HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.8 ES Volume D - WNDA Development D8 - Surface water and groundwater

PINS Reference Number: EN010007

Application Reference Number: 6.4.8

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00040

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8 Surface water and groundwater

8.1 Introduction

8.1.1 This chapter describes the assessment of potential surface water and groundwater effects resulting from the construction, operation and decommissioning of the Power Station, other on-site development (as described in chapter A2 introduction to the project and approach to the EIA, Application Reference Number: 6.1.2), and the Site Campus within the Wylfa Newydd Development Area.

8.1.2 Please refer to chapter B8 (surface water and groundwater) (Application Reference Number: 6.2.8) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the surface water and groundwater assessment; and assessment methodologies and criteria.

8.2 Study areas

8.2.1 This section describes the study areas relevant to the surface water, fluvial geomorphology and groundwater assessment for all construction, operation and decommissioning activities associated with the Power Station and other land-based on-site development, including the Site Campus, within the Wylfa Newydd Development Area.

Surface water

8.2.2 The surface water study area (figure D8-1, Application Reference Number: 6.4.101) has been determined by an examination of the (freshwater) surface water features that could potentially be affected by works within the Wylfa Newydd Development Area and operation of the Power Station. This area includes all water features that may be hydrologically linked to the Wylfa Newydd Development Area and includes the land areas that drain to these features. The surface water study area is therefore based on the watercourse catchments at and around the Wylfa Newydd Development Area, as well as important surface water features within that area. These include the Sites of Special Scientific Interest (SSSIs) at Tre'r Gof, Cae Gwyn and Cemlyn Bay. Cemlyn Bay is a coastal lagoon and its assessment is included both within this chapter and chapter D13 (the marine environment) (Application Reference Number: 6.4.13). This chapter focusses on the potential freshwater effects on the lagoon, specifically at its eastern end close to the Nant Cemlyn inflow point.

8.2.3 The northern boundary of the surface water study area is defined by the Irish Sea coastline. The eastern, southern and western boundaries are defined by the surface water catchment boundaries of relevant watercourses.

8.2.4 The study area comprises five small surface water catchments which are discussed later in this chapter. The catchments and the watercourses within them are:

- Tre'r Gof Catchment – Tre'r Gof drains;

- Afon Cafnan Catchment – the Afon Cafnan, Nant Caerdegog Isaf, and wetted ditches and field drains;
- Cemaes Catchment – Nant Cemaes;
- Cemlyn Catchment – Nant Cemlyn and Nant Plas Cemlyn;
- Power Station Catchment – Nant Porth-y-pistyll; and
- other catchments – coastal areas that drain directly to the sea and small isolated drainage systems.

8.2.5 The Afon Wygyr Catchment has not been included within the surface water study area because no part of the Wylfa Newydd Development Area is sited within that catchment and there are no works proposed within the catchment, or which could affect the catchment.

8.2.6 As the Wylfa Newydd Development Area is wholly encompassed by these catchments, and does not extend up to the edge of these catchments (except at the coast) there are no activities that are likely to affect adjacent catchments. The extent of the study area is therefore appropriate for this assessment.

Fluvial geomorphology

8.2.7 A study area (figure D8-2, Application Reference Number: 6.4.101) has been defined for the fluvial geomorphology component of the assessment by taking into account all receptors that could potentially be affected by works within the Wylfa Newydd Development Area and operation of the Power Station. A 1km buffer has been selected around the Wylfa Newydd Development Area boundary allowing for assessment of potential direct effects, as well as providing a broader catchment context. This buffer includes lengths of watercourse both upstream and downstream of the Wylfa Newydd Development Area and extends as far as the coast, since the watercourses could act as pathways for sediments to the sea. The coastal environment and remainder of the sea within the fluvial geomorphological study area is considered in chapter D12 (coastal processes and coastal geomorphology) (Application Reference Number: 6.4.12).

Groundwater

8.2.8 The groundwater level data collected as part of the baseline study (figure 6-2 in appendix D8-3, groundwater baseline report, Application Reference Number: 6.4.28) show that bedrock groundwater generally flows from the south to the north-west, north and north-east, discharging into the sea. The northerly boundary of the study area is therefore defined by the coastline and there are no sensitive groundwater receptors downgradient of this area with the exception of the marine environment (which is assessed in chapter D13, Application Reference Number: 6.4.13).

8.2.9 The upgradient extent of the study area is not as simple to establish as there is no well-defined groundwater catchment or geological boundary. Therefore, due to uncertainties regarding the radius of potential effects on hydrogeological receptors, a conservative approach to the assessment has been taken by identifying two zones of the groundwater study area.

- An inner study area with a 1.8km radius from the centre of the Wylfa Newydd Development Area (see figure D8-3, Application Reference Number: 6.4.101). The boundary has been selected as a circular area (albeit truncated by the coast) to reflect the nature of groundwater movement and the potential zones of influence of dewatering activities, which in homogeneous aquifers will be circular in nature. The 1.8km radius incorporates all of the land-based Wylfa Newydd Development Area out to its furthest points from the centre (figure D8-3, Application Reference Number: 6.4.101). In addition, the inner study area captures all of the groundwater features considered to have the highest potential of being affected by works within the Wylfa Newydd Development Area. Important ecological sites, which need to be assessed due to their sensitivity (including the Tre'r Gof and the Cae Gwyn SSSIs and the Cemlyn Bay SSSI), are also captured by the inner study area.
- An outer study area, which measures 3km in radius, has also been defined (see figure D8-3, Application Reference Number: 6.4.101) in order to capture residual uncertainty associated with the radius of influence calculations, especially the degree of heterogeneity of the aquifer, and the possibility that potential effects may extend further than 1.8km. The degree of uncertainty (in heterogeneity) was determined using data collected in pumping tests undertaken in late summer 2015 (see section 6 of appendix D8-3, Application Reference Number: 6.4.28). The 3km boundary ensures that all relevant features that could be of concern to the public and regulators are assessed, even where the potential effect is assessed as being extremely low.

8.2.10 Defining two areas allows this assessment to be concentrated in the area of most concern, but does not lose sight of the fact that features further from the Wylfa Newydd Development Area may be of relevance, thereby enabling a conservative approach to the impact assessment. The approach also allows the study area to be easily and simply revised in the future if required as further data are collected. It should also be noted that the area considered for a numerical groundwater model comprises a larger study area than shown above to ensure that boundary effects in the model do not affect the results of the model within the study area.

8.2.11 The groundwater flow direction, with groundwater broadly flowing from the south and east to discharge at the coast, is such that the groundwater study area also incorporates all surface water features that could potentially be affected by changes to the groundwater regime. The inner groundwater study area is wholly within the surface water study area with the exception of a small area in the east where the groundwater study area extends into the Wygyr Catchment. As the groundwater and surface water catchments will not necessarily be the same, this does not affect the assessment in terms of the groundwater and surface water interactions.

8.3 Baseline environment

8.3.1 This section provides a summary of the baseline conditions for surface water and groundwater within the study areas described in section 8.2.

8.3.2 The baseline environment has been assessed in a number of appendices to this chapter as follows with the key points provided in this section of the report:

- appendix D8-1 (surface water baseline report) (Application Reference Number: 6.4.26);
- appendix D8-2 (fluvial geomorphology baseline report) (Application Reference Number: 6.4.27);
- appendix D8-3 (groundwater baseline report) (Application Reference Number: 6.4.28);
- appendix D8-4 (flood consequences assessment) (Application Reference Number: 6.4.29) – baseline for flooding (included within the Flood Consequence Assessment (FCA) Report);
- appendix D8-5 (Tre'r Gof hydroecological assessment) (Application Reference Number: 6.4.30) – baseline conditions at the Tre'r Gof SSSI; and
- appendix D8-6 (Cae Gwyn hydroecological assessment) (Application Reference Number: 6.4.31) – baseline conditions at the Cae Gwyn SSSI.

Surface water

8.3.3 The surface water receptors were selected based on professional judgement of an understanding of the potential for effects from construction, operation and decommissioning where activities could have the potential to cause an impact on surface water features in terms of water availably and water quality. More information on the use of professional judgement is provided in section 8.4 of chapter B8 (Application Reference Number: 6.2.8). The groups of receptors which were selected are as follows.

- Surface water catchments including rivers, drains, lakes and other flow pathways. These receptors are sensitive to changes in water quality, changes in water availability and changes in flow and flood risk.
- Designated sites – these are water-dependent statutory designated sites. These receptors are sensitive to changes in water quality and water availability.

8.3.4 The existing baseline context of the surface water within the study area is discussed in detail within the surface water baseline report (appendix D8-1, Application Reference Number: 6.4.26). This is based on a combination of a desk study, site walkovers, site surveys, field monitoring and hydrological and hydraulic modelling. Details of the surface water baseline with respect to flood risk are contained in appendix D8-4 (Application Reference Number: 6.4.29).

Data sources

8.3.5 All data sources used to identify surface water features that could be impacted, the nature of these features, and assessment of how they may vary over time are outlined below. In some instances monitoring data are limited due to access constraints and/or the duration of monitoring. Monitoring is ongoing such that the baseline dataset would be more comprehensive than that discussed here. A limitation on all monitoring is the number of extreme events that are captured, the relevance of which is related to the duration of construction and operation of the Power Station. Uncertainties due to monitoring limitations are taken into account in this assessment by using a conservative approach to assess a likely worst case scenario or by providing a range of potential effects (for example in modelling studies).

Mapping

- Ordnance Survey maps [RD1];
- British Geological Survey geological maps [RD2]; and
- Natural Resources Wales (NRW) Water Watch Wales Map Gallery [RD3].

Meteorological data and monitoring

- Twenty years of rainfall data to 2016 available from the NRW-operated Llyn Alaw rain gauge which is 7km to the south-east.
- The Royal Air Force Valley rain gauge (approximately 17km to the south of the Wylfa Newydd Development Area) comprises more than 50 years of digitised hourly data (1960 – 2016).
- A meteorological station was installed by Magnox at the Existing Power Station site in May 2010. Rainfall depths, humidity, temperature and wind speed are all collected at this station, although technical problems do mean that significant gaps exist in this data record and so this data has not been used as part of this assessment.
- In March 2015, Horizon Nuclear Power (Horizon) installed an additional meteorological station within the Wylfa Newydd Development Area. Rainfall depths, humidity, temperature and wind speed (all required for assessing potential evaporation) are all collected at this station. These data are used to supplement data from other sources as the data provide site-specific information, although they are only available to late 2016.

Water flow data and surveys

- NRW provided spot gauge flow rate readings for the Afon Cafnan. The surface water baseline report (appendix D8-1, Application Reference Number: 6.4.26) provides the results.
- NRW has a permanent gauging station on Anglesey in the Cefni Catchment at Bodffordd, 14km south of the study area. Flow from this catchment has been monitored continuously and recorded every 15 minutes since 1988. This catchment is 21.4km^2 with a southerly aspect

and elevations of between 35m Above Ordnance Datum (AOD) and 100mAOD. The geology and land use in this catchment are broadly similar to those in the study area and therefore this catchment is a suitable data source for this assessment.

- Spot flow gauging has been undertaken on a fortnightly basis from December 2014 to May 2015, and then on a monthly basis from May 2015 until August 2017. This was carried out at three locations within the study area: on Nant Caerdegog Isaf downstream of the Cae Gwyn SSSI; on Nant Cemlyn immediately upstream of the Cemlyn Bay SSSI; and on Afon Cafnan immediately before the discharge into Porth-y-pistyll. The results of these are contained in the surface water baseline report (appendix D8-1, Application Reference Number: 6.4.26). Monitoring is ongoing but for this assessment only data to August 2017 have been analysed.
- Flumes were installed in May 2015 with water level monitoring at each flume used to derive a continuous flow series on Nant Caerdegog Isaf and Nant Cemlyn. These installations aim to provide a better indication of flow conditions in these two catchments, particularly through storm events. Data up to August 2017 have been analysed in this Environmental Statement, although monitoring is ongoing.

Water quality data and surveys

- NRW provided the results of water quality monitoring undertaken at the outfall of Llyn Llygeirian (SH 34330 89950) within the study area. This occurred monthly between October 2003 and June 2007.
- Surface water quality data have been collected by Horizon from around the Wylfa Newydd Development Area on a quarterly basis from February 2011 to August 2017. Monitoring commenced at five locations but was subsequently expanded to more locations and more regular sampling as detailed in appendix D8-1 (Application Reference Number: 6.4.26). This monitoring is ongoing.
- Water quality monitoring around the Tre’r Gof SSSI and the Cae Gwyn SSSI is outlined below.
- Continuous water quality monitoring commenced in May 2015 at two monitoring stations on Nant Caerdegog Isaf downstream of the Cae Gwyn SSSI and on Nant Cemlyn immediately upstream of the Cemlyn Bay SSSI. These take readings every 15 minutes and monitor temporal variations in a small number of water quality parameters. Data up to August 2017 have been analysed in this Environmental Statement, although monitoring is ongoing.

Tre'r Gof SSSI monitoring and studies

- In April 2015, a hydrologist and hydrogeologist from Jacobs UK Limited (Jacobs) (on behalf of Horizon) carried out a walkover of the Tre'r Gof SSSI.
- In order to measure stream flow rates, five flumes and data loggers were installed around the Tre'r Gof SSSI in 2010: four on the inflows and one on the outflow. Data are available from January 2012 to August 2017, but with significant data gaps prior to April 2015 due to equipment failure. There are smaller data gaps post-April 2015 due to equipment failure and vandalism of monitoring equipment.
- At Tre'r Gof water quality sampling of surface water and shallow groundwater have been carried out on an ad hoc basis since 2011, with nominally monthly sampling since November 2015.
- In November 2015, nine piezometers were installed into the Tre'r Gof SSSI with water level loggers continuously monitoring water levels in each of these.
- A detailed study into the current hydrological function of the Tre'r Gof SSSI has been undertaken by Jacobs (appendix D8-5 Tre'r Gof hydroecological assessment, Application Reference Number: 6.4.30). This details all monitoring data collected/locations of monitoring points and includes analysis of the flume data to establish a water balance to determine the surface water and groundwater inflows and outflows of the SSSI.
- Data have been analysed to August 2017, although data collection is ongoing.

Cae Gwyn SSSI monitoring and studies

- In November 2015, a Jacobs' hydrologist and hydrogeologist carried out a walkover of the Cae Gwyn SSSI.
- Water quality sampling of surface water and shallow groundwater have been carried out on a nominal monthly basis between November 2015 and May 2017. Surveys of the Cae Gwyn SSSI started at a later date than at the Tre'r Gof SSSI due to land access restrictions. The locations of all monitoring points are shown on figures included in appendix D8-6 (Application Reference Number: 6.4.31).
- In January 2016, four piezometers were installed, one into each of the four basins at the Cae Gwyn SSSI with water level loggers continuously monitoring water levels until May 2017.
- A detailed study into the current hydrological function of the Cae Gwyn SSSI has been undertaken by Jacobs (appendix D8-6, Application Reference Number: 6.4.31). This details all monitoring data collected/locations of monitoring points and includes analysis of the meteorological data along with known flow routes to establish a water

balance for the surface water and groundwater inflows and outflows to and from and within the SSSI.

- Data have been analysed to May 2017, with access restrictions preventing data collection after this date.

Flooding

- NRW flood mapping is publicly available and was delivered as part of a national programme to delineate indicative areas of elevated flood risk [RD4].
- Technical Advice Note (TAN) 15 Development Advice Map [RD5] is publicly available mapping created by the Welsh Government and is based on the NRW flood map [RD4] and British Geological Survey mapping [RD2].
- Hydrological modelling to understand the water availability within each catchment was undertaken in 2017 (see appendix D8-7, surface water and groundwater modelling results, Application Reference Number: 6.4.32).
- Flood risk modelling was undertaken for each catchment in 2015 and 2017 (see appendix D8-4, Application Reference Number: 6.4.29).

Tre'r Gof Catchment

8.3.6 The Tre'r Gof Catchment has an estimated area of 1km^2 and is almost entirely located within the north-east corner of the Wylfa Newydd Development Area. The catchment drains into the Tre'r Gof SSSI to the east of the Power Station Site. The Tre'r Gof SSSI is fed by a number of springs and small watercourses and ditches. The small watercourses and ditches are referred to here as the Tre'r Gof drains. The Tre'r Gof Catchment discharges to the sea from the Tre'r Gof SSSI basin via a culvert and outfall at Porth y Wylfa.

8.3.7 Surface water flow data indicate that for much of the year the SSSI is drying out, with a recharge/wetting-up season occurring at the onset of winter (November/December). During the summer (June to August) many springs and many of the smaller Tre'r Gof drains are dry. Water quality monitoring does not indicate significant pollution in the streams that flow into the SSSI, although coliforms and ammoniacal nitrogen are both elevated due to the surrounding agricultural land use.

8.3.8 Tre'r Gof SSSI is a naturally complex hydrological system which has interactions between direct rainfall, surface water, soil and sub-soil water and shallow (and to a lesser degree deep) groundwater. The geology beneath and adjacent to the SSSI is complex with a variety of drift deposits present underlain by bedrock which is heterogeneous. There are substantial variations in recharge and stream flow through the SSSI and therefore significant changes in water quality across the area caused by the different water sources and flow routes. Significant hydrological changes occur over a range of timescales, including short term changes during rainfall events (especially summer storms), medium term changes due to seasons and long

term changes caused by climate change and other factors such as management practices. The drainage system in Tre'r Gof is itself artificial having been installed to drain the wetland area several hundred years ago, and controlled by a culvert outfall. The hydrological system is still changing and it has been noted during site walkover surveys for example that the location of some seeps and flushes move even over the medium term. A detailed assessment of the hydrology of the Tre'r Gof SSSI is contained in appendix D8-5 (Application Reference Number: 6.4.30) and is not repeated here.

8.3.9 The TAN 15 Development Advice Map [RD5] indicates that the Tre'r Gof Catchment is predominantly at low risk (Zone A) from fluvial and coastal flooding, aside from the low-lying Tre'r Gof SSSI basin, which is classified as an area known to have been flooded in the past (Zone B).

8.3.10 The Tre'r Gof drains feed directly into the Tre'r Gof SSSI. On the basis that the SSSI is a designated site of national importance and hence has a high ecological value, the Tre'r Gof Catchment has also been assessed as having a high value in terms of its hydrology (water flow and water quality) as changes to these factors have the potential to affect the SSSI's ecology.

Afon Cafnan Catchment

8.3.11 The Afon Cafnan Catchment has an estimated area of 9.9km^2 and comprises the Afon Cafnan as well as its tributaries, including Nant Caerdegog Isaf. The Cae Gwyn SSSI is situated within this catchment at the head of the Nant Caerdegog Isaf. The majority of the catchment is located to the south of the Wylfa Newydd Development Area but the lower reaches of the catchment are situated within the centre and west of the Wylfa Newydd Development Area. The Afon Cafnan and the Nant Caerdegog Isaf are classified by NRW as main rivers. These are rivers that NRW is responsible for carrying out maintenance, improvement or construction work on in order to manage flood risk.

8.3.12 Detailed assessment of gauging data demonstrated a 'flashy' (i.e. stream flow responds rapidly to rainfall) flow regime and that during the summer months the Nant Caerdegog Isaf was almost dry (typically less than 0.02l/s) for long periods. This indicates that in the summer months, surface water runoff is the key driver of flow with no base flow.

8.3.13 NRW has provided water quality data for the outfall from Llyn Llygeirian in the upstream part of the Afon Cafnan; these data do not suggest the presence of any significant pollution in this part of the catchment. Monitoring by Horizon lower in the catchment indicates water quality that is consistent with pollution caused by livestock grazing (coliforms and ammoniacal nitrogen).

8.3.14 *In situ* monitoring of a small number of parameters on Nant Caerdegog Isaf indicates that 'normal' concentrations of suspended solids are below 25mg/l, but there are regular fluctuations of between 40mg/l and 200mg/l, with a maximum measured suspended solid concentration (estimated from turbidity measurements) of 1,067mg/l. Peaks in suspended solids concentrations are likely to be associated with rainstorms due to greater overland flow rates washing off soil as well as with bank erosion and cattle poaching (i.e. erosion resulting from hooves of livestock).

8.3.15 The TAN 15 Development Advice Map [RD5] indicates that the Afon Cafnan Catchment is predominantly at low risk from fluvial and coastal flooding (Zone A). Only two areas are shown to be at risk of flooding, that is:

- low-lying areas inland of Porth-y-pistyll where extreme sea levels result in inland flooding; and
- along the majority of the Afon Cafnan, and the lower reaches of Nant Caerdegog Isaf, where areas within fluvial Flood Zone C are shown, that is areas with a 0.1% annual chance of fluvial flooding or greater.

8.3.16 The Afon Cafnan Catchment has been assessed as having a medium value based on the main river status of the Afon Cafnan and the Nant Caerdegog Isaf.

Cemaes Catchment

8.3.17 The Cemaes Catchment drains an area of 3.0km² that is mostly situated to the east and south-east of the Wylfa Newydd Development Area. Nant Cemaes, which is classified as a main river by NRW, flows in a generally northern direction through Tregele and to the west of Cemaes before discharging to Cemaes Bay via a culvert.

