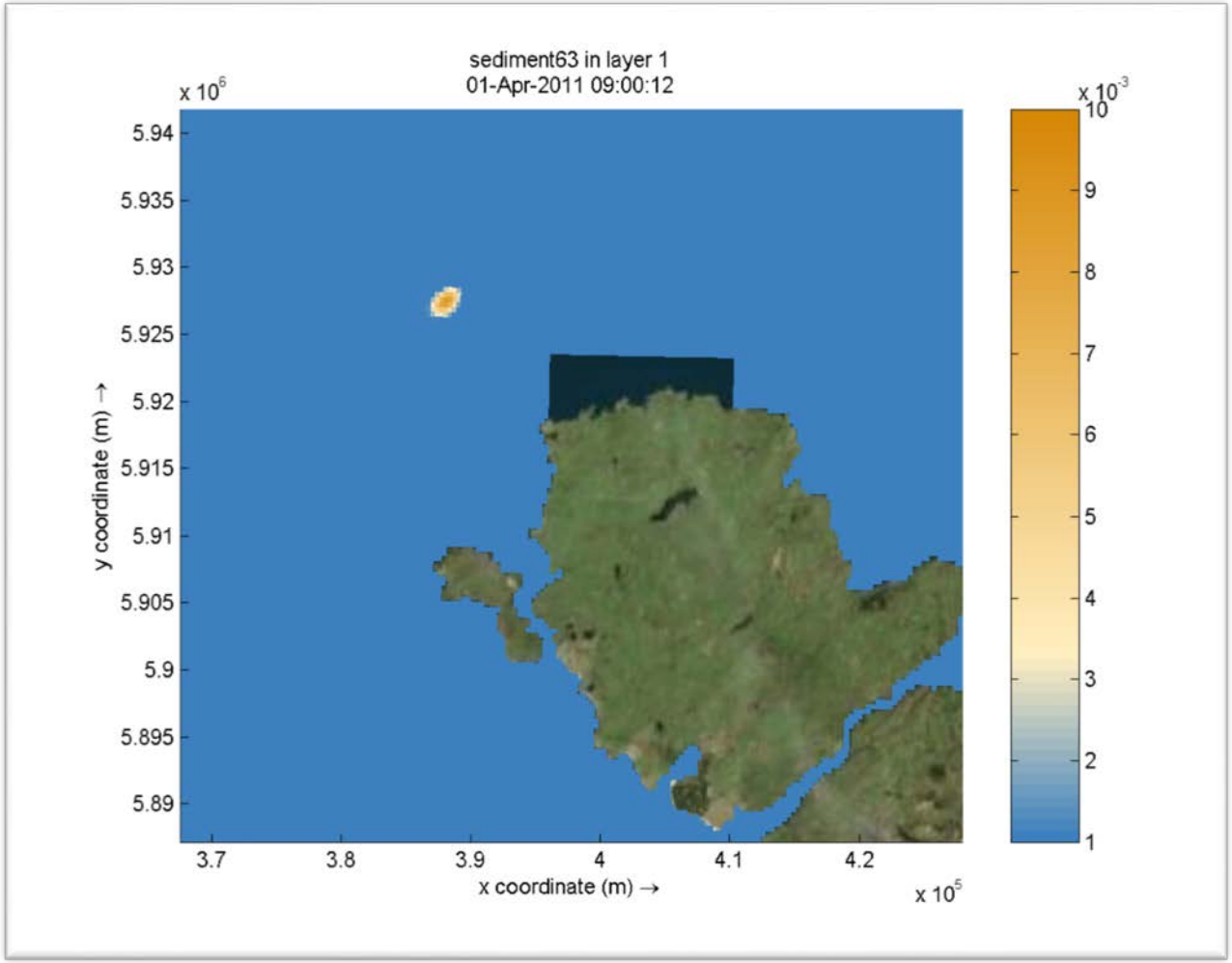

Figure 8-2 Suspended Sediment Concentrations, kg m-3, single disposal +3h, fines