8.3.18 Water quality data collected by Horizon do not indicate any major evidence of pollution although coliforms and ammoniacal nitrogen were elevated and suspended solids within the Nant Cemaes were variable, regularly exceeding 25mg/l with a mean value of 16mg/l, median value of 7mg/l and maximum of 106mg/l. Monitoring by NRW at Cemaes Bay in 2015 and 2016 suggests that bathing water quality standards are regularly exceeded for total coliforms and other microbiological contaminants which are likely due to livestock grazing within the catchment.

8.3.19 The TAN 15 Development Advice Map [RD5] indicates that the Cemaes Catchment is predominantly at low risk from fluvial and coastal flooding (Zone A), with only one small area in the upper reaches of a tributary of Nant Cemaes within Flood Zone B (an area known to have flooded in the past).

8.3.20 The Cemaes Catchment has been assessed as having a medium value based on the main river status of Nant Cemaes and, as it discharges to Cemaes Bay which is used for bathing, it is locally important.

Cemlyn Catchment

8.3.21 The Cemlyn Catchment drains an area of 2.3km^2 and is mostly situated beyond and to the south-west of the Wylfa Newydd Development Area. The Nant Cemlyn flows in a northerly direction along the western boundary of the Wylfa Newydd Development Area prior to draining into Cemlyn Lagoon which forms part of the Cemlyn Bay SSSI, Special Protection Area (SPA) and Special Area of Conservation (SAC). Flow monitoring results show that Nant Cemlyn has a ‘flashy’ flow regime and indicates that both surface water runoff and groundwater contribute to this watercourse.

8.3.22 Ongoing surface water quality monitoring does not indicate any major evidence of pollution, although elevated coliforms and ammoniacal nitrogen

were detected, likely due to agricultural activities. Suspended solids within the Nant Cemlyn were variable, regularly exceeding 25mg/l. From 35 samples collected between 2013 and 2017, suspended solids concentrations ranged from 2.3mg/l to 161mg/l (appendix D8-1, Application Reference Number: 6.4.26), with the higher concentrations generally in summer months.

8.3.23 The TAN 15 Development Advice Map [RD5] indicates that the Cemlyn Catchment is predominantly at low risk from fluvial and coastal flooding (Zone A), with only the lower reaches of Nant Cemlyn within fluvial Flood Zone C.

8.3.24 Nant Cemlyn outfalls directly into Cemlyn Lagoon. On the basis that the Cemlyn Bay SSSI is a designated site of national importance and a SPA and SAC, which are both designations of international importance, and all of which have a high value, the Cemlyn Catchment has been assessed as having a high value.

Power Station Catchment

8.3.25 The Power Station Catchment drains a small area of approximately 0.3km^2 immediately to the south of the Existing Power Station. The small channel within this catchment is unnamed but termed here Nant Porth-y-pistyll. The upper reaches of this channel are culverted, and the channel is a large flush (wetland) across a field that drains in a westward direction and discharges to the sea at Porth-y-pistyll. Due to the low flows which have been observed in this watercourse, no flow monitoring has been or is proposed to be undertaken within this catchment.

8.3.26 Ongoing surface water quality data collected by Horizon do not indicate any evidence of pollution. However, there was an oil leak from an oil-cooled cable, detected in 2016, adjacent to a historical lime kiln. Contamination was found that matched the oil recovered from the spill location with very low concentrations of pollutants found within Nant Porth-y-pistyll.

8.3.27 The TAN 15 Development Advice Map [RD5] indicates that the Power Station Catchment is predominantly at low risk from fluvial and coastal flooding (Zone A), with only the low-lying areas inland of Porth-y-pistyll in Zone C2, where extreme sea levels result in inland flooding. It should be noted that the lower limit of modelling undertaken to generate TAN 15 mapping is a catchment area of 3km^2. Therefore, flood mapping may not represent the true flood risk in small catchments, such as the Power Station Catchment. However, in this case, there is considered to be a low fluvial flood risk due to absence of main rivers, and a low coastal flood risk due to the catchment topography relative to the sea; the catchment being over 5m above sea level and rising inland.

8.3.28 The Power Station Catchment has been assessed as having a low value given that it comprises ordinary watercourses (watercourses which are not designated as main rivers and which are the responsibility of the riparian landowners).

Other areas

8.3.29 Areas within the study area adjacent to the coast, and not within the catchments defined above, are believed to drain informally (i.e. not in defined

drainage channels or watercourses) directly to the coast. The only exceptions to this are discussed below.

- The area between the Cemlyn Catchment and Cemlyn Bay. In this area, a very small ephemeral drain along the western side of the road down to Cemlyn Bay car park collects surface runoff and directs this into the eastern end of Cemlyn Bay.
- The Existing Power Station, which is drained by three surface water drainage systems. Two of these discharge onto the foreshore, and one discharges into the main Existing Power Station outfall which discharges into the sea.

8.3.30 The area between the Cemlyn Catchment and Cemlyn Bay has been monitored for suspended solids and microbiological analysis between 2015 and 2016. The full results are contained in appendix D8-1 (Application Reference Number: 6.4.26). The results show variable suspended solids and high concentrations of total coliforms and other microbiological organisms, due to the agricultural use of adjacent land.

8.3.31 The TAN 15 Development Advice Map [RD5] indicates that the area between the Cemlyn Catchment and Cemlyn Bay is predominantly at high risk from coastal flooding (Zone C2). The flood risk area is largely confined to Cemlyn Lagoon; however, sections of the road leading down to Bryn Aber property and Bryn Aber itself are located within the floodplain. These flood risk receptors have been assigned a high value, in line with the TAN 15 advice, which states that all developments are highly sensitive [RD6].

8.3.32 The TAN 15 Development Advice Map [RD5] indicates that the Existing Power Station is entirely located within Flood Zone A, and at low risk of fluvial and coastal flooding.

8.3.33 The above areas have been assessed as having a low value given that they comprise ordinary watercourses.

Designated sites

Tre'r Gof SSSI

8.3.34 The NRW citation [RD7] states that the Tre'r Gof SSSI is a lime-rich wetland, dependent on a gradual movement of water through the site derived from springs, groundwater seepages, ditches and surface water runoff. It is sensitive to changes in water flow, water level and water quality.

8.3.35 A hydroecological assessment of the Tre'r Gof SSSI (appendix D8-5, Application Reference Number: 6.4.30) has shown that the Tre'r Gof SSSI is situated in a topographic basin which intersects the water table held within superficial deposits and that this shallow water table is important in maintaining saturation during drier periods. Groundwater within the shallow superficial deposits was also identified as critical for maintaining base flow to seepages, drains and springs which discharge directly into the Tre'r Gof SSSI. The assessment has identified that groundwater input from the bedrock aquifer is only a small component of the overall water balance for the Tre'r Gof

SSSI. However, it is recognised that the hydroecology is complex and there is some uncertainty regarding water movement to the SSSI.

8.3.36 The Tre'r Gof SSSI has been assessed as having a high value based on its designation as an SSSI.

Cae Gwyn SSSI

8.3.37 The Cae Gwyn SSSI is located immediately south of the Wylfa Newydd Development Area. The NRW citation [RD8] classified Cae Gwyn SSSI as two small acidic basin mires separated by rocky heathland, dependent on a steady water supply through springs, groundwater seepages and surface water runoff. The citation for this site indicates it to be groundwater-fed in part and that a high groundwater table is essential for the survival of wetland plants and animals. The citation also states that it is important not to lower water levels at the Cae Gwyn SSSI and to maintain the water supply through springs and groundwater seepage.

8.3.38 The hydroecological assessment of the Cae Gwyn SSSI, provided in appendix D8-6 (Application Reference Number: 6.4.31), has identified four small basins and indicates that the input to the wetland from groundwater in the bedrock aquifer is likely to be limited. The basins are largely maintained by direct rainfall over the basins and inflows from the adjacent catchment area. There are only limited hydrological data available (in terms of space and time) regarding the Cae Gwyn SSSI so there is considerable uncertainty regarding the hydrology of the SSSI and its surrounds. There is ongoing data collection to reduce these uncertainties.

8.3.39 The Cae Gwyn SSSI has been assessed as having a high value based on its nationally important designation as an SSSI.

Cemlyn Bay SSSI, SPA and SAC

8.3.40 This saline coastal lagoon is designated as an SSSI, SPA and SAC (for brevity, in this chapter it is referred to as the Cemlyn Bay SSSI). The lagoon that forms part of the Cemlyn Bay SSSI is separated from the sea by a shingle bank with a narrow channel at the western end.

8.3.41 Cemlyn Bay is located outside of the Wylfa Newydd Development Area. However, it is close to the Wylfa Newydd Development Area and drainage from one of the landscape mounds would discharge into Nant Cemlyn leading to the Cemlyn Bay SSSI. The SSSI has been assessed in order to establish its characteristics and to determine if there is potential for it to be affected by works within the Wylfa Newydd Development Area.

8.3.42 The Cemlyn Bay SSSI has been assessed as having a high value based on its nationally and internationally important designations as an SSSI, SPA and SAC.

Fluvial geomorphology

8.3.43 A summary of the fluvial geomorphology environmental baseline is presented in the following section; detailed results are provided in appendix D8-2 (Application Reference Number: 6.4.27). This includes information on channel

dimensions, bed substrate, flow types, bank material and profile and structure of the riparian zone. The receptors for fluvial geomorphology have been selected based on professional judgement of an understanding of the potential for effects from construction, operation and decommissioning. This judgement includes identifying where activities could have the potential to cause an impact on the fluvial geomorphology due to changes in sediment loads, watercourse flow rates or from works that are proposed to be undertaken within the watercourses. The receptors, including tributaries and drains to the named watercourses, are as follows:

- Afon Cafnan;
- Nant Caerdegog Isaf;
- Nant Cemaes;
- Tre'r Gof SSSI drains;
- Nant Cemlyn; and
- Power Station drain.

8.3.44 Three watercourses within the study area, the Afon Wygyr, Afon Traeth Mawr and Nant Caerdegog Uchaf, have been scoped out of further assessment. This is due to the absence of effects on these watercourses in terms of fluvial geomorphology. These watercourses are either upstream of the Wylfa Newydd Development Area, or are in a different catchment that has no connection to the Wylfa Newydd Development Area. There would be no direct modifications to these watercourses and sufficient distances separate them from construction activities to prevent potential effects.

8.3.45 The watercourses listed above ultimately discharge to the sea within the study area at Porth-y-pistyll, Cemaes Bay, Porth y Wylfa and Cemlyn Lagoon. The baseline information for these coastal features is provided within chapter D12 (Application Reference Number: 6.4.12) and chapter D13 (Application Reference Numbers: 6.4.13). The effects due to the transfer of sediments through the fluvial system on the coastal features are also covered within those chapters and so are not discussed in this chapter.

Data sources

8.3.46 The following provides an overview of the data sources used to inform the fluvial geomorphology baseline:

Desk study sources

- Ordnance Survey maps [RD1];
- geological maps [RD2];
- NRW Water Watch Wales Map Gallery [RD3];
- Western Wales River Basin Management Plan (RBMP) [RD9];
- Multi-Agency Geographic Information for the Countryside [RD10];
- aerial photographs [RD11]; and
- historical maps [RD12].

Site walkovers

- geomorphological reconnaissance survey undertaken from 17 November 2014 to 20 November 2014; and
- geomorphological reconnaissance survey undertaken from 20 July 2015 to 24 July 2015.

Afon Cafnan

8.3.47 The Afon Cafnan flows from two sources, one from Llyn Llygeirian and the other from land to the north of Llanrhyddlad. The watercourse draining from Llyn Llygeirian is referred to here as Nant Llygeirian.

8.3.48 Much of the Afon Cafnan channel has an artificially straightened planform. It is likely that this is a reflection of the historical need to establish relatively straight field boundaries. Realignment probably also provided an opportunity to deepen some channels, particularly within fields with poor arterial drainage.

8.3.49 Some lengths of channel show evidence of natural processes and forms, particularly between Mynydd-Ithel and Cafnan. Here the channel is naturally sinuous within the confines of a relatively narrow floodplain. A natural bedrock cascade is present within the upstream reach immediately downstream of the small road crossing near Cefn Coch.

8.3.50 The Nant Llygeirian is similar in nature to the main channel of the Afon Cafnan, with evidence of historical artificial straightening. The channel is approximately 2m to 3m wide (measured during the walkover surveys in 2015), with the bed and banks consisting primarily of finer sediment fractions (i.e. silt, sand and fine gravels).

8.3.51 The vegetation within the riparian zone is fragmented along most of the Afon Cafnan and Nant Llygeirian. The predominant land use is livestock grazing; with significant poaching along some lengths leading to fine sediment input to the channel. Analysis of historical maps depicts that there has been no significant change in the planform of the Afon Cafnan since 1889 (the first published map of the area).

8.3.52 The Afon Cafnan exhibits a range of morphological features and has a gravel-bed and riffle-pool sequence. It is assessed as having a medium value with regards to fluvial geomorphology.

8.3.53 Due to the sufficient distance (approximately 2km upstream) from the Wylfa Newydd Development Area, the Nant Llygeirian has been scoped out of this assessment.

Afon Cafnan – tributaries

8.3.54 There are two smaller tributaries forming part of the Afon Cafnan fluvial geomorphology receptor, the Afon Cefn Coch and the Bod-hedd Drain.

8.3.55 The Afon Cefn Coch has an artificially straight planform through agricultural land and semi-improved grassland. The watercourse has a vegetated riparian zone comprising trees and shrubs along the right bank but with no significant vegetation along the left bank. The channel has a uniform cross-section and

several reaches are choked with terrestrial vegetation. The substrate consists mainly of silt and lengths of the watercourse have been poached by livestock. There has been no significant change to the planform of the Afon Cefn Coch since 1889 (the first published map of the area).

8.3.56 The Bod-hedd Drain has an artificially straightened planform through agricultural, semi-improved grassland and has no vegetated riparian buffer zone. Some local deposition of silt was noted at the channel margins, particularly upstream of the confluence with the Afon Cafnan. The bed substrate is typically fine and coarse gravel, and some mud. The left bank appeared poached, potentially acting as a sediment source. There has been no significant change to the planform of the Bod-hedd Drain since 1889 (the first published map of the area).

8.3.57 The Afon Cefn Coch and Bod-hedd Drain both have a low value with regards to fluvial geomorphology. As the Afon Cefn Coch is just at the upstream limit of the study area and the Bod-hedd Drain is outside of the study area, they are both scoped out of this assessment.

Nant Caerdegog Isaf

8.3.58 The Nant Caerdegog Isaf is located to the west of Tregele and the A5025. The watercourse has an artificially straight planform with a uniform and modified channel cross-section. The substrate is mainly silt with some fine gravel. The watercourse overall is a sediment sink, i.e. it is locally narrowing as a result of areas of sediment deposition in an over-wide channel. There has been no significant change to the planform of the Nant Caerdegog Isaf since 1889 (the first published map of the area).

8.3.59 The Nant Caerdegog Isaf has a low value with regards to fluvial geomorphology.

Nant Cemaes

8.3.60 The Nant Cemaes is a small watercourse with an artificially straightened planform and no significant vegetated riparian zone, with some trees noted intermittently.

8.3.61 The watercourse has a uniform channel cross-section which is over-deep and over-wide and smooth (glide) flow predominates. The upstream reach along the A5025 is artificially reinforced and a silty substrate was observed. The downstream reach, immediately upstream of Cemaes Bay, has fully vegetated banks. There has been no significant change to the planform of the Nant Cemaes since 1889 (the first published map of the area).

8.3.62 The Nant Cemaes has a low value with regards to fluvial geomorphology.

Tre’r Gof SSSI drains

8.3.63 A network of small watercourses is located within the Tre’r Gof SSSI to the east of the Existing Power Station. The watercourses appear to have artificially straight planforms and they join before discharging into the Irish Sea at Porth y Wylfa. The watercourses are over-deep and over-wide and choked with terrestrial vegetation; and are considered a sink for sediment, locally

narrowing. The channel substrate is predominantly silt. There has been no significant change to the planform of the Tre'r Gof SSSI drains since 1889.

8.3.64 The Tre'r Gof SSSI drains have a low value with regards to fluvial geomorphology.

Nant Cemlyn

8.3.65 The Nant Cemlyn has a shallow valley gradient. Most of the Nant Cemlyn channel has an artificially straight planform, likely to accommodate field boundaries and aid field drainage. The main land use is agricultural, with the fields being used predominantly for pasture and some as tilled arable land. Some lengths of natural channel recovery are present, with erosion and deposition creating a more sinuous planform within the artificially constrained channel. Several lengths of poaching and consequent bank slumping were recorded as present along the left bank. Culverts and bridges are present along the entire reach. Terrestrial vegetation is present alongside the channel on the floodplain which suggests a well-established riparian corridor. However, there is also some terrestrial vegetation within the channel which suggests that the riparian floodplain is encroaching on the channel. Substrate consists of gravel, cobbles and pebbles. There has been no significant change to the planform of the Nant Cemlyn since 1889 (the first published map of the area).

8.3.66 The Nant Cemlyn has a low value with regards to fluvial geomorphology due to the limited range of morphological features present and as it has been modified in several reaches.

Nant Porth-y-pistyll

8.3.67 The Nant Porth-y-pistyll was found to typically have no vegetated riparian corridor, with grassed banks and some scattered trees in the furthest upstream reach. The channel is uniform with limited morphological features and is affected by adjacent land uses (including poaching by livestock). There has been no significant change to the planform of the Nant Porth-y-pistyll since 1889.

8.3.68 The Nant Porth-y-pistyll has a low value with regards to fluvial geomorphology.

Groundwater

Data sources

8.3.69 This topic is defined by a number of receptor groups. Table D8-1 summarises those groupings and their data sources used to identify the receptors, with full details provided in appendix D8-3 (Application Reference Number: 6.4.28).

Table D8-1 Groundwater receptor baseline characterisation

Receptor	Data collection to identify receptors (including duration where relevant)
Groundwater in Secondary Aquifers	• Groundwater quality sampling as part of Ground Investigation (GI) works and longer-term monitoring from November 2014 to August 2017. Although data collection is ongoing, this chapter only assesses data to August 2017 as this is the cut-off date for reporting. • Measurement of groundwater levels using manual measurements and from groundwater level data loggers from March 2010 to August 2017, although data collection is ongoing. • Groundwater modelling.
Groundwater abstractions (Private Water Supplies (PWSs))	• Provision of data from the Isle of Anglesey County Council (IACC) and water quality monitoring from one PWS.
Groundwater abstractions (Historical Public Wells)	• Provision of data from the IACC.
Groundwater Dependent Terrestrial Ecosystems (GWDTEs) (the Tre'r Gof and Cae Gwyn SSSIs)	• Bespoke studies of the two SSSIs from November 2015 to August 2017 including collection of groundwater and surface water quality and groundwater level data.
Watercourses considered as secondary receptors for groundwater	• Measurement of watercourse flows and quality from December 2014 to August 2017 and groundwater modelling studies.

8.3.70 The baseline condition of groundwater and identification of associated receptors has been characterised through the analysis of a variety of data sources. In summary, this includes a desk study of available information, including data published by regulators such as NRW, historical groundwater data and data collected on soils and geology. Site investigations have been undertaken to expand the historical dataset and collect further information on groundwater levels and groundwater quality. The key sources of data are outlined in table D8-2 and a full description of the data and methods used to characterise the existing groundwater baseline are outlined in appendix D8-3 (Application Reference Number: 6.4.28).

Table D8-2 Sources of data used in the characterisation of the groundwater baseline

Data source	Description of data
Desk study (including assessment of available GI data)	• The Environment Agency's 'What's in Your Backyard?' online tool accessed March 2015 to establish aquifer designations [RD13]. It should be noted that the Environment Agency has subsequently removed data from its 'What's In Your Backyard?' website in relation to Wales (which is now regulated by NRW). However, data were obtained prior to this for production of the baseline report. More recent data produced by the Environment Agency does show that the glacial tills have been re-designated [RD14]. • Ordnance Survey maps [RD1]. • Geological maps [RD2]. • Geological, water level and water quality data collected as part of GI. • Consultancy reports: - Surface Water Baseline Report (appendix D8-1, Application Reference Number: 6.4.26); - Groundwater Baseline Report (appendix D8-3, Application Reference Number: 6.4.28); - Tre'r Gof SSSI Hydroecological Assessment (appendix D8-5, Application Reference Number: 6.4.30); - Cae Gwyn SSSI Hydroecological Assessment (appendix D8-6, Application Reference Number: 6.4.31); and - interpretation of geological data is presented in chapter D7 (soils and geology) (Application Reference Number: 6.4.7).
Groundwater baseline surveys	• Groundwater sampling and associated chemical analysis from boreholes installed during GI across the Wylfa Newydd Development Area and immediately outside of the Wylfa Newydd Development Area. • Collection and chemical analysis of groundwater samples from a PWS. • Measurement of groundwater levels using manual measurements and groundwater level data loggers from boreholes across the Wylfa Newydd Development Area and immediately outside of the Wylfa Newydd Development Area. • Installation of shallow groundwater monitoring points (piezometers) within the Tre'r Gof and Cae Gwyn SSSIs with associated groundwater level and groundwater quality monitoring.

Data source	Description of data
	• Pumping tests which involved the drilling of two groundwater abstraction boreholes, associated observation boreholes and pumping tests at two locations (PW1 and PW2).

8.3.71 Following collection and assessment of the baseline data, a groundwater conceptual site model has been produced for the Wylfa Newydd Development Area (appendix D8-3, Application Reference Number: 6.4.28) with further conceptual site models produced for the Tre'r Gof SSSI (appendix D8-5, Application Reference Number: 6.4.30) and the Cae Gwyn SSSI (appendix D8-6, Application Reference Number: 6.4.31).

8.3.72 Groundwater modelling studies have also been undertaken, principally to assess the effects of dewatering for deep basement construction and the effects of the Power Station on the groundwater levels in the bedrock for the long-term operation of the Power Station. Details of this groundwater modelling and the model results are provided in appendix D8-7 (Application Reference Number: 6.4.32) with the results used, where relevant, for assessing the effects considered later in this chapter.

8.3.73 The groundwater modelling was undertaken assuming that dewatering in the excavation for the reactors during construction would be required down to an elevation of -18mAOD for the reactor building (as detailed in chapter D1 (proposed development) (Application Reference Number: 6.4.1)). As a conservative approach, the model for the construction phase does not allow for shotcreting of the excavation walls as for a time during construction, prior to shotcreting or construction of the basement floors, groundwater inflow to the exaction would continue either through the walls or base of the excavation until the fissures were sealed. For the operational phase, the model assumes that major fractures encountered in the excavations would be sealed with shotcrete and a drain would be installed around this shotcreted excavation for passive drainage, with the drains at an elevation of 6mAOD.

8.3.74 The model considered in this assessment is termed the 'Central' model as it uses the most likely parameter values with respect to the amount of rainfall (the recharge) reaching the bedrock and the permeability of the bedrock aquifer. Comparison of modelled to measured groundwater levels shows this model to represent actual conditions reasonably closely, although as with most groundwater models in a relatively complex hydrogeological setting, comparison of actual and modelled groundwater levels for individual boreholes may not always perfectly match. The model has been used to assess the effects of the construction and operation of the Power Station and associated landscape mounds on the groundwater environment and associated secondary receptors such as GWDTEs and PWSs.

8.3.75 Two additional models were also constructed in order to test the sensitivity of the Central model to changes in recharge and permeability. The 'High' groundwater model included a four times increase in recharge to the bedrock and corresponding increase in permeability compared to the Central model. The 'Low' groundwater model has a four times reduction in recharge and permeability compared to the Central model. In both instances the modelled

water levels do not compare well to the measured groundwater levels indicating that these models are not a good indication of reality and that the Central model uses broadly appropriate values for recharge and permeability.

8.3.76 The groundwater modelling work does not consider the consequences of climate change or drought events more severe than those experienced in the historical climate record from 1960 to 2016. This historical record does include some significant drought and wet periods and these have been selected as a focus for output analysis. However, the focus of this modelling work is to assess the effects of the construction and operational phases on the water and hydroecological regimes experienced by the environmental receptors in comparison with the current baseline over timescales of weeks, months and years. As such, including the unpredictable effects of climate change in this comparison would introduce a greater level of uncertainty in the assessment.

Soils and geology

8.3.77 The soils across the study area are generally 'freely draining, slightly acid loamy soils' in the areas towards the coast, and 'slowly permeable, seasonally wet, acid loamy and clayey soil' further inland. The former would allow more recharge to groundwater than the latter.

8.3.78 Made ground is not widespread across the Wylfa Newydd Development Area. Where it has been identified, it is generally related to the construction of the Existing Power Station, and is normally less than 2m thick, although made ground over 4m thick has been encountered (see chapter D7, Application Reference Number: 6.4.7).

8.3.79 The superficial deposits of glacial origin overlie much of the Wylfa Newydd Development Area in varying thicknesses. Typically, the superficial deposits are less than 5m thick; however, superficial deposits are up to 30m thick beneath half-egg-shaped hills known as 'drumlins'. A deep sequence, over 25m thick, of alluvial deposits and lacustrine sediments infill has been measured in BH311 on the northern side of the Tre'r Gof SSSI. This feature is thought to have either been formed in a glacial feature known as a kettle hole or is part of a buried valley (appendix D8-5, Application Reference Number: 6.4.30).

8.3.80 The majority of the Wylfa Newydd Development Area is underlain by rocks belonging to the New Harbour Group, which also incorporates the Skerries Group, with the Gwna Group being at the northern extent near Wylfa Head and the proposed cooling water outfall at Porth Wnal. The elevation of the rock head in the Wylfa Newydd Development Area is typically 10mAOD to 20mAOD, although it is lower than this in the west and north adjacent to the coast.

Aquifer designations and vulnerability

8.3.81 The glacial till superficial deposits across the majority of the Wylfa Newydd Development Area are defined by the Environment Agency (NRW has not separately defined aquifer types) as a Secondary (Undifferentiated) aquifer [RD14] due to their importance in maintaining local water supplies and base flow to wetlands, lakes and rivers. Secondary (Undifferentiated) aquifers were

previously designated as both minor and non-aquifers in different locations due to the variable characteristics of the rock type. Within the Wylfa Newydd Development Area, the superficial deposits are generally of low permeability and across the majority of the Wylfa Newydd Development Area it is unlikely that there will be any significant groundwater flow within these deposits. Granular superficial deposits, expected to be more permeable and consisting of variably clayey, silty sand and gravel, are present across the south-western portion of the Wylfa Newydd Development Area. These include examples where significant layers of both low permeability and granular materials are present. The GI information suggests that granular materials become the predominant superficial deposits broadly to the south-west of a line between Tregele village and Porth-y-pistyll, although low permeability, clay dominated deposits are still present in this area and are observed further to the south-west in the vicinity of Cae Gwyn.

8.3.82 The superficial deposits at the Tre'r Gof SSSI are defined as a Secondary A aquifer, although the available borehole logs (appendix D-5, Application Reference Number: 6.4.30) do not indicate any extensive granular layers beneath the SSSI. The bedrock beneath the Wylfa Newydd Development Area is defined as a Secondary B aquifer.

8.3.83 NRW's "Water Watch Wales Map Gallery" [RD3] shows that the Wylfa Newydd Development Area boundary lies within the Ynys Môn Secondary water body unit (GB41002G204400) which covers a large part of Anglesey (see appendix D8-3, Application Reference Number: 6.4.28) and applies to both the bedrock and superficial deposits. This area was designated in 2015 as being of good quantitative status and poor quality status. The poor quality status relates to hazardous substances in groundwater which are associated with historical mining activities (metals) which are impacting on surface water quality in the Amlwch area over 8km to the west of the Wylfa Newydd Development Area. As the groundwater body covers much of Anglesey, the chemical water quality will vary throughout and groundwater quality is better in the vast majority of areas than the classification for the whole water body would indicate.

Aquifer recharge

8.3.84 Groundwater recharge refers to the flux of water, which moves from the ground surface or a surface water body into an underlying aquifer. Rainfall is normally the most significant source of recharge, although only a proportion of total annual rainfall actually enters the groundwater system. Runoff and shallow base flow to surface water, evaporation and transpiration from plants and reduction of soil moisture deficits all reduce the total annual downward flux. The actual volume of rainfall that is available for groundwater recharge and surface water runoff following evapotranspiration losses and reduction of soil moisture deficits is known as 'effective rainfall'.

8.3.85 Effective rainfall has been estimated to be approximately 500mm per year, based on data reported for the Cefni flow gauging station (station number 102001) on Anglesey, at National Grid Reference SH 429 769 [RD15]. The effective rainfall rate of approximately 500mm per year in part reflects the flux, which recharges shallow groundwater located in the superficial deposits to

provide shallow base flow or that, where overburden is very thin or absent, which recharges the shallow bedrock to provide base flow.

8.3.86 Recharge to bedrock in areas where the low permeability superficial overburden is very thick, such as beneath drumlins, is likely to be significantly lower. Studies indicate recharge rates through glacial till in other parts of the UK are typically around 20% of the total annual effective rainfall [RD16]. In this case, this would be approximately 100mm per year although the actual rate will vary markedly depending on the nature and thickness of the till which can differ substantially both locally and over larger areas.

8.3.87 Groundwater modelling has also assessed the recharge to the bedrock aquifer, as this is a key parameter for calibration of the model. Appendix D8-7 (Application Reference Number: 6.4.32) shows that for the Central model recharge amounts to the bedrock ranges from around 30mm per year to 100mm per year. Based on the above assessment of recharge through till, this is not unreasonable.

Groundwater flow and levels

8.3.88 The key findings from analysis of the water level data are summarised below.

- Groundwater levels typically rise by around 2.5m in the winter.
- Groundwater levels in the bedrock and superficial deposits are similar in most cases, although there are significant differences in specific areas such as beneath drumlins.
- Where there are boreholes near to watercourses, the groundwater level and elevation of water levels in the watercourse are both at similar elevations, although winter groundwater levels can be higher than watercourse levels and in summer they can be lower. This means during the winter, groundwater will be discharging to the streams, but during summer there is the potential for streams to leak to groundwater. The degree of interaction between groundwater and surface water will depend on the stream bed's permeability and local geology. However, the data suggest that groundwater and surface water are in continuity over much of the Wylfa Newydd Development Area.
- Groundwater levels can respond quickly to rainfall.
- Tidal influences on the groundwater appear generally to be very slight and restricted to a maximum of approximately 50m from the coast.
- Groundwater flow direction generally follows the broad ground elevation with the highest bedrock groundwater levels being to the south of the Wylfa Newydd Development Area and the lowest at the coast.
- There is an inferred groundwater divide trending from the south-west towards the north-east under a slight topographic ridge that passes beneath Tregele. Groundwater west of the divide flows north-west across the Wylfa Newydd Development Area towards Porth-y-pistyll whilst

groundwater east of the divide flows towards Porth y Wylfa and the Tre'r Gof SSSI.

- A further groundwater divide is present to the east, close to the line of the surface water catchment for the Nant Cemaes.
- Towards the west of the Wylfa Newydd Development Area, another divide indicates that groundwater to the west of the divide flows in the direction of Nant Cemlyn and Cemlyn Lagoon whilst that to the east flows towards the coast to the west of Porth-y-pistyll.

Aquifer permeability

8.3.89 Permeability indicates the ease with which a fluid can move through rock. Technically, permeability is a function of the liquid moving through the rock as well as the properties of the rock. However, in this chapter, the general term of "permeability" is used rather than the term "hydraulic conductivity" which is the term used in a technical sense when the liquid moving through the rock is water. Testing to determine this parameter has been undertaken in a number of boreholes in the various phases of site investigations. The pumping tests also recorded permeability.

8.3.90 The permeability testing undertaken is presented in appendix D8-3 (Application Reference Number: 6.4.28). In summary, the permeability testing indicates a range in the superficial deposits from 0.0005m/d to 60m/d, whilst that in the bedrock ranges from 0.001m/d to 3m/d. Results of the pumping tests, which measure permeability over a larger area than the tests in individual boreholes, showed permeability to be approximately 0.1m/d to 1m/d.

8.3.91 The data, combined with information on the borehole logs, show that for the superficial deposits, intergranular flow through the pore spaces is the dominant flow mechanism. The data also show that fracture flow is the dominant groundwater flow mechanism for the bedrock with the majority of this fracture flow being in the upper portion of the bedrock aquifer.

Aquifer storage

8.3.92 Porosity, water content and bulk density tests were carried out on soil and rock samples as part of the GI. The results of these tests are summarised in table 6-6 of appendix D8-3 (Application Reference Number: 6.4.28). The clay deposits have a relatively high porosity and moisture content whereas the bedrock is lower with a mean porosity of around 2% and moisture content of 4%.

Groundwater quality

8.3.93 Groundwater quality data showed that for the majority of locations and determinands, the groundwater was of good quality compared to water quality standards associated with river quality and drinking water. In relation to the substances that are likely to be of most relevance to the works taking place within the Wylfa Newydd Development Area, the following are noted.

- Concentrations of dissolved manganese are particularly high, probably reflecting mineralisation from both rock and superficial deposits.
- No saline waters due to sea water ingress were identified in the aquifer.
- In a small number of groundwater samples, concentrations of aluminium, arsenic, nickel, lead, copper and zinc exceeded one or more water quality standards. With respect to the majority of these metals, the source is considered most likely to be natural. For lead it is likely that the elevated concentration in some areas (particularly to the south-west of the Existing Power Station) is the result of contaminated made ground (see chapter D7, Application Reference Number: 6.4.7).
- Iron showed a more widespread elevated concentration in comparison to the water quality standards.
- Organic compounds were generally below the level of detection. However, chlorinated solvents have been detected to the immediate south of the Existing Power Station, and are thought to be associated with historical contamination (see chapter D7, Application Reference Number: 6.4.7 for further consideration of this contamination).
- Total petroleum hydrocarbons have been detected in a small number of boreholes within the Wylfa Newydd Development Area.
- In the autumn of 2015, a leak of oil from a below ground electricity cable was identified to the east of Porth-y-pistyll. The subsequent groundwater investigation and monitoring near the leak did not identify any groundwater contamination associated with the leak. However, as oil was observed at the shoreline, and it probably reached the Nant Porth-y-pistyll (very low concentrations of Total Petroleum Hydrocarbons were measured in this watercourse), it is likely that localised groundwater contamination did occur near the leak.

Groundwater Dependent Terrestrial Ecosystems

8.3.94 A GWDTE is a wetland that critically depends on groundwater flow and/or water quality. As GWDTEs are intrinsically linked to the aquifer body that supports them, they are considered a part of the groundwater system. Two sites have been identified as GWDTE, the Tre'r Gof SSSI and the Cae Gwyn SSSI (figure D8-3, Application Reference Number: 6.4.101). Further details of these are provided in chapter D9 (terrestrial and freshwater ecology) (Application Reference Number: 6.4.9).

8.3.95 A study into the Tre'r Gof SSSI is provided in appendix D8-5 (Application Reference Number: 6.4.30). This shows that the Tre'r Gof SSSI is dependent on shallow calcareous groundwater and surface water inflows with the input of bedrock groundwater to the system being a minor component. The shallow groundwater inputs to the Tre'r Gof SSSI are considered alongside the surface water inputs within the relevant sections of this chapter.

8.3.96 A study into the Cae Gwyn SSSI has been undertaken and is provided in appendix D8-6 (Application Reference Number: 6.4.31). This shows that in

relation to groundwater levels, the feature is not downgradient of the Wylfa Newydd Development Area. This means that significant effects from a groundwater contamination perspective on this feature are unlikely. However, there could potentially be effects on its catchment area from the proposed car park to the east of the SSSI. Based on the identified groundwater flow direction, any effects would be to the primary outflow basin at the extreme east of the SSSI.

Groundwater abstractions

8.3.97 Up until January 2018, the Wylfa Newydd Development Area was located in a geographical area that was exempt from the requirements for licensing of groundwater abstractions greater than 20m^3/day. However, it will be a few years until all existing groundwater abstractions are licenced and NRW does not currently have a list of groundwater abstractions within the study area.

8.3.98 The IACC maintains a list of PWSs under the Private Water Supplies (Wales) Regulations 2010. The IACC provided information on a total of 29 wells within the outer groundwater study area. The majority of these are historical public supplies and are no longer in use for any purposes, although some of these are still physically present within the groundwater inner study area. The three historical public supply wells within the Wylfa Newydd Development Area which have the potential to be lost as part of the construction works, have been confirmed to no longer be used as water supplies.

8.3.99 Three PWSs were identified within the inner groundwater study area, Foel Fawr, Caerdegog Uchaf and Cae Gwyn. Their locations are shown on figure D8-3 (Application Reference Number: 6.4.101). Foel Fawr PWS has been sampled for chemical analysis. Caerdegog Uchaf and Cae Gwyn have not been sampled due to access restrictions. These two properties are towards the edge of the inner study area and up hydraulic gradient of the Wylfa Newydd Development Area. As such, it is unlikely that water quality at these locations would be affected by the work across the Wylfa Newydd Development Area.

8.3.100 In Wales, all Water Framework Directive (WFD) designated groundwater bodies, including the Ynys Môn Secondary groundwater body, are designated as Groundwater Drinking Water Protected Areas. These areas have to be protected with the aim of avoiding deterioration in their water quality which would compromise a relevant abstraction of groundwater intended for human consumption. The status of water bodies under the WFD, as opposed to Drinking Water Protected Areas, is considered below.

Existing buildings

8.3.101 To consider the potential effects on building foundations due to the lowering of the bedrock groundwater table, existing buildings have been considered. The nearest main development at the time that dewatering starts would comprise the Existing Power Station, although, due to the nature of the construction it is only services and/or the smaller ancillary buildings that could be affected if there was any drawdown. In addition to the ancillary buildings at the Existing Power Station there are buildings in the village of Tregele which

could potentially be affected. Further isolated buildings are also present close to the boundary of the Wylfa Newydd Development Area (see figure 8-4, Application Reference Number: 6.4.101 for properties that have been identified in groundwater modelling work as having the potential to be most affected).

Water Framework Directive

8.3.102 The WFD requires the consideration of any effects associated with the introduction of a modification or change in activity/structure on or near a WFD water body to determine if it could cause deterioration in any quality elements. A WFD compliance assessment is required to assess if the potential effects are deemed to be substantial and cause a deterioration in the status of a WFD water body or prevention of it achieving Good Ecological Status or Good Ecological Potential and consideration of deterioration in status of a groundwater body from “good” to “poor”.

8.3.103 Consideration must also be given to whether the works could prevent any planned mitigation measures or actions intended to achieve Good Ecological Status or Good Ecological Potential from being implemented, potentially resulting in the WFD water body failing to meet its objectives.

8.3.104 A Preliminary WFD Report was provided to NRW in 2016 for comment, in particular to agree upon the WFD water bodies to be screened in for assessment. The comments have subsequently been taken into account in the detailed WFD Compliance Assessment (Application Reference Number: 8.26).

8.3.105 The surface water study area is within the geographical coverage of the Western Wales River Basin District and is included in the corresponding Western Wales RBMP. One fluvial WFD water body, three coastal WFD water bodies and one groundwater WFD water body have been identified within the study areas. Due to the lack of potential direct or indirect effects on the only fluvial WFD water body (Wygyr – GB110102059170), this receptor has been scoped out of further assessment. The other surface waters within the hydrology study area form part of the coastal WFD water bodies. The coastal WFD water bodies are described in table D8-3 whilst the groundwater WFD water body (which includes the superficial and bedrock aquifers) is described in table D8-4.

8.3.106 Under the WFD, NRW requires all potentially impacted watercourses within the coastal WFD water body catchments to be considered and assessed. Impacts have been assessed using fluvial WFD parameters; however, the overall assessment is displayed as a potential impact to the relevant coastal WFD water body (table D8-3). Within this chapter, the Afon Cafnan, Nant Caerdegog Isaf and tributary of the Afon Cafnan are considered part of The Skerries coastal WFD water body; the Nant Cemaes and the Tre’r Gof SSSI drains form part of Anglesey North WFD water body whilst the Nant Cemlyn forms part of the Cemlyn Lagoon WFD water body.

Table D8-3 Coastal WFD water body quality elements [RD3]

Element	Classification		
WFD water body no.	GB11010390000	GB641010620000	GB610100083000
WFD water body name	The Skerries	Anglesey North	Cemlyn Lagoon
Typology	Exposed, microtidal	Moderately exposed, microtidal	Coastal water body
Hydromorph-ological status	Not A/HMWB*	Not A/HMWB*	HMWB*
Overall ecological status	High	Moderate	Good potential
Chemical status	Good	Fail	Good
Ecological status	High	Good	Good potential

*A/HMWB – artificial/heavily modified water body

Table D8-4 Groundwater WFD water body quality elements [RD3]

Element	Classification
WFD water body no.	GB41002G204400
WFD water body name	Ynys Môn Secondary
Overall status	Poor
Quantitative status	Good
Chemical status	Poor

8.3.107 The RBMP [RD9] was the subject of a public consultation process during the first half of 2015. Specifically, the Ynys Môn Management Catchment Summary formed part of this consultation. The summary briefly describes the current status of the water environment and its main challenges, objectives and measures. The stated aim is "*…to develop a single integrated programme of measures by 2021 that meets Water Framework Directive Objectives*". The objectives include the following:

- prevent deterioration in status of a water body (from current status);
- achieve the objectives for protected areas (i.e. water-dependent Natura 2000 sites); and
- aim to achieve good overall status for surface water and groundwater.

Summary of receptors

8.3.108 A summary of the identified receptors is provided in table D8-5, along with their value. The value for the receptors has been determined based on the methodology provided in chapter B8 (Application Reference Number: 6.2.8) and detailed in section 8.3 of this chapter. Only receptors of a low, medium or high value are taken through to the effects assessment, with receptors of negligible value being scoped out of further consideration.

8.3.109 The WFD Ynys Môn Secondary Groundwater Body relates to both groundwater in the bedrock aquifer and the glacial till aquifer, and considers these as a single unit across the majority of Anglesey. However, it is the groundwater in the study area that is being considered as a receptor in this assessment and so this is termed the "Secondary aquifers". This term incorporates the Secondary B bedrock aquifer and the Secondary (Undifferentiated) glacial till aquifers. Although observations from the GIs indicate that the Secondary (Undifferentiated) glacial till aquifer would not form a productive aquifer due to the predominantly clay matrix of the glacial till (see appendix D8-3 (Application Reference Number: 6.8.30), it is still included here as a receptor.