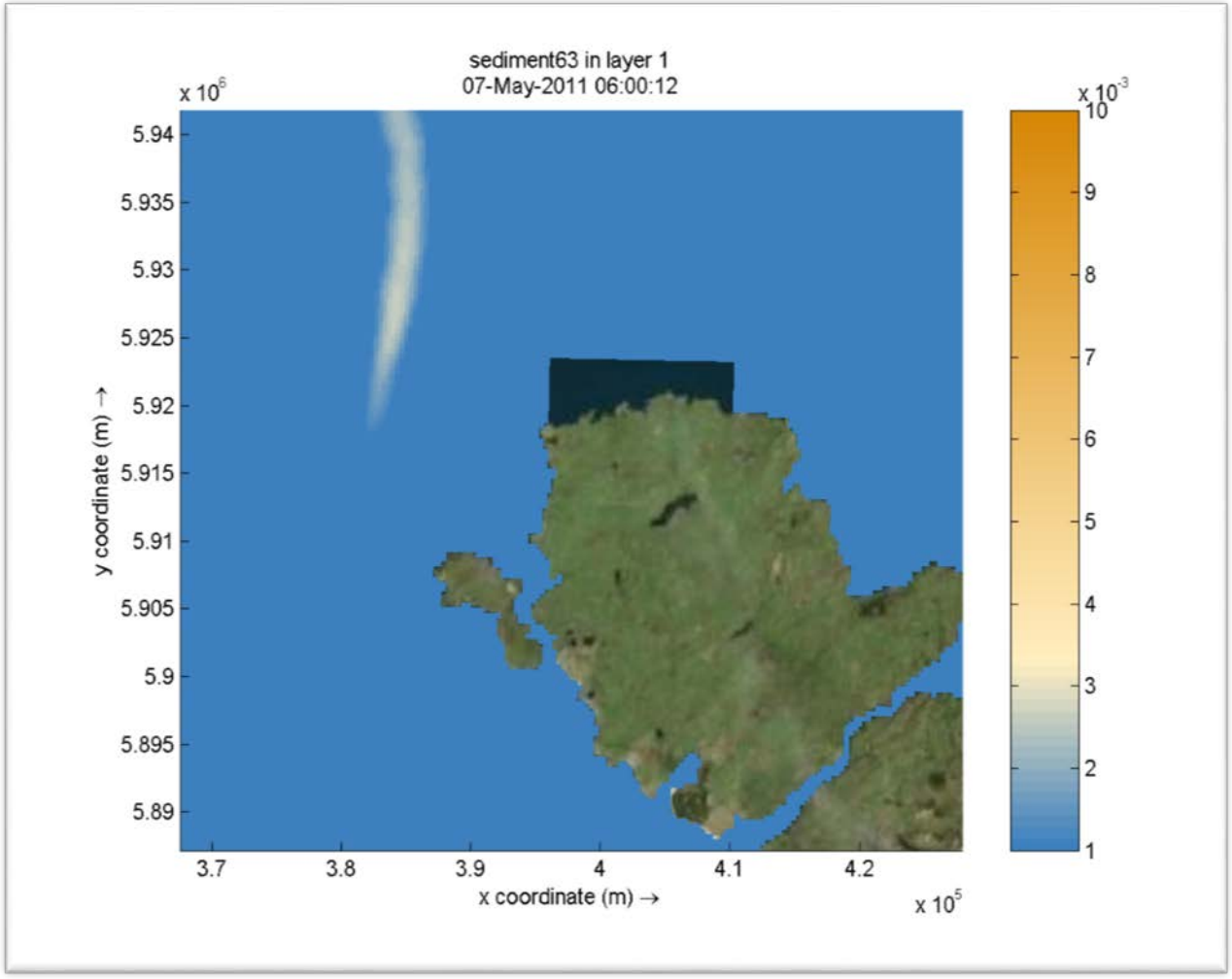

Figure 8-3 Suspended sediment concentrations kg m-3, full programme, final disposal + 48 hours, fines