8.3.110 Although the strata at the Tre'r Gof SSSI are classified as a Secondary A aquifer, this designation is believed to be incorrect as it is based on limited geological data. Borehole and piezometers installed into and around the SSSI indicate that the SSSI comprises peat overlying silts and clays (appendix D8-5, Application Reference Number: 6.4.30). These strata will not form a productive Secondary A aquifer and so have been treated here as a Secondary (Undifferentiated) deposit.

8.3.111 Marine receptors are not included in this chapter as these are discussed in chapter D13 (Application Reference Number: 6.4.13). As noted previously, Cemlyn Lagoon is considered in both the marine chapter and this chapter as it is a brackish coastal lagoon which can be affected by changes to both environments.

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Table D8-5 Freshwater receptors and assigned values

Receptor	Value	Rationale for value
Surface water receptors		
Tre'r Gof Catchment and water within the Tre'r Gof SSSI	High	Water supporting a site with a high environmental importance and international or national value.
Afon Cafnan Catchment	Medium	Main river within a catchment, locally important watercourse.
Water within the Cae Gwyn SSSI	High	Water supporting a site with a high environmental importance and international or national value.
Cemaes Catchment	Medium	Main river within a catchment, locally important watercourse.
Cemlyn Catchment	High	Water supporting a site with a high environmental importance and international or national value.
Water within the Cemlyn Bay SSSI	High	Water supporting a site with a high environmental importance and international or national value.
Power Station Catchment	Low	Minor watercourse.
Flood risk receptors	Medium to High	All construction areas, temporary and permanent structures and supporting infrastructure are key receptors for flood risk, as well as all onshore land outside of the Wylfa Newydd Development Area boundary where there is a potential flood risk downstream of the development. Further details are provided in the FCA in appendix D8-4 (Application Reference Number: 6.4.29).
Fluvial geomorphology receptors		
The Tre'r Gof SSSI drains	Low	A network of small drains, likely to have been historically modified and with a limited range of morphological features.

Receptor	Value	Rationale for value
Afon Cafnan	Medium	A watercourse that appears to be adjusting following historical channel change and exhibits some morphological features. Watercourse has a gravel-bed with a riffle-pool sequence and localised areas of erosion and deposition.
Nant Caerdegog Isaf	Low	A small gravel and silt bed watercourse with limited geomorphological features including areas of erosion and deposition.
Nant Cemaes	Low	A small stream with straight planform with limited vegetated riparian buffer. Some channel adjustment.
Nant Cemlyn	Low	A small stream with a straight planform and some channel adjustment through erosion.
Nant Porth-y-pistyll	Low	Small artificially straight watercourse with limited morphological features.
Groundwater receptors		
Groundwater in Secondary Aquifers	Low	Low productivity aquifers including glacial till and bedrock.
Private water supplies	Medium	PWSs serving three or more (but fewer than 50) properties and where viable alternative supplies are available.
Historical public wells	Low	Wells not used for a potable or other use for many years.
Ancillary buildings and services at the Existing Power Station	High	Infrastructure of national importance. Potential effects due to lowing of the bedrock groundwater table leading to subsidence.
Off-site properties (houses/farms)	High	Residential properties. Potential effects due to lowering of the bedrock groundwater table leading to subsidence.
The Wylfa Newydd Development Area following decommissioning*	High	Former Power Station infrastructure would remain on-site for some time during and following the decommissioning process.

Receptor	Value	Rationale for value
		The land could ultimately be brought back to beneficial use.
Tre'r Gof Catchment and water within the Tre'r Gof SSSI	High	Secondary receptor for groundwater. Site designated as a GWDTE. Water supporting a site with a high environmental importance and international or national value.
Water within the Cae Gwyn SSSI	High	Secondary receptor for groundwater. Site designated as a GWDTE. Water supporting a site with a high environmental importance and international or national value.
Water within the Cemlyn Bay SSSI	High	Secondary receptor for groundwater although this SSSI is not designated as a GWDTE. Water supporting a site with a high environmental importance and international or national value.
Nant Cemlyn	High	Secondary receptor for groundwater. Water supporting a site with a high environmental importance and international or national value.
Afon Cafnan	Medium	Secondary receptor for groundwater. Main river within a catchment, locally important watercourse.
Nant Porth-y-pistyll	Low	Secondary receptor for groundwater. Minor watercourse.
Nant Cemaes	Medium	Secondary receptor for groundwater. Main river within a catchment, locally important watercourse.
Land at the Power Station (post decommissioning)	High	The land would be of high value post decommissioning

* This receptor is related to the land within the Wylfa Newydd Development Area which following decommissioning has the potential to be subject to groundwater flooding.

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Evolution of the baseline

Surface water

8.3.112 Further information on the evolution of the surface water baseline is provided in appendix D8-1 (Application Reference Number: 6.4.26). In summary the following is considered.

- **Evolution due to climate change.** The direct effect of climate change on surface water depends primarily upon the change in the intensity, volume and seasonal distribution of rainfall. Drier, warmer summers could lead to reduced flows in watercourses which would result in less water available for riparian use and other abstractions, and could also affect flora and fauna living in or by watercourses. Some watercourses could dry up completely in the summer months. More intense rain storms in the summer months could give rise to more rapid runoff and result in localised flooding and affect water quality. Similarly, an increase in rainfall volume, particularly in winter when it falls on saturated soils, could give rise to prolonged periods of flooding over much larger areas than is currently the case and it could also increase suspended sediment loads. Climate change is provided by UK Climate Change Projections (UKCP09) [RD17] including the principle that climate change will likely increase the risk of coastal and river flooding. Climate change allowances are included in the FCA (appendix D8-4, Application Reference Number: 6.4.29).
- **Evolution due to changes in abstractions.** It is possible in the future that if there were longer, drier summers that surface water abstraction could become more common and widespread, particularly for agricultural purposes in the summer months.

Fluvial geomorphology

8.3.113 In summary the following evolution is considered with respect to fluvial geomorphology.

- **Evolution due to natural adjustment.** The Afon Cafnan, Nant Llygeirian and Nant Cemlyn are currently exhibiting some evidence of channel adjustment. These channels have been assessed as having a low to moderate energy, with limited competence to actively move the course of the planform. It is anticipated that if left undisturbed, the watercourses would continue to adjust slowly laterally and potentially through incision within the defined wider corridor. The remaining watercourses in the study area (Tre'r Gof SSSI drains, Nant Porth-y-pistyll, Nant Caerdegog Isaf and Nant Cemaes) exhibited less evidence of adjustment, with lower energies (arising from a combination of low slope/discharge). These were observed to be typically artificial field drains and artificial extensions to the drainage network. These could potentially continue receiving fine sediment, which would become

deposited and, in the absence of maintenance to remove accumulated deposits, remain on the channel bed.

- **Evolution due to meeting policy objectives.** The Western Wales RBMP provides details of the anticipated ecological status (which is partly dependent on stream morphology) for the WFD water bodies within the study area for years 2021 and subsequently 2027. As suitable mitigation is put in place, it is anticipated that WFD water body status and the quality elements (including hydromorphology) would improve.
- **Evolution due to climate change.** Over a medium to long-term time period, climate change could potentially alter the hydrological regime of the watercourses. Increased frequency/severity of droughts and floods could potentially lead to the watercourses adjusting to different patterns of erosion and deposition. However, it is likely that the adjustment would remain localised and of relatively low magnitude given the channel types.

Groundwater

8.3.114 Further information on the evolution of the groundwater baseline is provided in appendix D8-3 (Application Reference Number: 6.4.28). In summary the following is considered.

- **Evolution due to reasonably foreseeable development**. For reasonably foreseeable external third party projects as identified in volume I (cumulative assessment) of this Environmental Statement, there would be no impact on groundwater resources and associated receptors that would significantly change the groundwater baseline.
- **Evolution due to climate change**. Over the medium-term and long-term, groundwater resources in the groundwater study area may be affected by climate change. However, any changes would be complex and may result in:
  - a long-term decline in groundwater storage due to higher soil moisture deficits due to warmer, drier summers; and
  - increased frequency and severity of groundwater droughts leading to reduction in base flow to watercourses or GWDTEs.
- **Evolution due to changes in groundwater abstraction**. There is no reason to suspect any significant changes in groundwater abstractions across northern Anglesey.
- **Evolution due to changes in groundwater quality**. Based on currently available information, there is unlikely to be a significant change in the baseline groundwater quality. Changes to the groundwater regime brought about by climate change are unlikely to affect groundwater quality (for example, saline intrusion would not be anticipated).

8.3.115 Overall, changes to the current baseline for surface water, fluvial geomorphology and groundwater are likely to be limited in the foreseeable future.

8.4 Design basis and activities

8.4.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that would be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

8.4.2 Details of the design for the Power Station, Site Campus, landscape mounds and drainage are provided in chapter D1 (proposed development) (Application Reference Number: 6.4.1) along with detailed descriptions of the development phases and activities. The approach adopted for the design of the Power Station, Site Campus and landscape mounds has been to utilise a parameter approach to the development. Parameter plans have been submitted with the application for development consent and show the extent of each parameter zone as shown in figures D1-1 to D1-6 (Application Reference Number: 6.4.101).

8.4.3 For the Power Station, parameters have been set for platform elevation and for building location and size. With regard to platform elevation, ten work areas have been identified with a range of minimum and maximum elevations from 6mAOD to 34mAOD (see table D1-1 in chapter D1 (Application Reference Number: 6.4.1).

8.4.4 The groundwater model used to assess the effects of groundwater dewatering (appendix D8-7, Application Reference Number: 6.4.32) has assumed a maximum depth of dewatering down to -18mAOD. Although the design depth for the excavation is -16.9mAOD, the modelled depth is slightly deeper to allow for any sumps needed in the base of the excavation for dewatering. This also makes the model slightly more conservative than would otherwise be the case.

8.4.5 With regard to building/structure location and size, parameter zones for the Power Station, including building/structure length, width and height, have been set as detailed in table D1-2 in chapter D1 (Application Reference Number: 6.4.1). As the area outside of the buildings/structures will be predominantly hardstanding with very little landscaped area, the majority of rainfall runoff would be to drains with little recharge to groundwater. The actual above-ground size of the buildings within the parameter zones would not therefore have any effect on the surface water and groundwater environment as rainfall runoff would be either from buildings or hardstanding and flow into the surface water drainage system.

8.4.6 However, the extent of parameter zones could have an important effect as they could change the extent of hardstanding area and runoff that is apportioned between natural catchments when compared to the baseline. The worst case situation would be all parameter zones at the Power Station covered with buildings/structures or hardstanding to the maximum extent with no/minimal landscaped areas.

8.4.7 The extent of the parameter zones for the Power Station Site have been compared to the extent of hardstanding used in the surface water modelling.

Comparison of the areas of hardstanding defined by the parameter plan areas to the areas of hardstanding modelled in the surface water modelling, shows that there may be a slight reduction in the amount of hardstanding within the Power Station Site. It is not considered that the slight difference in impermeable area would materially affect the level of flood risk from the assessment presented in this chapter.

8.4.8 For the Site Campus, parameter zones have been established that identify the location of the accommodation blocks, amenity building, substation, cycle store and other facilities. The parameters listed in table D1-11 in chapter D1 (Application Reference Number: 6.4.1) only allow the size of the buildings to be changed within each zone and this has the potential to change groundwater recharge and rainfall/runoff response. Smaller buildings would mean more landscape area which would result in less rapid rainfall runoff and more infiltration to the ground. As the largest building size would result in the most change from baseline it is this that has been assessed in this chapter as it represents the worst case within these parameters.

8.4.9 For the Wylfa Newydd Development Area, parameter zones have been set for the construction works and the five landscape Mounds A to E, including height and slope. Details can be found in Table D1-4 of chapter D1 (Application Reference Number: 6.4.1).

8.4.10 The assessment of effects due to storm runoff has used a likely worst case for the mounds as they would be constrained in terms of height and footprint. The storm water settlement ponds considered in the assessment have been sized in relation to the size and slope angle for each mound. If the slope-angles were to change significantly this would require reassessment of the size of the settlement ponds.

8.4.11 In the case of the Tre'r Gof, SSSI, the construction parameter plan limits the extent of works around the Tre'r Gof SSSI and provides a buffer between the area that work would take place in the Wylfa Newydd Development Area, and the SSSI.

Construction

Basis of assessment and assumptions

8.4.12 The activities relevant to surface water, fluvial geomorphology and groundwater as set out in chapter D1 (Application Reference Number: 6.4.1) and appendix D1-1 (construction method statement) (Application Reference Number: 6.4.17) that are considered within this chapter are as follows.

- Construction site establishment (Site Preparation and Clearance works and the Main Construction phase), including:
  - Establishment of the Main Site Compound and satellite and material compounds. Compounds would not be constructed within 15m of main rivers or 8m of ordinary watercourses.
  - The Main Site Compound and associated construction establishment facilities would be surfaced with different surface materials depending on operational, safety and security requirements.

Hardstanding with falls to drainage trenches would be used for the Main Site Compound and other areas where required. Graded and compacted stone would be used in other areas and would enable rainfall to percolate into the ground rather than forming surface water runoff. Drainage (comprising stone-filled trenches or perforated pipes) would be installed beneath the surfacing to prevent runoff onto the Existing Power Station access road. This would be channelled and discharged to swales located adjacent to all areas of the site establishment facilities.

- Construction of temporary parking areas associated with the Main Site Compound for office workers and the workforce.
- Creation of laydown areas.
- A fuel store would be constructed within the Main Site Compound and used to supply the double-skinned mobile fuel bowser. Fuel would be delivered to the compound for storage within a single 15,000L tank with a bund capacity 110% of the storage volume. The tank would be located in a facility on a concrete hardstanding area with secondary containment systems (such as bunds) with vehicle damage protection and integrated drainage. The drainage would pass through an oil/water interceptor prior to discharge to a swale.
- Mobile fuel bowsers would be transported around the Wylfa Newydd Development Area to refuel plant and machinery.
- The Material Compounds would be located around the Wylfa Newydd Development Area and would be used for the temporary storage of materials from building demolition, removal of walls etc. during the Site Preparation and Clearance works.
- Where practicable, the Satellite and Material Compounds would be sited partially on existing areas of hardstanding with the remaining areas surfaced with crushed stone.
- Creation of laydown areas for the Main Construction works principally in the south-west and east of the Wylfa Newydd Development Area and creation of areas for delivery and storage of hazardous materials and storage and removal of waste. On completion of construction work, the western laydown area would become a building platform and landscape Mound D. The eastern platform would become the location of landscape Mound B.
- Construction of concrete batching plant in the north-west of the Wylfa Newydd Development Area.
- Demolition of remaining buildings, clearance of stone walls, gates and field boundaries down to ground level.
- Removal of trees and hedges to ground level and above-ground features.

  - Ground improvement works comprising removal of contaminated soils from areas of potential concern and treatment or removal of invasive non-native species. Contaminated soils would be treated in an on-site remediation processing compound.
  - Construction of access roads, haul roads and a security track adjacent to the perimeter fence. This would include diversion of the Existing Power Station access road including a temporary bridge (this is a land bridge and does not cross a watercourse). Creation of construction routes and temporary bridges/culverts, including the Afon Cafnan crossing. The haul road bridge over the Afon Cafnan would be clear span and of an appropriate construction and design (to be agreed with the regulators), to reduce the potential for flooding as far as practicable.
  - Topsoil and subsoil would be stripped from all areas required for development. All topsoil and subsoil removed during construction would be temporarily stored within the Wylfa Newydd Development Area and ultimately re-used to top landscape mounds. The maximum duration of temporary soil storage would be approximately eight years. Topsoil would be stripped from a number of areas including: the footprints of the land-based Power Station Site; Site Campus; haul roads; satellite and material compounds; and, the proposed new channel of the watercourse realignment.
  - Watercourse (Nant Caerdegog Isaf) realignment.
  - Installation of surface water site drainage, including construction of outfalls (these may require appropriate permits from NRW or the IACC depending upon the nature of the work and the watercourse). The surface water drainage scheme for site construction is detailed in appendix D8-8, Summary of preliminary design for construction surface water drainage (Application Reference Number: 6.4.33). The surface water drainage system would be installed prior to any major earth works (including topsoil stripping) and would remain in place throughout the construction works. To control suspended solid concentrations, an active treatment system would be installed which, when required, would use a polyelectrolyte to aid settlement. Following construction, most of this drainage system would remain, and that remaining would be a passive system (i.e. the ditches and swales and settlement ponds would remain but the active polyelectrolyte treatment equipment and any additional temporary measures such as silt fences, would be removed).
- Construction of temporary buildings:
  - Construction of security access and site entrance plaza to the south-east of the Power Station Site.
  - Creation of the Site Campus in the northern part of the Wylfa Newydd Development Area, partly within the Tre'r Gof Catchment. This would

be constructed, operated and decommissioned during the construction period for the Power Station.

  - Temporary buildings to be erected on the Main Site Compound to provide office and welfare facilities during the early site clearance works. The amount of office and welfare facilities provided would then increase to suit the workforce profile as Main Construction progresses.

- Major civil groundworks:
  - Creation of a series of level platforms including at the cooling water intake, for the two Units, for the laydown areas, and for numerous structures associated with the two Units.
  - Bulk earthworks.
  - Deep excavation for reactor and turbine building basements, including groundwater dewatering. Both Units would be constructed within a single excavation together with the excavation for the cooling water intakes and tunnels from the intakes to the reactor building. The excavations for the reactor and turbine buildings would be down to an elevation of approximately -18mAOD. With the platform at between 6mAOD and 22mAOD, this means that the excavations would be around 22m to 38m deep. The target dredge depth for the MOLF would be -10mAOD down to -13mAOD at the berthing pockets.
  - Excavation for other features including for the cooling water outfall tunnels in the cut-and-cover section of the tunnel. The cut-and-cover sections of the cooling water outfall tunnel would be the sections of tunnel closest to the excavation for the Units and at the outfalls to the north of the Existing Power Station. The remaining section of cooling water outfall tunnel would be constructed by road header and drill and blast methods depending on depth and ground conditions.
- Groundwater dewatering:
  - In order to work deep excavations in the dry, dewatering of the excavations would be required to remove groundwater and rainfall ingress to the excavations. Drawdown of water levels in the deep excavation would be to just below the base of the excavations at -16.9mAOD, so groundwater levels would be pumped to a level of about -18mAOD. Water levels would need to be controlled to this depth over an area of around 150,000m^2 for approximately 2 to 3 years. The proposed method of dewatering would be to manage the inflows by a combination of drains, ditches and surface grading within the excavation to collect the water in the excavations and pump it to sediment settlement ponds located on the working platform. This water would then be discharged to the sea (see chapter D13,

Application Reference Number: 6.4.13 for an assessment of the effects of this discharge).

- A groundwater model has been established to assess the effects of dewatering on the groundwater receptors. This model also provides an estimate of how much water may be removed from the excavation by pumping (appendix D8-7, Application Reference Number: 6.4.32). The model results show that for the most likely modelled scenario, an estimated 175m^3/day of groundwater would be abstracted from the excavations (45m^3 from the seaward excavation and 130m^3/day from the inland excavation) with typically a further 750m^3/day of direct rainfall being abstracted. The amount of rainwater removed would vary greatly from day to day. The model results based on the historical rainfall data show a range of 0m^3/day to in excess of 5,500m^3/day of rainfall being removed from the inland and seaward excavations.
- To reduce groundwater inflow to the excavation, particularly through fractures, the walls of the deep excavations would be sprayed with concrete ('shotcrete') as the excavation deepens. As such, the model results are likely to be an overestimate of the extent of drawdown and the groundwater volumes that would need to be abstracted (the direct rainfall volumes to be abstracted, however, would not be affected by this mitigation measure).
- To reduce surface water inflows running into the excavations, a bund and surface water drains would be installed around the periphery of the excavation.

- Material stockpiles and mounding:
  - Creation of temporary stockpiles of material.
  - Creation of landscape mounds. Following creation of the mounds with site-won material, the landscape mounds would be covered with topsoil collected from the temporary topsoil mounds and vegetated as soon as practicable.
- Marine construction:
  - MOLF.
  - Construction and removal of temporary cofferdam and dewatering from behind the dam to provide a dry working area.
  - Construction of cooling water intake and outfall facilities with local dewatering to provide a dry working area. The excavation for the intake facilities would form one combined excavation with the excavation for the deep basements required for the Units.
- Building and infrastructure construction:
  - Unit 1 and Unit 2 reactor and control buildings.
  - Other main plant buildings.

  - Construction of the Power Station Site permanent drainage, security fencing and parking.
  - Construction of utilities infrastructure.
- De-mobilisation and removal of temporary facilities:
  - Removal of the contractor(s) compounds and fuel storage facilities.
  - Removal of the concrete batching plant.
  - Clearance and landscaping of material storage and laydown areas.
  - Demolition of the Site Campus in the north-east of the Wylfa Newydd Development Area.
  - Removal of temporary haul roads and any temporary bridges.
  - Removal of water treatment facilities and conversion of the active drainage system around the landscape mounds to a passive system.

8.4.13 All water supplies for construction activities and for potable supply in the Site Campus and elsewhere around the construction site would be provided from the water main by Dŵr Cymru Welsh Water (DCWW) (Application Reference Number: 6.4.17). It has been estimated by Horizon that during the construction phase, a peak demand of potable water would be 2,550m^3/day excluding potable water required for the Site Campus which would be around 400m^3/day (so a potential maximum of 2,950m^3/day although over any given day the peak potable water use within the site campus will be at a different time of day to that of the construction site). However, the requirements of the latter would vary during the construction programme depending upon the number of workers housed at the Site Campus and this has been discussed with DCWW.

8.4.14 This supply would be provided from within DCWW's existing licensed abstractions with no requirement for new abstractions or increase in licensed quantities for existing abstractions. As these licensed quantities were subject to detailed environmental assessment at the time of issue and subsequently as part of water management plans, any impacts of water supply are not considered within this Environmental Statement.

8.4.15 As set out in appendix D1-1 (Application Reference Number: 6.4.17) construction sewage would be dealt with by the construction sewage package plant, with sewage from the Site Campus treated at the existing DCWW Cemaes Waste Water Treatment Works, with the latter likely to be extended as required by the number of workers staying at the Site Campus. There would be no discharges of treated foul sewage to fresh surface water and all discharges would be to the sea and are therefore assessed in chapter D13 (Application Reference Number: 6.4.13).

Embedded mitigation

8.4.16 As detailed in chapter D1 (Application Reference Number: 6.4.1) a buffer zone around the Tre'r Gof SSSI would be put in place. This zone would be a minimum of 20m to the north and west adjacent to the Site Campus, a 50m buffer around the south of the SSSI, with approximately 100m on the SSSI's south-eastern and eastern sides where the most sensitive areas within the

SSSI have been identified. Although there would be some work inside the buffer this would be limited to the installation of drainage on the northern side of the SSSI associated with the Site Campus and drainage around the south, east and north-east of the SSSI to manage runoff from the landscape mounds. The drainage around the northern side of the SSSI would seek to maintain the shallow groundwater flow to the SSSI.

8.4.17 The drainage design detailed in appendix D8-8 (Application Reference Number: 6.4.33) has incorporated the following features for the Tre'r Gof SSSI:

- A permeable drainage blanket made up of inert rock material beneath the Mound A to the south and east of the Tre'r Gof SSSI. This will allow the shallow groundwater and surface water runoff flowing from the south and east of Mound A to flow under the mound into the SSSI as it currently does. The drainage blanket would be continued beneath the drainage ditch so that water can seep from the base of the drainage ditch into the drainage blanket and move towards the Tre'r Gof SSSI (see appendix D8-8, Application Reference Number: 6.4.33 for more detail). The use of inert rock will seek to ensure that the shallow groundwater chemistry does not change appreciably from the baseline conditions.
- Overflow features (e.g. low points in the ditch bank, gravel fill in patches of the bank or pipes) at intervals of about 50m in the drainage ditch to the north and west of Mound A. This will mean that during times of higher rainfall, water will flow from the ditch to the ground adjacent to the drain, allowing overland flow to the Tre'r Gof SSSI to be maintained. The effect of this will be monitored and the overflow features modified where necessary to control the flow to the SSSI.
- The drainage system has been designed to incorporate as much flexibility as possible so that changes can be made to drainage water treatment and to the volume of water being released to various discharge points during the construction period.

8.4.18 As set out in the Landscape Principles of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) the landscape mounding has been designed to avoid changes in catchment boundaries as far as practicable. This notwithstanding, some changes do result from the mounding and these have been taken into account in this assessment. The designs have reduced the potential for changes in baseline flow in watercourses around the mounds by trying to keep the runoff volume the same (i.e. by not significantly changing the extent of the catchment) although where mounds would become steeper the speed of runoff would increase. These changes have been considered in this assessment.

8.4.19 As set out in the Phasing Strategy (Application Reference Number: 8.29), Horizon would install appropriate drainage on-site prior to main construction to manage run-off. This would include combined attenuation and sediment settlement ponds, with the attenuation being sized to manage 1 in 100 year events to greenfield runoff rates. The sediment settlement pond and

associated treatment would be employed to meet water quality thresholds. An application would be made for an Environmental Permit which would set limits on the concentrations of substances which could be discharged to protect the receiving surface water.

8.4.20 As set out in the Main Power Station Site sub-Code of Construction Practice (CoCP) (Application Reference Number: 8.6) surface water runoff from exposed topsoil during construction and later from the newly formed landscape mounds will be managed by a treatment train of sustainable drainage system (SuDS) features, as detailed in appendix D8-8 (Application Reference Number: 6.4.33). Sediment settlement ponds would be used in conjunction with other measures including silt traps, silt curtains, silt fences and vegetated channels. Ditches would be constructed around the base of the landscape mounds to allow flows to be captured and discharged to the drainage system. The discharge limit for suspended solids for each discharge point would be set in the construction Environmental Permit with the limit set based on baseline conditions so that there would be no significant effect on the receiving water. The design has been prepared to meet a minimum treatment standard of between 40mg/l and 70mg/l total suspended solids (depending upon the background concentration in the receiving watercourse) during normal rainfall conditions.

8.4.21 During rainfall events that exceed the 1 in 2 year return period the treatment systems would all continue to operate, but it is likely that the volume of water entering the system would be greater than that capable of being treated. In these instances, where practicable water would be retained in the sediment settlement ponds (which are also flow attenuation ponds, designed to manage up to a 1 in 100 year event) and the stored water treated when flows into the system decline. In the event that the storage and sediment treatment system is overwhelmed, overflow discharge would be direct to stream without treatment of the overflow water (treatment would continue for water routed through the treatment train). At these times sediment will naturally be higher in the receiving watercourses, as identified during background monitoring (appendix D8-1, Application Reference Number: 6.8.26) where concentrations of over 1000mg/l total suspended solids have been measured.

8.4.22 Chemical dosing using polyelectrolyte coagulant may be required to meet the concentrations specified in the Environmental Permit and would almost certainly be required during the construction stage if there is insufficient settlement of solids in the settlement ponds (e.g. due to high flow rates). Details are provided in appendix D8-8 (Application Reference Number: 6.4.33). The 40 to 70mg/l limits could be met for the majority of the time by the passive system of settlement ponds and swales, with the active treatment system when required. Ultimately the outfall concentration would need to meet the conditions for each outfall set in the construction Environmental Permit which would be agreed with NRW.

8.4.23 In order to manage the risks to Cemlyn Lagoon, the drainage to Nant Cemlyn would be modified as part of construction activities as detailed in appendix D8-8 (Application Reference Number: 6.4.33). Prior to construction commencing the drainage system would be installed around the base of Mound E. Once topsoil stripping and soil movement commences the drainage

from Mound E would be collected, treated and routed to the Afon Cafnan. There would therefore be no discharges to the Nant Cemlyn during construction, until the western side of Mound E is vegetated and there is no risk of sediment runoff (except that which would naturally occur). Once fully vegetated the drainage would be re-routed back to the Nant Cemlyn via the attenuation pond which would be used to attenuate flows to greenfield runoff rates.

8.4.24 The Site Campus would be constructed in a phased manner. The first construction would be to the northwest of, and as far as practicable from, the Tre'r Gof SSSI. As on-site accommodation increases, then construction would come closer to the Tre'r Gof SSSI. As set out in volume 3 of the Design and Access Statement (Associated Developments and Off-Site Power Station Facilities) (Application Reference Number: 8.2.3) all surface water during construction of the Site Campus will run into a drainage channel to the east and west and discharge into attenuation ponds, to allow appropriate sedimentation control. After each phase of Site Campus construction, surface water drainage from the completed elements of the Site Campus will either run into the ground around the site, or into surface water channels to the east of the site. Discharges to the west will be taken to the outfall currently used by the foul water treatment plant. Drainage design for operation of the Site Campus will include attenuation of discharge to surface water (e.g. geocellular attenuation tank) and recharge of storm water runoff (e.g. via infiltration trenches, reno mattress, swales) in order to reduce potential hydrological effects on the SSSI arising from surface water flows.

8.4.25 Water would be pumped from the car park runoff system to a recharge trench along the boundary with Cae Gwyn SSSI.

8.4.26 As set out in appendix D1-1 (Application Reference Number: 6.4.17) oil interceptors would be provided to areas of hardstanding where there is a potential risk from oil/fuel contamination (e.g. at car parking areas). This would mitigate potential effects of oil/fuel on water quality.

8.4.27 As set out in volume 2 of the Design and Access Statement (Power Station Site) (Application Reference Number: 8.2.2), appropriate construction drainage will be installed prior to construction of the Spent Fuel Store, including any necessary treatment of runoff water prior to discharge. Detailed construction drainage will be designed to prevent any increases in flood risk to off-site receptors through the inclusion of appropriate attenuation.

8.4.28 Horizon will develop a passive engineered drainage system by completion of construction as set out in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). The drainage system will be managed in relation to sensitive ecological receptors and incorporate appropriate attenuation to prevent any increases to flood risk off-site and reduce significant effects on water availability.

8.4.29 As stated in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2), surface water drainage will discharge to the sea, subject to qualitative and quantitative control measures set in an Environmental Permit authorising the discharge.

Good practice mitigation

8.4.30 Horizon will comply with relevant legislation (including, but not limited to, the Water Resources Act 1991, the Environmental Permitting Regulations 2016 and the Land Drainage Act 1991 (as amended)), as set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6).

8.4.31 Horizon will implement working methods to protect surface water and groundwater from pollution and other adverse impacts, including changes to flow, flood storage volume, water levels and water quality as set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6).

8.4.32 The water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the water management strategy of the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) set out the strategies to be applied throughout the construction period to protect water resources. As stated in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) Construction Industry Research and Information Association (CIRIA) Guidance will be adopted as appropriate from the following publications:

- Environmental Handbook for Building and Civil Engineering Projects (3 Parts: C512 [RD18], C528 [RD19] and C529 [RD20]).
- Control of water pollution from construction sites. Guidance for consultants and contractors (C532) [RD21].
- Environmental good practice on site guide (fourth edition) (C741) [RD22].
- Land use management effects on flood flows and sediment – guidance on prediction (C719D) [RD23].
- The SuDS Manual (C753) [RD24].
- Development and flood risk – guidance for the construction industry (C624) [RD25].
- Culvert Design and Operating Guide (C689) [RD26].

8.4.33 Horizon will ensure suitable procedures are in place to provide protection for watercourses, such as appropriate control measures and resources to manage the risk of spills and accidents, as set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

8.4.34 In line with CIRIA Guidance C741, Environmental Good Practice on Site Guide [RD22], buffer zones will be established adjacent to watercourses. Requirements for buffer zones for specific surface water receptors are set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6).

8.4.35 To protect surface waters, suitably demarcated buffer zones will be established adjacent to the following watercourses that have been identified as potentially most affected, as set out in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7):

- A 15m buffer zone along the Nant Cemlyn and Nant Cemaes where the watercourses cross the Wylfa Newydd Development Area.
- A 15m buffer around watercourses draining into the Tre'r Gof SSSI.
- A 15m buffer zone along the Afon Cafnan and its main tributary (Nant Caerdegog Isaf). For the watercourse realignment on the Nant Caerdegog Isaf, a risk assessment approach will be undertaken with relevant approval and consents for works from NRW.

8.4.36 Where unavoidable small scale works are identified as being required within these buffer zones, detailed methodologies and risk assessments will be developed by Horizon that ensure those works can be undertaken without adversely affecting the designated areas or their special interest features. Examples of small scale works that may be required include installing appropriate types of fencing, vegetation management, and undertaking monitoring surveys within the buffer zones.

8.4.37 Horizon will carry out a risk assessment for all works within surface water buffer zones, including but not limited to, vegetation management adjacent to watercourses, construction of bridges and drainage outfalls. Furthermore, a risk assessment will be undertaken for use of any cementitious materials within 50m of any active watercourse. Appropriate controls, proportionate to the level of risk identified, will be applied to the works.

8.4.38 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) adequate drainage systems will be installed prior to construction works with appropriate treatment prior to discharge. This will include sediment treatment and the inclusion of oil separators where necessary. The drainage system will be appropriately maintained throughout the works such that it remains efficient. Sediment would go to sediment lagoons.

8.4.39 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) measures will be taken to prevent the deposition of silt or other material arising from work operations in existing watercourses or catchment areas. The measures will accord with the principles set out in industry guidelines, including NRW's Works and maintenance in or near or water: Guidance for pollution prevention (GPP) 5 [RD27]. Measures include use and maintenance of temporary lagoons, tanks, bunds, silt fences or silt screens, as well as consideration of the type of plant used and the time of year for working in watercourses.

8.4.40 As set out in the Wylfa Newydd CoCP (Application Reference Number 8.6) the following guidance, which is provided at [RD27] will be followed:

- Understanding your environmental responsibilities – good environmental practices: Pollution Prevention Guidelines (PPG) 1. This general guidance includes elements of relevance to surface water and groundwater that will be applied across the Wylfa Newydd Development Area, including details on understanding what is required to protect the environment, making a drainage plan, understanding and maintaining

treatment facilities, chemical storage and spill avoidance, and flood risk. More detail is provided on certain aspects in other PPGs or GPPs.

- Working at construction and demolition sites: PPG 6. With regard to the water environment and controls that will be applied across the Wylfa Newydd Development Area, this PPG provides guidance regarding understanding and management of drainage, excavations, controlling risks from stockpiles and exposed ground, storage and use of cement and concrete, land contamination and chemical storage and use. The PPG contains a number of checklists of activities that will be used as the basis for managing pollution risks across the Wylfa Newydd Development Area.
- Vehicle washing and cleaning: GPP 13. This GPP will be applied to vehicle washing across the Wylfa Newydd Development Area. It details the importance of understanding drainage and having a drainage plan, water treatment, management of cleaning chemicals and disposal of wash effluent. The types of controls that would be used include having a drainage plan and only washing vehicles in controlled areas, and not on bare ground.
- Dewatering underground ducts and chambers: GPP 20. This GPP would be applied to dewatering activities across the Wylfa Newydd Development Area and in particular the options for water management and control of silt. The GPP also outlines the control of oil and chemicals. The types of controls that would be used include use of oil / water separators on any discharges at risk from oil contamination and avoiding disturbance of silt during pumping.
- Pollution incident response planning: GPP 21. This guidance would be used as the basis for developing an incident response plan for construction activities, including risks assessment, contacts, chemical inventory, drainage plans, training and waste management.
- Safe storage – drums and intermediate bulk containers: PPG 26. This guidance, which is applicable to storage up to 1000L, would be used as part of pollution prevention activities across the Wylfa Newydd Development Area. In particular, the guidance on storage, secondary containment and spill response would be implemented.

8.4.41 Horizon's management of construction activities would be updated by NRW's GPPs [RD27] as they are made available, replacing PPGs in time.

8.4.42 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) measures would be taken with regard to any works within a watercourse to restrict the release of suspended sediment and solids into the water column as far as practicable.

8.4.43 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) where practicable, sustainable methods will be utilised for discharges including site drainage, surface runoff and dewatering discharges.

8.4.44 Horizon will ensure runoff is managed appropriately, according to the controls within the Wylfa Newydd CoCP (Application Reference Number: 8.6) and Main Power Station Site sub-CoCP (Application Reference Number 8.7) as well as any permits or other relevant approvals being obtained. This will include use of sediment settlement ponds and other appropriate treatment to manage flows and meet water quality thresholds as per the findings of the Wylfa Newydd DCO Project Water Framework Directive Compliance Assessment.

8.4.45 Horizon will ensure sufficient drainage is installed prior to topsoil strip or major works occurring in a particular area (including construction of site compounds) to comply with the requirements in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number 8.7).

8.4.46 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6), Horizon will ensure all relevant construction activities are managed within the limits of an obtained Environmental Permit, for example keeping within limits on the concentrations of substances to be discharged, as far as possible, to protect receiving surface waters.

8.4.47 All temporary hardstanding (on non-foreshore sites) as far as is reasonably practicable, will incorporate permeable surfacing unless there is a risk of surface water or groundwater pollution from contaminants.

8.4.48 Horizon will employ protective measures to control the risk of pollution to groundwater, which will, in particular, be consistent with the Environmental Permitting (England and Wales) Regulations 2016. Furthermore, as detailed in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) prior to, and during construction of the cooling water tunnels, quarterly monitoring would be undertaken. Where practicable, existing boreholes would be used. If the monitoring identifies that the proposed installation of the cooling water tunnels will lead to a statistically significant increase in contaminant levels compared to baseline, additional mitigation would be required and agreed with the regulator. Options could include (1) detailed quantitative risk assessment to provide further information on the risk posed by the changes in concentration (2) remediation of groundwater using an appropriate technique to reduce contaminants concentrations – the actual remedial option would be identified by a remediation options appraisal.

8.4.49 Horizon will address the handling of material from excavations being a potential source of contamination. Horizon will ensure measures will be put in place to prevent contaminated runoff reaching open ground.

8.4.50 In addition, Horizon will avoid using materials that could result in direct or indirect discharge of hazardous substances or non-hazardous pollutants to groundwater.

8.4.51 Horizon will ensure that flood risk is managed safely throughout the construction period and that all designs comply with the FCA in appendix D8-4 (Application Reference Number: 6.4.29).

8.4.52 Horizon's flood risk compliance will be based upon a risk-based precautionary approach, using the source-pathway-receptor concept, drawing information

from NRW's online flood warning advice [RD28] or other such reputable service as appropriate.

8.4.53 As stated in the water management strategy of the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) there will be no discharge of drainage from the construction areas to the Cae Gwyn SSSI.

8.4.54 Soils would be managed as set out in the waste and materials management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6). As set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) where soils would be stored for longer than 60 days, stockpiles will be seeded with an appropriate low-maintenance seed mix.

8.4.55 As shown in the air quality management strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) hard surfaced haul routes would be damped down with fixed or mobile sprinkler systems, or mobile water bowsers, and cleaned regularly. All sites across the Wylfa Newydd Development Area would implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site).

8.4.56 As set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) Horizon will ensure that protection measures to control the risk of pollution to surface water are adopted, including the following:

- All deemed requirements of the Environmental Permitting (England and Wales) Regulations 2016.
- Any containers of contaminating substances on-site will be leak-proof and kept in a safe and secure building or compound from which they cannot leak, spill or be open to vandalism. The containers will be protected by temporary impermeable bunds (or drip trays for small containers) with a capacity of 110% of the maximum stored volume. Areas for transfer of contaminating substances (including refuelling areas) will be similarly protected and have appropriate spill kits.
- In addition, any permanent oil storage tanks and temporary storage of over 200L of oil in drums and mobile bowsers, as well as ancillary pipe work, valves, filters, sight gauges and equipment will be stored within secondary containment, e.g. bunding (Water Resources (Control of Pollution) (Oil Storage) (Wales) Regulations 2016) with a capacity of at least 110% of the maximum contents of the container's storage capacity.
- No fuel, oil or chemical substances will be stored within 15m of a watercourse.
- Above-ground pipework will be properly supported and underground pipework will be protected from physical damage and subject to adequate leakage detection. Mechanical joints on oil pipes would be inspectable. Oil and hydrocarbon underground pipes will not extend into the groundwater saturated zone without a risk assessment being undertaken.

8.4.57 As stated in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6) measures would be taken to prevent the deposition of silt or other material arising from work operations in existing watercourses or catchment areas. The measures will accord with the principles set out in industry guidelines, including NRW's Works and maintenance in or near or water: GPP 5 [RD27]. Measures include use and maintenance of temporary lagoons, tanks, bunds, silt fences or silt screens, as well as consideration of the type of plant used and the time of year for working in watercourses. Appropriate measures will be taken to protect erodible earthwork surfaces, such as the use of sheeting.

8.4.58 As stated in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6):

- All refuelling, oiling and greasing would take place above drip trays or on impermeable surfaces (e.g. plant nappy) with sealed drainage and an oil interceptor, which provides protection to underground strata and watercourses, and away from drains as far as is reasonably practicable. Vehicles and plant would not be left unattended during refuelling. Appropriate spill kits would be easily accessible during these activities.
- All construction equipment and vehicles will be maintained in line with manufacturer's instructions to ensure it is in good working order. Should any oil or fuel leaks occur, corrective action will be taken.
- Drip trays will be placed below static mechanical plant.
- All washing-down of vehicles (including wheel washing) and equipment will take place in designated areas and wash water will be prevented from passing untreated into watercourses and groundwater in accordance with NRW's GPP 13 [RD27] and subject to Environmental Permit requirements if discharged to controlled waters.
- NRW's GPP 5 [RD27] will be followed when carrying out maintenance of structures over water. Where practicable, only biodegradable hydraulic oils will be used in equipment working in or over watercourses.
- Appropriate measures will be taken to protect erodible earthwork surfaces.

8.4.59 As stated in the water management strategy of the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) water used in the concrete batching plant for plant wash-down, cleaning and other similar activities will be recycled where possible (estimated to be 90% of the water used). Any excess water shall be tankered off-site for treatment and disposal at a permitted waste facility.

8.4.60 As stated in the water management strategy of the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) for the watercourse realignment works on the Nant Caerdegog Isaf, a risk assessment will be undertaken, with relevant approval and consents for works from NRW.