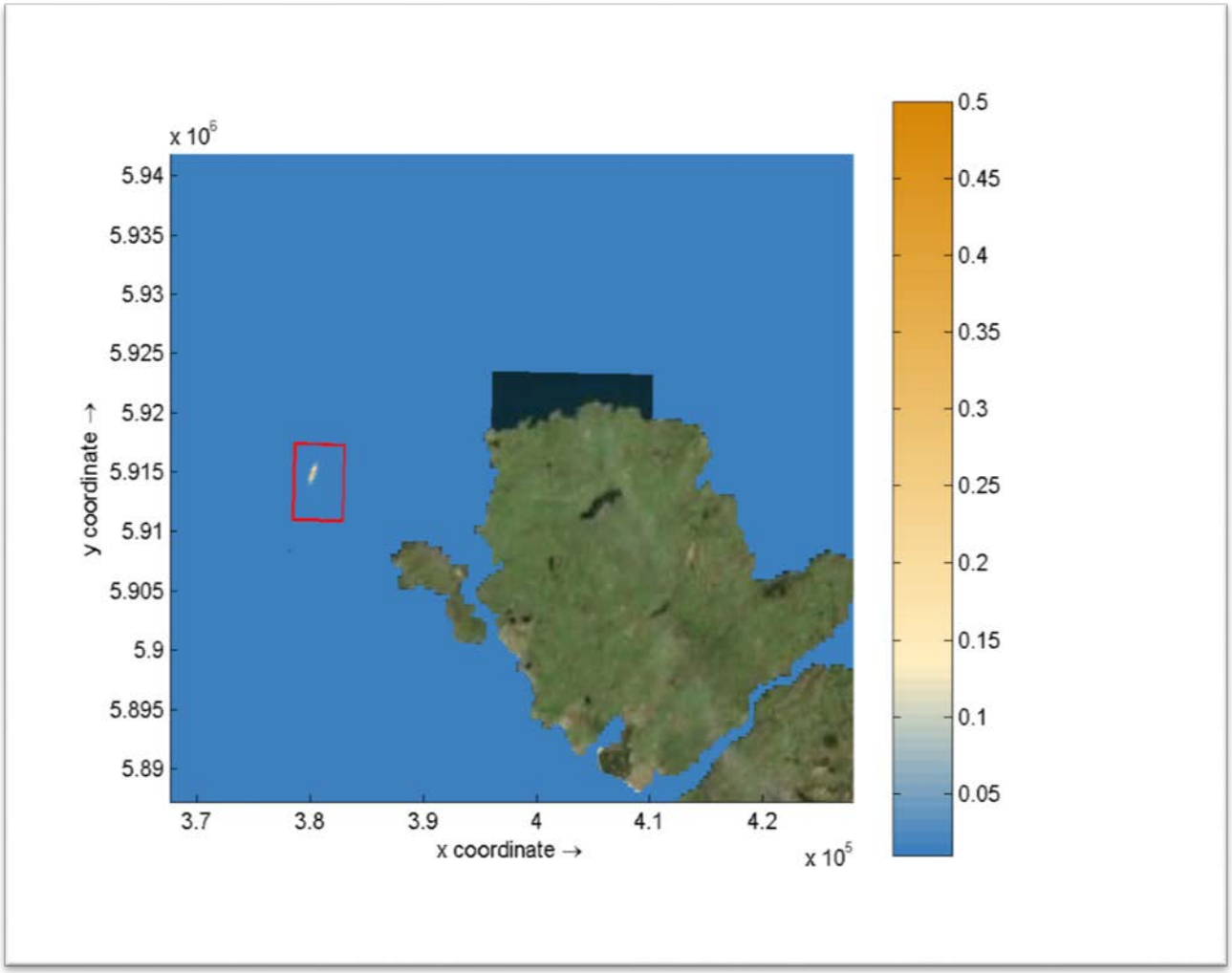

Figure 8-4 Disposed sediment thickness (m) on completion of the full sediment disposal programme