8.4.61 The watercourse realignment will be constructed using techniques to control sediment release. These may include:

- leaving a minimum 2m 'plug' of uncut channel at either end of the new channel until all work is completed and the realigned section is ready to be connected to the existing stream;
- completing all works along the bank of the new channel prior to connecting to the existing channel;
- using plant with a low ground bearing pressure to avoid damage to newly dug banks;
- completing any revegetation as early as possible to reduce the potential for sediment from bare areas moving into the completed channel;
- compacting the stream bed sufficiently so that there is not substantial loose sediment to be entrained;
- removing the 2m plug from the downstream end prior to the upstream end;
- if flows are high, consider delaying connection; and
- pump water from upstream of the connection to downstream prior to breaking through, with gradual cessation in pumping once the connection is made.

Operation

Basis of assessment and assumptions

8.4.62 The aspects of the commissioning and operation works outlined below are relevant to surface water and groundwater receptors.

- Presence of the Power Station buildings, impermeable hardstanding and the Power Station Site surface water drainage and infrastructure. These buildings, hardstanding and drains would alter the natural recharge to groundwater and runoff to surface waters. The drainage systems of building and hardstanding areas would comprise drainage pipes, ditches and channels with surface water being discharged to the sea. In terms of the buildings and hardstanding areas, as set out in the it is assumed (based on designs in volume 2 of the Design and Access Statement, Application Reference Number: 8.2.2) that 90% or more of the developed Power Station Site would be impermeable, with 10% of the Power Station Site allowing rainwater infiltration.
- Presence of landscape mounds and associated mound drainage. Once the landscape mounds are vegetated and the risk of increased sediment loads to the watercourses has been reduced, the construction phase drainage system would be transitioned from the actively managed system during construction to a passive system. This passive system would remain in place for the operation of the Power Station. The drainage system of the landscaped areas post-construction has been developed

to ensure that surface water flows from landscaped areas outside of the Power Station platform would not impact on the platform itself. The ditches/swales created for drainage for the construction works around the landscape mounds would remain for the operational phase with the discharge points remaining the same. The settlement / attenuation ponds would remain but there would be no active treatment of the discharge. The concept design for surface water drainage in the landscaped areas post-construction is contained in appendix D8-8 (Application Reference Number: 6.4.33).

- Car parking areas and vehicular movements.
- Storage and use of fuels and oils (including waste oils) including that required for Emergency Diesel Generators and other emergency equipment. The principal storage of fuels as set out in Chapter D1 (Application Reference Number: 6.4.1) will be as follows:
  - The light oil tanks for the two emergency diesel generators would contain approximately 225,000L of fuel each (a total of 450,000L). The fuel day tank for each generator would contain approximately 20,000L of fuel. A lubricant oil system provides lubrication and cooling for the generators and the supply tanks for this oil would contain 7,100L of oil (one required for each emergency diesel generator).
  - The four Back-up Building Generators would each have a fuel oil day tank of approximately 8,000L and both tanks in each Unit will be fed from a common light oil tank which would contain approximately 170,000L of fuel. These generators would also have a lubricant oil system and the oil tank for each generator would contain 7,100L of oil.
  - There would be two Auxiliary Standby Generators and each generator would have a 240,000L fuel storage tank supplemented by a day tank at each generator location with eight hours' worth of fuel storage.
- A fuelling station would comprise an area of hardstanding within the southern part of the Power Station Site, which would contain a fuel pump for refuelling site vehicles.
- Storage and use of chemicals. In most cases the quantities of these chemicals are relatively small and storage would be in tins or drums rather than in bulk containers. Based on the design information in chapter D1 (Application Reference Number: 6.4.1) chemicals likely to be present in larger quantities are shown below.
  - Sodium hypochlorite (for biocide dosing) stored in bulk tanks in the cooling water pump house. Estimated storage volume of 600m^3 with an annual consumption of 31,200m^3.

  - Sodium nitrite (corrosion inhibitor) stored inside the reactor and turbine building. Estimated annual consumption of 500kg.
  - Ethylene glycol (antifreeze) to be held within stores and then added to the equipment.
- Collection, treatment and discharge of sewage. During operation all sewage would be piped to and treated at DCWW's Cemaes Waste Water Treatment Works and the treated effluent would be discharged to the sea via an existing consented discharge point. If required, process waste water would be disposed of following treatment via the cooling water outfall tunnel direct to the sea. These discharges are detailed in chapter D13 (Application Reference Number: 6.4.13).
- The waste and recycling facility (Conventional and Hazardous Waste Building and Conventional Waste Storage Compound) within the outer perimeter of the Power Station Site would be for conventional waste streams (such as fluorescent tubes, batteries, flammable liquids, paints, or aerosols) including a specific area for the storage of hazardous waste. The waste and recycling facility is likely to comprise a combination of containers such as wheelie bins and skips of varying sizes. The waste compound has been designed to be compliant with NRW's permit requirements and waste exemptions. The waste and recycling facility would have sealed drainage and hazardous waste would be suitably contained to prevent any spillages entering the drainage system.
- Construction of a spent fuel store in the south of the Power Station Site approximately 10 years after the start of the Power Station operation.

8.4.63 For the operation of the Power Station, no active groundwater dewatering of the ground outside of basements would be required. However, a passive (gravity) drainage system at approximately 6mAOD would be installed around the deep basements with water collected in the drain being directed to the sea. The inflow to this drainage system is likely to be limited by the shotcreting of the excavation walls following excavation.

8.4.64 All fresh water supplies for operation activities and to be used for potable purposes would be provided from the water main by DCWW. It is estimated that the typical potable water demand from DCWW mains would be 830m^3/day. During a single unit outage for planned maintenance, daily water requirements would rise to 2,330m^3/day. The water supply would be provided from within DCWW's existing licensed abstractions with no requirement for new abstractions or increase in licensed quantities for existing abstractions. There is no intention for surface water, groundwater or seawater to be abstracted by Horizon for supply of potable water specifically to meet the project demand for potable supply.

8.4.65 The cooling water used for the power station during operation would be abstracted from, and discharged back to, the marine environment and so is assessed in chapter D13 (Application Reference Number: 6.4.13).

8.4.66 No other effects on the freshwater environment would be present for the commissioning or operation of the Power Station as set out in chapter D1 (Application Reference Number: 6.4.1).

Embedded mitigation

8.4.67 As stated in the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13) foul water discharge would be to existing DCWW Sewage Treatment Works and to on-site package treatment plants. Foul water would not be discharged to the fresh surface water environment.

8.4.68 As set out in the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13), Horizon will develop a passive engineered drainage system by completion of construction as set out in the Landscape and Habitat Management Strategy. Such a drainage system will be managed in relation to sensitive ecological receptors and incorporate appropriate attenuation to prevent any increases to flood risk off-site and reduce significant effects on water availability.

Good practice mitigation

8.4.69 The Wylfa Newydd CoOP (Application Reference Number: 8.13) would set out the overarching pollution management principles to be applied throughout the operation of the Power Station, as set out below.

8.4.70 All fuel and chemical storage at the Power Station will be within engineered containment facilities, including (where appropriate) suitably bunded tanks, and will comply with the requirements of the project's Environmental Permit(s). As set out in the Mitigation Route Map (Application Reference Number: 8.14) any below-ground fuel storage tanks will comply with the Association for Petroleum and Explosives Administration's guidance including their 'Blue Book' [RD29] and will meet the requirements of The Environment Agency's approach to groundwater protection (which has been adopted by NRW) [RD30]. Above-ground fuel storage of over 200L will comply with the Water Resources (Control of Pollution) (Oil Storage) (Wales) Regulations 2016.

8.4.71 At all sites, storage areas for fuel and chemicals will be located more than 15m away from watercourses, and protected to avoid damage by plant and vehicles.

8.4.72 Operational pollution prevention controls will be defined at all sites and will include measures relating to:

- the designation of refuelling areas and areas handling liquid chemicals;
- operational controls around access to and use of refuelling and chemical storage facilities;
- regular inspection and maintenance of fuel and chemical storage facilities and associated equipment, including oil interceptors;
- spill response and clean-up procedures;
- regular maintenance of any on-site sewage pipes, and any on-site treatment systems or related sewage infrastructure;

- cleaning out of any sediment traps on the drainage system; and
- regular inspection of the parking areas for fuel and oils.

Decommissioning

Basis of assessment and assumptions

8.4.73 The Power Station Site would be landscaped and restored to an 'equivalent' land use and ecological condition to that prior to construction (i.e. as similar as possible to baseline, although recognising it would be impossible to exactly recreate previous situations). The decommissioning works as outlined below are relevant to surface water and groundwater receptors.

- Decommissioning of Unit 1 and Unit 2 would be undertaken simultaneously.
- All reactor buildings will be sealed with concrete according to the Decommissioning Strategy. Civil structures greater than 1m depth which contain voids would be left *in situ* and backfilled or grout filled, including the discharge water channel and the discharge water tunnels. The puncturing of basements below the bedrock and superficial groundwater table to allow groundwater to enter. Structures would be removed to 1m below site grade level. Structures below this level would be punctured to allow drainage, and voids below this level would be infilled with inert rubble/aggregate.
- Removal of hardstanding areas.
- Removal of operational drainage from the Power Station Site. All drainage systems, pipes and ducting located less than 1m below finished ground level would be removed and disposed of via a licenced process. Any uncontaminated drainage, pipework or ducting located greater than 1m below finished ground level would be flushed out and then grouted up.

8.4.74 In this assessment, it has been assumed that, following any necessary de-contamination, demolition would be as per any large civil demolition project using relatively standard techniques.

8.4.75 It has also been assumed that for the decommissioning of the Power Station, landscape mounds created during the construction of the Power Station would not be removed and the drainage system established during the operational phase around the landscape mounds would remain.

Embedded mitigation

8.4.76 Mitigation embedded into the design has been taken into consideration in determining the potential effects of the decommissioning works, although given that much of these works would not be undertaken for at least another 70 years, the mitigation measures have not been fully developed.

Landscaped areas outside of the Power Station Site, including landscape mounding and associated pasture and planting, will be retained, with no

removal of topsoil, or major earthworks. Following decommissioning, no major restoration works would therefore be required to areas outside of the Power Station Site, because landscaping created during construction would not be affected by decommissioning works. This is to be set out in a Decommissioning Plan.

Good practice mitigation

8.4.77 Good practice mitigation has been taken into consideration in determining the potential effects of the decommissioning works. For the purposes of this chapter, good practice mitigation to protect the surface water and groundwater environment would be largely the same as for the construction phase.

8.4.78 The Power Station Site, once hardstanding has been removed, would incorporate appropriate drainage channels. These would be installed in parallel with the removal of the operational Power Station drainage whenever practicable. This is to be set out in a Decommissioning Plan.

8.4.79 All reactor buildings will be sealed appropriately, for example, with concrete, according to relevant regulations at the time of decommissioning. This is to be set out in a Decommissioning Plan.

8.5 Assessment of effects

8.5.1 This section presents the findings of the assessment of effects associated with the construction, operation and decommissioning of the Power Station (including the cooling water system), the other on-site development (as detailed in chapter A2, Application Reference Number: 6.1.2) within the Wylfa Newydd Development Area, including the Site Campus.

8.5.2 A WFD compliance assessment has been undertaken in parallel with the assessment of the surface water and groundwater receptors detailed within this chapter. The potential compliance against the legislation as a consequence of the development of the Wylfa Newydd Development Area is provided in the WFD Compliance Assessment (Application Reference Number: 8.26).

8.5.3 As detailed in chapter B8 (Application Reference Number: 6.2.8), this assessment has adopted a precautionary approach. Due to uncertainties in some elements of the assessment, where there is a range of possible effects, the worst of the options is selected so that a level of conservatism is included. The MODFLOW computer model which is used to assess a number of groundwater effects is also conservative as it assumes, for example, that dewatering operations during construction would take place for an indefinite period and does not allow for any shotcreting in the deep excavations to seal the principal flowpaths.

8.5.4 An FCA (appendix D8-4, Application Reference Number: 6.4.29) has been undertaken for development proposed within the Wylfa Newydd Development Area. The method applied within the FCA to determine the significance of effect (which is informed by TAN 15 [RD6] as outlined in appendix D8-1.4 of the FCA) differs from the methodology used for this Environmental Impact Assessment (see section 8.4 in chapter B8, Application Reference Number:

6.2.8). The key differences relate to how the value of the receptor and the magnitude are assigned, which therefore drives slightly differing significances of effect. The FCA assigns the value of a receptor based on categories defined within TAN 15 that are specific to flood risk only and are not applicable to other aspects of surface water and groundwater. The FCA assigns an absolute magnitude to the flood hazard which includes, but is not confined to, the extent, depth and duration of flooding, and the velocity of flood waters. The Environmental Impact Assessment only considers the change to the flood risk that would be caused by the development.

8.5.5 In order to assess the flood risk consistently with other surface water and groundwater effects within this Environmental Statement, the following assessment of flood risk during operation of the Power Station considers changes that would potentially be caused by the development. The assessment therefore assigns a magnitude of change to the risk of flooding to receptors based on the method stated in chapter B8 (Application Reference Number: 6.2.8). The FCA is the key source of information for this assessment; however, given the difference in methods between the FCA and the Environmental Statement, the magnitude of change within this assessment is not directly comparable to the magnitude of hazard or flood risk within the FCA. Nevertheless, whilst the significance of effect may vary between the FCA and the Environmental Statement, the overall conclusions are consistent (i.e. significant or not significant effect).

Construction

8.5.6 The following sections provide an assessment of the effects specific to each receptor or group of receptors identified for surface water, fluvial geomorphology and groundwater.

Surface water

8.5.7 The value of the surface water receptors is given in table D8-5 which has identified that the value ranges from low for the Power Station Catchment up to high for the catchments in which there are SSSIs. These values are used in the assessment of effects detailed below. The key potential effects of construction on the surface water environment include issues relating to water quality, water availability and changes in flood risk. Potential effects have been assessed and where, following consideration of the embedded mitigation and good practice mitigation, potential effects of moderate or major significance are considered likely, these have been recorded within table D8-9. Where the embedded mitigation and good practice mitigation mean that potential effects would not be significant, these have been discounted.

8.5.8 To allow the discharge of water from the construction phase drainage scheme, an Environmental Permit issued by NRW would be required. To support the application for this permit, an “H1 assessment” has been undertaken [RD31] to determine the concentration of potentially polluting substances in the discharges, including metals, nutrients and polyelectrolyte. The modelling work has utilised the Environment Agency’s River Quality Planning (RQP) modelling package utilising predicted substance concentrations and flows

from each discharge pond and existing (measured) and predicted flows and water quality in the receiving watercourses. This assessment identifies that concentrations of bioavailable copper, iron and bioavailable lead and the nutrient orthophosphate could leach from soils and cause deterioration of the surface water quality for certain construction discharges. The assessment also shows that the concentration of polyelectrolyte used for the treatment of the discharged water to reduce sediment concentrations could cause deterioration of surface water quality (deterioration is defined here as causing the existing surface water quality to deteriorate by more than 10% of the EQS for that substance). Furthermore, the assessment shows that for orthophosphate the concentrations in the receiving watercourses could exceed the Annual Average EQS for this substance and for lead, the short term Maximum Acceptable Concentration, again only at certain locations. Where the H1 assessment has identified the potential for deterioration in water quality or exceedance of an EQS this is identified in the following sections for each catchment.

Tre'r Gof Catchment and Tre'r Gof SSSI

8.5.9 Almost the whole of the Tre'r Gof Catchment is within the Wylfa Newydd Development Area and there are a number of construction activities proposed within this area. However, no works would take place within the boundary of the Tre'r Gof SSSI. The activities within the Tre'r Gof Catchment, and activities which could potentially affect this catchment, include:

- site clearance and construction, operation and removal of temporary haul roads and car parks, including minor watercourse crossings;
- construction, operation and removal of the Site Campus, including installation and removal of drainage from the campus;
- demolition of Horizon site office and Existing Power Station visitor centre, and construction of a car park;
- construction, operation and removal of the Main Site Compound and satellite compounds and material compounds;
- construction and operation of drainage which would include drains to the south and east of the SSSI to manage runoff from landscape Mounds A and B (figure D8-4, Application Reference Number: 6.4.101);
- topsoil strip, storage and replacement;
- material storage areas and landscape mound creation;
- dewatering of deep excavations; and
- construction of the cut-and-cover section of the cooling water tunnels in the vicinity of Wylfa Head, although this is likely to be outside of the Tre'r Gof surface water catchment.

8.5.10 Some sections of the cooling water tunnels would not be constructed using cut-and-cover methods. They would likely be constructed by blasting and excavation or bored methods using a road header and are not anticipated to have an effect on Tre'r Gof Catchment.

8.5.11 A cut-and-cover section of the tunnel may be constructed at its northern end for around 200m, which would be outside of the Tre'r Gof surface water catchment and would not affect surface water flows to the SSSI. Based on the groundwater level contours for the superficial deposits, these excavations are also unlikely to affect shallow groundwater flows into the SSSI. If dewatering of the bedrock aquifer is required for the northern cut-and-cover section of the tunnel, drawdowns of groundwater levels in the bedrock at the Tre'r Gof SSSI could occur. However, as dewatering would be short-term (inflows would be sealed as tunnelling progresses) and only have a local effect, and bedrock groundwater inputs to the SSSI are a minor component of the SSSI's water balance, tunnel construction would not affect the Tre'r Gof SSSI overall water balance (see chapter D9, Application Reference Number: 6.4.9 for consideration of potential effects to plant assemblages within the SSSI).

8.5.12 The assessment has been completed on the basis of the Tre'r Gof SSSI being a naturally complex hydrological system and one in which there can be substantial variation in hydrological parameters over the short, medium and long-term. The SSSI is evolving and changing and it has been noted during site walkover surveys for example that the location of some seeps and flushes move even over short time periods. It is also recognised that there are considerable seasonal changes. This also influences the level of certainty that can be applied to the likely success of mitigation.

8.5.13 Potential effects from the above activities on surface water within the Tre'r Gof Catchment are summarised below.

- The landscape mounding and drainage would alter an area of the Tre'r Gof Catchment, resulting in changes to surface water flows within the catchment. These changes could particularly affect the south and west compartments of the Tre'r Gof SSSI, which are reliant on multiple sources of inflows (see appendix D8-5, Application Reference Number: 6.4.30). The hydrological 4Rs Model (4R) (see appendix D8-7 (Application Reference Number: 6.4.32) for further details) has quantified changes to water availability within the Tre'r Gof SSSI, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results show that the mean change in outflow from the baseline to the construction scenario across the Tre'r Gof SSSI at VN5 (the outfall from the SSSI) is an increase of 129m^3/day. Negative change in flow has been modelled at one of the four inflow points within the SSSI at VN1 in the west compartment where a decrease of 59m^3/day is predicted. Based on the percentage impact of operation on the flow duration curve, the increase in flow of 129m^3/day (or 1.5l/s) presents a temporary change equivalent to +/-10% or more of the Q_{95}. This equates to a medium magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8). However, given the small size of the Tre'r Gof drains and intermittent flows which range throughout the year from dry to flood conditions, variable flow conditions are a key hydrological function of the Tre'r Gof

SSSI. The criteria for water availability in table B8-12 in chapter B8 (Application Reference Number: 6.2.8) is less applicable to such small, intermittent watercourses and therefore the magnitude of change on water availability within the Tre'r Gof SSSI is considered to be small (partly as the change in flows would be temporary and short-term). This would result in a moderate effect which is significant. As stated in chapter B8 (Application Reference Number: 6.2.8) due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach and so a moderate adverse rather than minor adverse significance of effect has been identified. Although the change represents an increase in water availability in Tre'r Gof, which could potentially be beneficial, as it is a change from baseline and there is uncertainty regarding the hydrological functioning of the SSSI, a precautionary approach is followed and a significant adverse effect has been ascribed.

- A potential reduction in water availability from diffuse seeps within the Tre'r Gof SSSI could have subsequent effects on the water quality of the SSSI. The inflow of shallow groundwater in the soils, superficial deposits and potentially the top of the bedrock into the SSSI brings mineral enriched water into the SSSI via a series of small springs, seeps and flushes. The subsequent build-up of calcium concentrations in the peat fen is an important supporting condition for rare plant communities within the SSSI (appendix D8-5, Application Reference Number: 6.4.30). A reduction in diffuse inflows could therefore reduce calcium concentrations within the SSSI, particularly in the west compartment where negative water availability has been modelled. The overall magnitude of change on the whole SSSI is assessed as small, with the resulting effect being moderate adverse. This is a significant effect. It should be noted that, despite the embedded mitigation (as described above) there is a high degree of uncertainty in the likely effectiveness of the drainage system. Therefore, the assessment of effect has taken a precautionary approach.
- Rainfall onto the exposed bare earth surfaces from site clearance, demolition of structures, haul roads, car parks, construction and subsequent removal of the Site Campus, soil storage and landscape mound creation could all result in a high sediment loading in runoff. This could affect water quality within the Tre'r Gof drains. There is a particular risk of high suspended sediment concentrations in runoff from Mound A and Mound B before vegetation is fully established. The drainage system would incorporate settlement ponds, ditches/swales and an oil separator from the Site Campus prior to discharge of runoff to the Tre'r Gof drains, and stone-filled trenches set below ground to aid natural dispersion of flows into the Tre'r Gof SSSI. Initially these gabions could have a filtering effect that would trap silt, and as they fill with silt they would promote the growth of vegetation which would act as a natural filter. During construction of the Site Campus surface water would run into drainage

channels to the east and west and discharge into attenuation ponds. However, it is possible that suspended sediment concentrations would increase in the Tre'r Gof drains due to the permitted discharge limit being exceeded at discharge point B1 for very short periods while the system responds and active treatment by dosing is implemented (i.e. there is a lag between sediment increasing and additional treatment being implemented, although where practicable, in such situations the discharge could be temporarily halted). In addition, it is possible that the annual sediment load could increase even when the permitted limit is not exceeded. This is because small rainfall events that do not currently result in elevated suspended sediment could result in elevated sediment during construction when the area to be mounded is exposed soil. Furthermore, there could be additional loading due to storms beyond the 1 in 2 year event that could result in increased sediment input to Tre'r Gof drains. With application of the water management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and management of suspended sediment within the drainage design, including the use of settlement ponds and treatment (see appendix D8-8 (Application Reference Number: 6.4.33) for further details), and taking uncertainty into account, the magnitude of change on water quality would be medium. The potential effect would therefore be major adverse, and is considered to be significant.