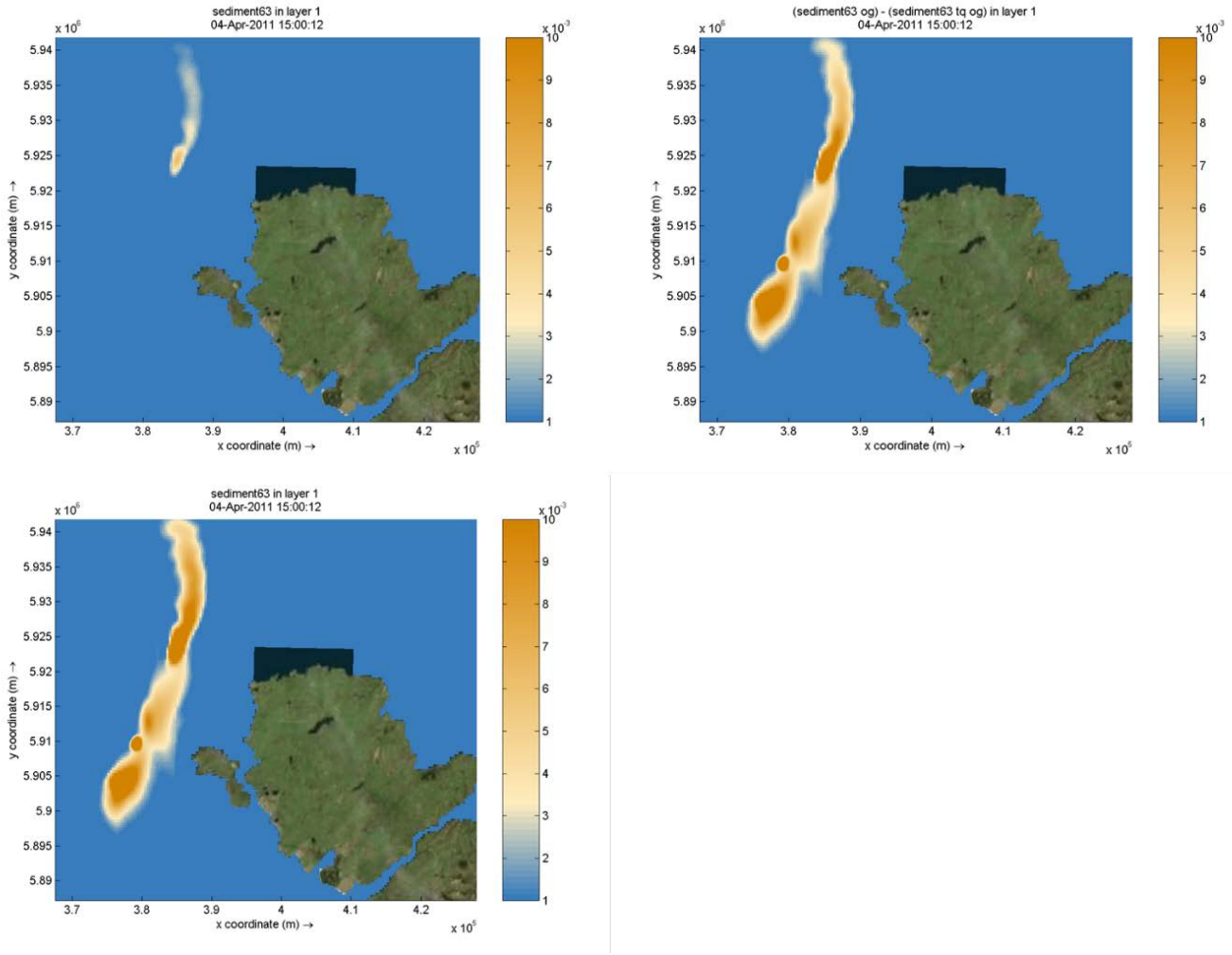

Figure 8-5 Sediment concentrations kg m-3, fines for Horizon only (top left) Holyhead Port only (top right), Horizon and Holyhead Port cumulative (bottom)

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CONTACT US:

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WN0902-ATK-PAC-REP-00003