- Topsoil strip, movement and replacement could result in mobilisation of nutrients and potentially metals that are currently not exposed to leaching (soil leaching tests have identified that both nutrients and metals could exceed freshwater EQSs). Leaching tests have indicated that elevated concentrations of nutrients could be released from topsoil and these could therefore change water quality. The RQP modelling undertaken in [RD31] has identified that within the Tre'r Gof Catchment, discharges from the surface water treatment ponds could cause the concentration of the nutrient orthophosphate to exceed the Annual Average EQS. In addition, the metal lead could exceed the short term Maximum Acceptable Concentration. In the case of orthophosphate, the existing measured upstream concentration already exceeds the EQS. In addition, [RD31] also shows that potentially the discharges to the catchment of bioavailable copper, iron, bioavailable lead and polyelectrolyte (from chemical dosing for water treatment) could cause the exiting surface water quality in the receiving watercourse to deteriorate by more than 10% of the Annual Average EQS and for lead, 10% of the short term Maximum Acceptable Concentration. However, any effect would be limited to the time periods when topsoil was being disturbed and the majority of increase in nutrients may pass through the Tre'r Gof SSSI in the drainage ditches rather than entering the peat fen. Furthermore, there would only be a finite amount of leaching which would reduce

rapidly with time. The magnitude of any change would therefore be small, which would result in a minor adverse effect, which is not significant.

- The dewatering during construction of the Power Station would change groundwater levels and groundwater flow direction in the bedrock, which may result in effects on base flow to the SSSI. The potential effect of dewatering on the water flow is contained in the groundwater section of this chapter.

8.5.14 The following potential effects from construction activities have been assessed as likely to result in negligible effects and therefore are not significant.

- The magnitude of change on water quality from leaks and spillages of fuels or oils is considered to be negligible due to the application of buffer zones (ranging from 20m to 100m) and emergency management procedures in accordance with the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6). Therefore, the potential effect would be negligible.
- The magnitude of change caused by spillages of cementitious materials from construction of structures is considered to be negligible. This is due to the limited number of concrete structures to be built within the catchment, the use of pre-cast concrete where practicable and through application of the buffer zones along watercourses, specific risk assessment for use of cementitious material within 50m of a watercourse, and emergency management procedures in accordance with the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6). Therefore, as the magnitude of change is negligible, the potential effect would also be negligible.
- Leaks of sewage from the Site Campus could affect the nutrient balance within the Tre'r Gof SSSI. Emergency management procedures in accordance with the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) would result in a negligible magnitude of change and a negligible effect. Foul sewage generated at the Site Campus would be discharged to the sea following treatment. On this basis the magnitude of change on (freshwater) surface water is considered to be negligible with the resulting effect also being negligible. Effects on the marine environment are considered separately in chapter D13 (Application Reference Number: 6.4.13).
- There is potential for adverse effects on water quality in Tre'r Gof drains from the use of polyelectrolytes for water treatment associated with drainage from Mound B, and potential for carry over into the SSSI. However, the system has been designed so that it would largely operate without chemical dosing (appendix D8-8, Application Reference Number: 6.4.33) and the chemical selected would have limited potential for carry

over. Providing that the water treatment systems are designed, maintained and managed appropriately, the magnitude of change and the effect would both be negligible.

- Increases to flooding could arise due to decreases in permeable area, increased steepness of the catchment, the creation of preferential flow pathways and flow constrictions at minor watercourse crossings within the Tre'r Gof Catchment. These effects have been assessed quantitatively with a pluvial flood model, which is summarised in the FCA in appendix D8-4 (Application Reference Number: 6.4.29). No fluvial modelling of the Tre'r Gof Catchment was undertaken. The pluvial model has taken into account mitigation through the drainage design and permeable surfacing for tracks and haul roads, where practicable. The drainage has been designed to prevent increased runoff rates and changes to shallow groundwater recharge by restricting off-site discharge to greenfield rates (as outlined in appendix D8-8, Application Reference Number: 6.4.33). The quantitative model outputs relate to the specific locations of drainage features, therefore it has not been reflective of flood risk to compare the construction phase (including drainage features) with the baseline (excluding drainage features). Instead, flood depth mapping outputs (appendix D8-4, Application Reference Number: 6.4.29) have been assessed to indicate the magnitude of change to flood risk. The mapping indicates that the magnitude of change is negligible and therefore not significant.

Afon Cafnan Catchment including Cae Gwyn SSSI

8.5.15 The construction works would only take place in a small percentage (approximately 12%) of the Afon Cafnan Catchment but the works would potentially affect the Afon Cafnan, Nant Caerdegog Isaf (including the realigned section of this watercourse) and unnamed tributaries and drains. The activities which could affect this catchment, include:

- site clearance, including demolition of buildings, walls, Cemlyn Road and removal of trees;
- construction, operation and removal of the Main Site Compound and satellite compounds and material compounds, construction offices and parking areas;
- construction of car parking and simulator and training building;
- construction of security access and site entrance plaza;
- creation and operation of laydown areas;
- construction, operation and removal of temporary haul roads, including temporary crossing of the Afon Cafnan and minor watercourse crossings;
- material storage areas and landscape mound creation (Mounds B, C, D and E);

- bulk earthworks including creation of platform levels for Unit 1 and Unit 2;
- dewatering of deep excavations; and
- construction of drainage, including temporary diversion of flow from the western side of Mound E, which would have discharged into Nant Cemlyn, being diverted to the Afon Cafnan.

8.5.16 Potential effects from the above activities on surface water within the Afon Cafnan Catchment are summarised below.

- Water availability in the Afon Cafnan Catchment may be affected due to construction of laydown areas, creation of platform levels, construction of facilities (including the simulator and training building), creation of mounds and the drainage. The hydrological 4R model has quantified potential changes to water availability within the Afon Cafnan Catchment, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results show that the mean change in flow duration from the baseline to the construction scenario at the downstream point on the Afon Cafnan Catchment (Caf11) is a decrease in flow of 424m^3/day. All except one of the 11 points modelled on the Afon Cafnan were found to have a reduction in flow. Based on the percentage impact on the flow duration curve, the decrease in flow of 424m^3/day (or 4.9l/s) represents a temporary change equivalent to less than +/-10% of the Q_{95}. This equates to a small magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8) which would result in a minor adverse effect. This is not a significant effect. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach. It should also be noted that the predicted reduction in flow in the Afon Cafnan excludes the temporary increase due to diverting flow from the western side of Mound E from Nant Cemlyn into Afon Cafnan. This would partly offset the reduction in flow. A sensitivity model run (as reported in section 7.5 of appendix D8-7 (Application Reference Number: 6.4.32) was undertaken to assess the temporary effect on river water levels of moving the runoff from the western side of Mound E to discharge point E2 on the Afon Cafnan. This indicated a change in level of between 0.07m to 0.01m depending upon the return period and location modelled.
- The landscape mounding would locally increase the steepness of land surfaces and the drainage and haul roads would provide preferential flow pathways for surface water. All factors would alter the rainfall/runoff response, and could result in a decrease in the long-term base flow to the Afon Cafnan. In addition, where practicable, permeable surfacing would be used on minor roads, haul roads, compounds and laydown areas. The surface water drainage system has been designed to provide sufficient attenuation to control surface water flows. However, landscape

mounding may have localised effects on water availability to Nant Caerdegog Isaf. The magnitude of change has been assessed as small, with the resulting effect being minor adverse meaning it is not significant.

- The construction of the laydown areas and drainage would result in the loss of the natural catchment of a small tributary of the Nant Caerdegog Isaf. As the tributary is small with very low flow in comparison to that in Nant Caerdegog Isaf, the magnitude of change to the Nant Caerdegog Isaf has been assessed as small, with the resulting effect being minor adverse, which is not significant.
- The provision of welfare facilities may carry the risk of leaks of sewage, which could cause degradation of water quality in any adjacent watercourses. However, timely maintenance of facilities and regular checking of pipes for leaks, as well as emergency management procedures, in accordance with the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) would reduce the risk of leaks. The magnitude of change for this effect has been assessed as small, with the resulting effect being minor adverse, which is not significant.
- Rainfall onto the exposed bare earth surfaces (topsoil strip, bulk earthworks, storage, mound creation and all construction activities) and in-channel works could result in high sediment loading in runoff, which could affect the water quality within the catchment. It is planned that during the construction phase the drainage system would include soil management, silt fences, silt traps, swales and settlement ponds and, if required, other pollution control features including chemical dosing, allowing sediment to be retained before flows are discharged to the surrounding surface water features. However, there is the potential that an effect could still occur under some scenarios. For example, in the event that finer particles are abundant in a section of mounding that is exposed during an extended period of rainfall, and it is considered appropriate to undertake chemical dosing to achieve a discharge level equivalent to the proposed construction Environmental Permit limit only (i.e. 40mg/l to 70mg/l during normal rainfall events), then this may result in an increase in the annual sediment loading. In addition, rainstorms greater than the 1 in 2 year event could result in increased loading to the Afon Cafnan. This would in turn affect water quality in comparison to baseline. Our approach in the assessment methodology is, where there is absence of information, to adopt a highly precautionary approach. Since the drainage design is still in development and that there are some unknowns, for the purpose of this assessment we have concluded that the magnitude of change to water quality could be medium (following a precautionary approach the significance of effect has been assessed assuming a medium magnitude of change) and consequently the resulting effect is concluded as being moderate adverse. This is a significant effect.

- There is the potential that metals and nutrients could leach from topsoil, used at the surface of the landscape mounds or temporarily stored in the catchment as they are stripped from the area. These dissolved phase substances could then be discharged to watercourses in the catchment. The RQP modelling undertaken in [RD31] has identified that within the Afon Cafnan Catchment, discharges from the surface water treatment ponds could cause the nutrient orthophosphate to exceed the Annual Average EQS, although the existing measured upstream concentration already exceeds the EQS. In addition, [RD31] also shows that potentially the discharges to the catchment of bioavailable lead and orthophosphate could cause the existing surface water quality in the receiving watercourse to deteriorate by more than 10% of the Annual Average EQS and for lead, 10% of the short-term Maximum Acceptable Concentration. However, any release would be limited to 'first flush' during topsoil movement (assuming that it rains sufficiently to exceed any soil moisture deficit at the time of movement), would only apply to seepage water (rather than direct runoff) and would be subject to dilution by runoff and in the Afon Cafnan. Once topsoil is removed there would be no further potential leaching as the glacial drift and bedrock is low in metals and nutrients. As such, the magnitude of change is considered to be small and the effect on watercourses within the catchment would be minor adverse. This is not a significant effect.
- Increases to flooding could arise due to decreases in permeable area, increased steepness of the catchment, the creation of preferential flow pathways and flow constrictions at minor watercourse crossings within the Afon Cafnan Catchment. These effects have been assessed quantitatively with fluvial and surface water flood models, which are summarised in the FCA in appendix D8-4 (Application Reference Number: 6.4.29). The models have taken into account mitigation through the drainage design and permeable surfacing for tracks and haul roads, where practicable, but not the temporary diversion from the western side of Mound E. The drainage has been designed to prevent increased runoff rates and changes to shallow groundwater recharge by restricting off-site discharge to greenfield rates (as outlined in appendix D8-8, Application Reference Number: 6.4.33). The modelling results indicate that there are increases to flood depths where Cemlyn Road crosses the Afon Cafnan and to land adjacent to the realigned section of Nant Caerdegog Isaf. The increases in fluvial flood depths during the 1 in 100 year event are 0.14m and 0.06m, respectively, whilst the increases in surface water flood depths are 0.12m and 0.04m, respectively (appendix D8-4, Application Reference Number: 6.4.29). In both instances the flood extents do not change significantly. The magnitude of change associated with these depth increases is medium. With Cemlyn Road being assigned a high value, the significance of effect would be major adverse. However, flood depths on Cemlyn Road would remain below 0.3m, hence

allow passage of vehicles. In addition, after the granting of the Development Consent Order the property at Cafnan that is accessed by Cemlyn Road at this point would become owned by Horizon and it would also be unoccupied during the construction period. Use of the road is likely to be limited to construction related traffic, and therefore exposure to this increased flood risk is expected to be significantly reduced. No additional mitigation measures are therefore proposed. For the land at Nant Caerdegog Isaf the increase in flood depths (up to 0.06m) would not alter the use of the land adjacent to the watercourse as the land is part of the buffer within which construction works are generally excluded. The magnitude of change in flood depths and increase in flood risk on the land adjacent to Nant Caerdegog Isaf is therefore not significant and no further mitigation is required. This assessment excludes the effect of the temporary pumping from discharge point E1 to E2 (see figure D8-4 in Application Reference Number: 6.4.101). As indicated above, a sensitivity model (see section 7.5 in appendix D8-7, Application Reference Number: 6.4.32) has been run for this scenario and it indicates an increase in stream level at Cemlyn Road of up to 0.07m for the 1:30 year AEP. Downstream of Cemlyn Road the modelled effect is predicted as up to 0.03m for the 1:30 year AEP. Although the diversion is temporary the sizing of the attenuation pond for the E1 discharge would be reviewed at detailed design and may be increased to provide a higher level of attenuation of flows into the Afon Cafnan.

8.5.17 The following have been assessed as likely to result in negligible effects on the Afon Cafnan Catchment, and therefore are not significant effects.

- Degradation of water quality could occur through leaks and spillages of fuels or oil from construction plant. This could affect downstream watercourses and features. However, through application of a buffer zone and the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the water management strategy set out in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) (including measures such as establishing a buffer zone, the provision of spill kits and defined areas for fuel storage) the magnitude of change is considered to be negligible. The resulting effect would therefore be negligible.
- The spillage of cementitious materials from construction is also considered to have a negligible magnitude of change and a negligible effect. This is due to many concrete structures being pre-cast off-site, while on-site concrete batching would take place outside the catchment and concrete would be brought to the catchment as and when needed. In addition, there would be bespoke risk assessments for any activities using cement within 50m of a watercourse.
- Increases to flooding could arise due to decreases in permeable area due to construction works, increased steepness of the catchment, the

creation of preferential flow pathways and minor watercourse crossings restricting flow. With the exception of the Cemlyn Road where it crosses the Afon Cafnan, these effects have all been mitigated through the drainage design and these effects have been assessed quantitatively with a flood model, which is summarised in the FCA in appendix D8-4 (Application Reference Number: 6.4.29). The drainage has been designed to prevent increased runoff rates and changes to shallow groundwater recharge by restricting off-site discharge to greenfield rates. There is a negligible change in pluvial flood depths within the Afon Cafnan Catchment in rainfall events up the 1 in 100 year event. The magnitude of change to flood risk has been assessed as negligible with the resulting effect being negligible.

- The realignment of part of Nant Caerdegog Isaf would be constructed using techniques to control sediment release, such as not connecting the realigned section until it is complete, opening the downstream end first and pumping water around the upstream end of the aligned section whilst the realigned section is connected. It would also be designed to provide floodplain storage up to the 1 in 100 year event (including climate change projections) preventing flood increases off-site. On this basis the magnitude of change to water quality has been assessed as negligible with the resulting significance of effect being negligible.
- There is potential for adverse effects on water quality in the Afon Cafnan from the use of polyelectrolytes for water treatment and potential for carry over. However, the system has been designed so that it would largely operate without chemical dosing (appendix D8-8, Application Reference Number: 6.4.33) and the chemical selected for dosing would have limited potential for carry over when used correctly. Providing that the water treatment systems are designed, maintained and managed appropriately, the magnitude of change and the effect would both be negligible.

Cae Gwyn SSSI

8.5.18 No works would take place within the boundary of the Cae Gwyn SSSI. However, the activities taking place nearby which could affect the SSSI include the following.

- Clearance of topsoil for landscape mounding within a small part of the Wylfa Newydd Development Area to the east of the Cae Gwyn SSSI.
- Landscape mound creation (Mound C) within the Cae Gwyn SSSI topographic catchment area. This is potentially within the catchment area of the primary outfall basin (see appendix D8-6, Application Reference Number: 6.4.31 for the extent of this area) rather than the whole of the Cae Gwyn SSSI, although there is some uncertainty regarding this. It is possible that the catchment outside and to the east of the SSSI drains directly to drains or to the Nant Caerdegog Isaf such that mound creation would only alter water movement into the SSSI to a small degree.

- Construction of car parking within the Cae Gwyn SSSI topographic catchment area and potentially within the catchment area of the primary outfall basin.

8.5.19 Potential effects from the above activities on surface water within the Cae Gwyn SSSI are summarised below.

- The SSSI is at the upstream end of Nant Caerdegog Isaf and direct rainfall and surface water runoff from the immediately surrounding area provide the only surface water inflow into the Cae Gwyn SSSI (see appendix D8-6, Application Reference Number: 6.4.31). During dry periods the water table drops so that any base flow that discharges to Cae Gwyn SSSI in winter declines in summer. Thus, the dry period is important as this is the time when the potential for effects on the SSSI are greatest. Although there could be a minor groundwater inflow component (and groundwater inputs may be locally important for particular plant assemblages), this is unlikely to be substantial given the elevation and location of the SSSI. There could be some changes to the catchment area due to the construction of Mound C. However, as noted above, this is likely to have minimal effect on the primary outfall basin. Taking into account the uncertainties highlighted above, the potential magnitude of change to water flows to the primary outfall basin and to the rest of the Cae Gwyn SSSI is therefore likely to be small with the significance of effect being minor. This is not a significant effect.

8.5.20 The following have been assessed as likely to result in negligible effects, and therefore are not significant.

- There is little if any risk to water quality from leaks and spillages of fuels or oils as no construction works would take place within up to 15m of the Cae Gwyn SSSI and it is up hydraulic gradient of the majority of the Wylfa Newydd Development Area. Furthermore, with application of pollution management principles as set out in the water management strategy of the Wylfa Newydd CoCP (Application Reference Number: 8.6), the magnitude of change is assessed as negligible with the resulting effect being negligible.
- As the majority of construction works are downstream of the Cae Gwyn SSSI, there would be no flood risk effects on the SSSI.

Cemaes Catchment

8.5.21 There are few construction activities occurring within the Cemaes Catchment, and only a small part of the Cemaes Catchment (approximately 5%) is within the Wylfa Newydd Development Area. The activities within this area which could affect the catchment include:

- site clearance and topsoil strip;
- construction and operation of drainage, which would include construction of a drainage outfall; and

- landscape mound creation.

8.5.22 Potential effects from the above activities on surface water within the Cemaes Catchment are summarised below.

- Creation of the landscape mound may affect water availability within the catchment. The hydrological 4R model has quantified potential changes to water availability within the Cemaes Catchment, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results show that the mean change in flow duration from the baseline to the construction scenario across the Cemaes Catchment (Cae7) is a decrease of 166m^3/day. All except one of the seven points modelled were found to have a reduction in flow. Based on the percentage impact on the flow duration curve, the decrease in flow of 166m^3/day (or 1.9l/s) represents a temporary change equivalent to less than +/-10% of the Q_{95}. This equates to a small magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8) which would result in a minor adverse effect, meaning it is not significant. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach.
- Rainfall onto the exposed bare earth surfaces (site clearance, topsoil strip, bulk earthworks and landscape mound creation) and in-channel works could result in high sediment loading in the runoff from the Cemaes Catchment, which would affect the water quality within the catchment. It is planned that during the construction phase the drainage system would include drainage trenches that would incorporate settlement ponds and other pollution control features, allowing sediment to be retained before flows are discharged to the Nant Cemaes. However, there is the potential that an effect on water quality could still occur, either due to delays in implementing active water treatment systems following the on-set of rainfall, or due to the proposed 40mg/l limit being met for a 1 in 1 year storm event, but annual sediment loading increasing thereby affecting water quality in comparison to baseline. Therefore, considering this embedded mitigation, taking into account uncertainty, the magnitude of change to water quality has been assessed as small to medium, with the resulting effect being moderate adverse. This is a significant effect.
- There is the potential that metals and nutrients could leach from topsoil used at the surface of the landscape mounds. These dissolved phase substances could then be discharged to watercourses in the catchment. The RQP modelling undertaken in [RD31] has identified that within the Nant Cemaes Catchment, discharges from the surface water treatment ponds could cause the nutrient orthophosphate to exceed the Annual Average EQS, although the existing measured upstream concentration already exceeds the EQS. In addition, [RD31] shows that potentially the discharges of lead to the catchment could cause the existing surface

water quality in the receiving watercourse to deteriorate by more than 10% of the short-term Maximum Acceptable Concentration. However, any release would be limited to first flush during topsoil movement (assuming that it rains sufficiently to exceed any soil moisture deficit at the time of movement), would only apply to seepage water (rather than direct runoff) and would be subject to dilution by runoff and dilution in the Nant Cemaes. As such, the magnitude of change is considered to be small for nutrients and negligible for metals with the effect on watercourses within the catchment being minor adverse for nutrients and negligible for metals. This is not a significant effect.

- Increases to flooding could arise due to decreases in permeable area, increased steepness of the catchment, the creation of preferential flow pathways and flow constrictions at any minor watercourse crossings downstream within the Cemaes Catchment. These effects have been assessed quantitatively with fluvial and surface water flood models, which are summarised in the FCA in appendix D8-4 (Application Reference Number: 6.4.29). The models have taken into account mitigation through the drainage design and permeable surfacing for tracks and haul roads, where practicable. The drainage has been designed to prevent increased runoff rates and changes to shallow groundwater recharge by restricting off-site discharge to greenfield rates (as outlined in appendix D8-8, Application Reference Number: 6.4.33). The modelling results indicate that there are increases in flood depths to land and residential properties upstream of Cemaes village including Brookside Garages and on Ffordd Y Traeth, which are already at risk of flooding. Increases in fluvial flood depths are predicted to be 0.04m during the 1 in 100 year event, whilst increases in surface water flood depths are 0.05m during the same event (appendix D8-4, Application Reference Number: 6.4.29). In both instances the flood extent does not change significantly. Despite minimal changes on flood extent and a small absolute change in flood depth, any increase in flood depth presents an increased risk of flooding to a residential property. The magnitude of change in flood depth is therefore small to medium. With residential properties being a high value flood risk receptor (appendix D8-4, Application Reference Number: 6.4.29) the significance of effect would be major adverse and this would be a significant effect. There is no change in fluvial flood risk to residential properties within Cemaes village itself but there is a small magnitude of change to surface water flood depths (a decrease in water depth of up to 0.07m). This is because Mound A drainage alters the surface water flow path and conveys surface water to the east towards the sea and around Mound A to the north.

8.5.23 The following have been assessed as likely to result in negligible effects, and are therefore not significant.

- Degradation of water quality could occur through the leaks and spillages of fuels or oil from construction plant. This could affect downstream

watercourses and features. However, through application of buffer zones and the water management strategies set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and Main Power Station Site sub-CoCP (Application Reference Number: 8.7) including measures such as limited use of machinery in close proximity to watercourses, the provision of spill kits and defined areas for fuel storage, the magnitude of change is considered to be negligible, with the resulting effect being negligible.

- The spillage of cementitious materials from construction is considered to have a negligible magnitude of change and a negligible significance of risk. This is due to the very limited use of concrete in this catchment and the concrete surface water outfall structure being pre-cast off-site.
- Increases to flooding could arise due to decreases in permeable area, increased steepness of the catchment, the creation of preferential flow pathways and minor watercourse crossings restricting flow. These effects have all been mitigated through the drainage design, in particular incorporation of an attenuation pond in the discharge to the Nant Cemaes. These effects have been assessed quantitatively with a flood model, which is summarised in the FCA in appendix D8-4 (Application Reference Number: 6.4.29). The drainage has been designed to prevent increased runoff rates and changes to shallow groundwater recharge by restricting off-site discharge to greenfield rates. With the exception of the properties upstream of Cemaes village (outlined above) there is a negligible change in pluvial flood depths within the Cemaes Catchment in rainfall events up to the 1 in 100 year event. The magnitude of change to flood risk has been assessed as negligible with the resulting effect being negligible.

Cemlyn Catchment and the Cemlyn Bay SSSI

8.5.24 Nant Cemlyn and a small drain (which falls outside of the study area) flow into Cemlyn Lagoon which forms part of the Cemlyn Bay SSSI, SPA and SAC. Given this, the Nant Cemlyn and the lagoon have been assessed together. Cemlyn Lagoon is a coastal lagoon with a brackish environment and is assessed in this chapter and in chapter D13 (Application Reference Number: 6.4.13) to ensure that all potential effects are assessed. In particular, this chapter focusses on the area within the lagoon where the Nant Cemlyn flows into it.

8.5.25 There are few construction activities occurring within the Cemlyn Catchment, and only a small part of the Cemlyn Catchment (approximately 5%) is within the Wylfa Newydd Development Area. The activities within this small area which could affect these receptors are outlined below.

- Site clearance and topsoil strip.
- Construction and operation of drainage which would involve construction of an outfall at location E1 (figure D8-4, Application Reference Number: 6.4.101) on the Nant Cemlyn as well as temporary pumping infrastructure. This outfall would only be used once the western side of

Mound E is vegetated and there is no risk of high suspended solids due to construction discharging to the watercourse. Whilst the risk of sediment mobilisation from Mound E exists, all surface runoff from Mound E would be gravity drained or pumped, treated and discharged to the Afon Cafnan, either at discharge point E2 (figure D8-4, Application Reference Number: 6.4.101), or potentially further downstream in order to manage flood risk (see below). This would be a temporary diversion in place only whilst there are earthworks on the western side of Mound E and there is a risk of increased sediment in runoff.

- Landscaping mound creation.

8.5.26 Potential effects from the above activities on surface water within the Cemlyn Catchment and the Cemlyn Bay SSSI are summarised below.

- The landscape mounding has been designed to avoid changes in catchment boundaries as far as practicable. The hydrological 4R model has quantified any changes to water availability within the Cemlyn Catchment, albeit excluding the temporary diversion of flow from the western side of Mound E to the Afon Cafnan. A summary of the 4R model is presented in appendix D8-7 (Application Reference Number: 6.4.32). The modelling results show that the mean change in flow duration from the baseline to the construction scenario at the downstream point on the Cemlyn Catchment (Cem4) prior to inflow into the Cemlyn Lagoon is an increase of 51m^3/day (or 0.6l/s). Based on the percentage impact on the flow duration curve, this increase in flow represents a temporary change equivalent to less than +/-10% of the Q_{95}. This equates to a small magnitude of change with regard to water availability in the catchment (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8) which would result in a minor adverse effect on the Nant Cemlyn and the Cemlyn Lagoon. This effect is not significant. The magnitude of this effect would be reduced by operation of the pumping infrastructure during construction to convey runoff from the western side of Mound E to discharge point E2 on the Afon Cafnan. A model sensitivity run (section 7.5 in appendix D8-7, Application Reference Number: 6.4.32) was completed to assess the effect of pumping from the western side of Mound E to discharge point E2 on the Afon Cafnan. This indicated that the potential change in depth at CemL7 on the Nant Cemlyn downstream of the outflow at E1 would be a reduction of between 0.01 and 0.02m for the 1 in 100 year event for pluvial and fluvial scenarios. The effect would therefore remain as minor adverse.
- As stated in the Shadow Habitats Regulations Assessment (Application Reference Number: 5.2), the volume of inflow from the Nant Cemlyn to the Cemlyn Lagoon is small in comparison to the size of the lagoon. The minimum flow recorded was 0.1l/s in September 2016 (appendix D8-1, Application Reference Number: 8.4.26), whilst the Q_{95} is about 4l/s.

However, only about 5% of this is derived from the western side of Mound E so the flow contribution from this area to the lagoon is very small. The effect on salinity is less than 1% (Shadow Habitats Regulations Assessment, Application Reference Number: 5.2) based on a 15 day period to account for the tidal effect. Therefore, the change in the volume of freshwater inflow from the Nant Cemlyn would not have a significant effect on salinity, even close to the point where the Nant Cemlyn flows into the lagoon. In addition, any changes would be small compared to changes caused by rainfall events of varying magnitude and seasonal changes. Therefore, the magnitude of change of inflow to Cemlyn Lagoon on water availability and salinity is predicted to be small, with a minor significance of effect meaning it is not significant. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach.

8.5.27 The following has been assessed as likely to result in negligible effects, and are therefore not significant.

- There would be no discharge from Mound E to the Nant Cemlyn until the earthworks on the western side of the mound are complete and the mound is vegetated and there is no risk of sediment inflow above that which could occur naturally. The magnitude of change and the effect of suspended sediment on the Nant Cemlyn and Cemlyn Lagoon would therefore both be negligible.
- There would be no discharge from Mound E to the Nant Cemlyn until all topsoil movement and placement is complete and the mound is vegetated. The magnitude of change and the effect of leaching of nutrients and metals from topsoil on the Nant Cemlyn and Cemlyn Lagoon would therefore both be negligible.
- There would be no treated water discharged to Nant Cemlyn so there is no potential for carry over of polyelectrolytes into Nant Cemlyn or Cemlyn Lagoon.
- The fluvial modelling results indicate that there is an increase in flood risk (increase in water depth of 0.02m in the 1 in 100 year event) at the outfall of the Nant Cemlyn into Cemlyn Lagoon (see appendix D8-4, Application Reference Number: 6.4.29) for details). As the increase in flood level in the Nant Cemlyn is relatively small and the size of the Cemlyn Lagoon is large in comparison to the Nant Cemlyn, the potential magnitude of change in water level in the lagoon is negligible and the flood risk to Cemlyn Lagoon is therefore also negligible. The significance of effect is therefore negligible to minor adverse, which is not a significant effect. The surface water flood depth at the outfall decreases by 0.02m during the 1 in 100 year event. The reason for this decrease in depth is because Mound E alters the surface water flow path.

Power Station Catchment

8.5.28 The Power Station Catchment is within the Wylfa Newydd Development Area and the majority of the catchment would be subject to construction works as it is the site of the Power Station and associated infrastructure, including:

- establishment of construction site compounds, offices and welfare facilities;
- bulk earthworks including creation of platform levels for cooling water intake, Unit 1, Unit 2, laydown areas and buildings associated with operation of the Power Station;
- deep excavation of Unit 1 and Unit 2, and other features (including cooling water tunnels);
- marine construction activities including construction of the MOLF, and associated land-based works;
- construction of Unit 1 and Unit 2 reactor and control buildings; and
- construction of the spent fuel store and radioactive waste storage and processing facilities.

8.5.29 Prior to most of the above activities occurring, establishment of the construction phase drainage would result in the loss of the natural catchment of Nant Porth-y-pistyll. The drainage system has been designed to accommodate the flows that would have been received by Nant Porth-y-pistyll and any remaining surface flows would drain directly to the coast via settlement ponds. Despite the embedded mitigation to compensate for the loss of Nant Porth-y-pistyll, the total loss of the watercourse and its catchment would result in a large magnitude of change, but due to the low value of this watercourse the significance of the effect would be minor adverse. This is not a significant effect.

8.5.30 The magnitude of change on water quality due to leaks and spillages of fuels or oils is considered to be negligible through application of emergency management procedures in accordance with the environmental emergency management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6). There would be secondary containment systems in fuel, oil and chemical storage areas with the engineered facilities following good practice and meeting statutory requirements (including the Oil Storage Regulations and Environmental Permitting guidance [RD32]). Due to the low value of this watercourse the significance of the effect would be negligible which is not a significant effect.

8.5.31 As this catchment drains to the coast and there are no remaining water features in the area, the main receptor for the above activities is the marine environment. Effects on the marine environment are assessed separately in chapter D13 (Application Reference Number: 6.4.13).

Other areas

8.5.32 Areas within the study area adjacent to the coast, and not within the catchments defined above, are believed to drain informally directly to the sea. The construction activities proposed within these areas include:

- construction of the concrete batching plant in the north-west of the Wylfa Newydd Development Area; and
- construction of the cooling water intakes and outfalls.

8.5.33 Due to their locations, neither the cooling water intakes and outfalls nor the concrete batching plant would affect the (fresh) surface water environment. As such, these areas have not been assessed further in this chapter. Effects on the marine environment are assessed separately in chapter D13 (Application Reference Number: 6.4.13).

Fluvial geomorphology

8.5.34 The value of the fluvial geomorphological receptors is given in table D8-5 which has identified that the value ranges from low to medium. This section presents the findings of the assessment of potential effects from works within the Wylfa Newydd Development Area to the identified fluvial geomorphology receptors with any effects identified as being moderate or greater, pre-additional mitigation, summarised in table D8-10.

Tre'r Gof SSSI drains

8.5.35 One new outfall would discharge into the Tre'r Gof SSSI drains (discharge point B1 which then discharges to the SSSI via a culvert at monitoring point VN1). However, this would be discharged to an existing culvert and would not require a new headwall structure and channel modification during construction. However, there is the potential for fine sediment input into the channel from in-channel construction and removal of riparian vegetation. The discharge from the outfall during construction would increase the quantity of water and alter flow and sediment processes in the drains, particularly during high flow conditions. However, due to the modified nature of the existing channel, the re-use of an existing structure and the implementation of the water management strategies set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) (including sediment management such as silt fences) during the construction period, the magnitude of change is considered to be small. Combined with a low receptor value, this results in a minor adverse effect, which is not significant.

8.5.36 In addition, there would be the potential for fine sediment input from bare earth surfaces within the vicinity of the Tre'r Gof SSSI drains during construction. Changes to overland flow paths from modifications to the land surface would also potentially alter flow and sediment processes within the channels. Due to the inclusion of a 15m buffer around watercourses draining into the SSSI, and the use of an existing structure (thereby minimising the extent of in-channel working) the potential magnitude of change is considered to be small. Combined with a low receptor value, this results in a minor adverse effect, which is not significant.

Afon Cafnan

8.5.37 Three new outfall structures are proposed along the Afon Cafnan. These would require in-channel working for construction, as well as the removal of a

short length of the vegetated riparian corridor and the adjoining channel banks. Fine sediment would be likely to enter the channel from the works. As the outfalls begin to discharge there would be the potential to alter flow processes (and consequently sediment processes) within the channel. This would lead to scour around the structure and of the opposite bank. The presence of the physical outfall structures would remove a small length of natural bed and bank, as well as riparian vegetation during construction.

8.5.38 With the implementation of the water management strategies set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) (including sediment management such as silt fences) as well as following good design practice for the outfalls, the effects on the Afon Cafnan and on the downstream channel would be reduced. As a consequence, the potential magnitude of change for the outfall construction is considered to be medium, based on the methodology and definitions detailed in chapter B8 (Application Reference Number: 6.2.8). Combined with a medium receptor value, this would often result in a moderate effect. However, in this instance, based on professional judgement and previous experience of the likely type, magnitude and duration of change associated with the work, the effect has been reduced and so would result in a minor adverse effect, which is not significant.

8.5.39 Works within the vicinity of the Afon Cafnan, such as topsoil storage, stockpiling, drainage construction and landscape mounding, would have the potential to lead to fine sediment input into the channel (i.e. from bare earth surfaces). This could smother bed substrate (mostly gravels) and lead to changes in the sediment processes within the channel. A 15m buffer has been embedded into the design, with the vegetated buffer acting to trap sediment and maintain natural processes locally within the channel. As a consequence, the magnitude of change is considered to be small, which, combined with a medium receptor value, results in a minor adverse effect on the Afon Cafnan. This is not a significant effect.

Nant Caerdegog Isaf

8.5.40 Channel realignment would require in-channel working on Nant Caerdegog Isaf (approximately 400m of channel is to be realigned). This could release sediment altering deposition and erosion regimes and disturb existing downstream channel bed forms (such as pools, riffles, depositional features etc.). The new channel would be constructed and only connected to the Nant Caerdegog Isaf once complete. The method of making the connection would be designed to limit sediment release (e.g. opening the downstream connection first, use of temporary flow control at the upstream end at the time of breakthrough etc.) and the timing of the connection (i.e. avoiding periods of heavy rainfall) would be such that there would be limited potential for an increase in downstream sediment concentrations. The magnitude of change would therefore be small and very short-term such that the effect, when combined with a low receptor value, would be negligible. This is not a significant effect.

8.5.41 Destabilisation of watercourse banks could occur through adjacent working encouraging lateral erosion. The extent of working along the banks of the

existing watercourse would be limited to the upstream and downstream connection points associated with channel realignment. Once the new watercourse is completed there would be very limited requirement for plant movement along the banks. In addition, appropriate plant would be used allowing a standoff from watercourse banks to be maintained and/or low ground-loading plant to be used. By these means the magnitude of any changes would be small and the effect, when combined with a low receptor value, would be negligible and not significant.

8.5.42 One new outfall would be built to discharge to the Nant Caerdegog Isaf during construction. The construction of the outfall headwall would require in-channel working, removal of a very small part of the existing bank and bed, and removal of a small area of riparian vegetation. The presence of the new structure within the channel would remove a very short length of the natural bank and potentially alter local interaction of flows with the floodplain. The new discharge during the construction phase would augment flows, particularly during higher flow periods, potentially leading to scour of the bed and banks in the vicinity of the outfall and changes to localised flow and sediment processes. The effects are likely to be localised and due to the nature of the watercourse, i.e. largely modified with a low receptor value, it would lead to a small magnitude of change, resulting in a minor adverse effect with appropriate good practice mitigation in the design (including angling the outfall downstream and tying in the structure with the natural bed and banks). This is not a significant effect.

8.5.43 Construction activities including topsoil stripping, topsoil storage, haul road construction and construction of parking areas would be within close proximity to Nant Caerdegog Isaf. These activities could potentially cause disturbance of fine sediment which could enter the channel, smothering the bed and altering morphological processes and forms. However, with embedded and good practice mitigation in place, including the implementation of the water management strategies set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) (including sediment management such as silt fences), the magnitude of change is considered medium resulting in a minor adverse effect. This is not a significant effect.

8.5.44 The construction phase would also involve complete removal (infilling) of a tributary of the Nant Caerdegog Isaf. This would directly affect any flow and natural sediment delivery to the watercourse. However, due to the very small size of the tributary and limited amount of water within the channel for the majority of the year, it is thought (based on professional judgement) that connectivity and contribution of water to the Nant Caerdegog Isaf is minimal. As a result, the magnitude of change from removing this tributary is considered to be medium which, when combined with a low value receptor, results in a minor adverse effect that is not significant.

8.5.45 A new culvert to facilitate a haul road is also proposed on a small tributary of the Nant Caerdegog Isaf in its headwaters, approximately 350m downstream of the Cae Gwyn SSSI. The culvert would remove a portion of the bed and banks of this small watercourse and locally change flow processes within the structure (due to changes in bed roughness). Due to the small size of the

tributary and limited geomorphological features the magnitude of change from the addition of a culvert on this tributary is considered to be small. When combined with a low value receptor, this results in a negligible effect, which is not significant.

Nant Cemaes

8.5.46 One outfall would be constructed along the Nant Cemaes, discharging to the channel. The construction of the outfall would require in-channel working and removal of a very short length of the existing bed and bank, and riparian vegetation. During the in-channel working there is the potential for fine sediment input to the downstream channel, and destabilising of the existing banks. As the outfall begins to discharge during the construction phase there would be a change in existing flow processes in the Nant Cemaes, particularly during high flow conditions. This could lead to potential scour of adjacent bare earth banks at the structure or on the opposite bank. Changes to flow processes could also lead to alteration in the sediment being transported through the system, with a potential for increased delivery of fine sediment to Cemaes Bay.

8.5.47 However, due to the very short length of channel potentially affected by the outfall structure, and by following good design practice (including angling the outfall downstream and tying in the structure with the natural bed and banks) the new outfall would cause a small magnitude of change, which, when combined with a low receptor value would result in a minor adverse effect. This is not significant.

Nant Cemlyn

8.5.48 During the construction there would be a new outfall constructed to discharge to the Nant Cemlyn. The construction of the outfall would require in-channel working and removal of a short length of the existing bed and bank, and riparian vegetation. Construction would require in-channel working, with the potential for fine sediment input downstream. The removal of a small area of riparian vegetation is also anticipated due to the movement of plant which could result in an area of exposed bank. The outfall structure would potentially affect the connection between the channel and floodplain in a very small area.

8.5.49 Discharges from the outfall would have the potential to cause scour of the bed and banks and to change flow (by altering existing flow patterns and deflecting flows) and sediment processes. Although as stated in section 8.4, this outfall will not be flowing for the whole duration of the construction phase as during earthworks on the western side of Mound E the flow would be diverted to the Afon Cafnan. For this reason, and with the inclusion of the water management strategies set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) as well as good practice design principles (including angling the outfall downstream and tying in the structure with the natural bed and banks), the magnitude of change would be small as a consequence of the construction of the outfall, with a minor adverse effect. This is not a significant effect.

Nant Porth-y-pistyll

8.5.50 The Nant Porth-y-pistyll would be completely removed as part of the construction phase to allow for construction of the development platforms. Although this would lead to complete removal of the channel, it is of low fluvial geomorphological value and has been extensively artificially modified for land drainage purposes and during the construction of the Existing Power Station. The magnitude of change is considered to be medium for fluvial geomorphology, which, when combined with a low receptor value, results in a minor adverse effect that is not significant.

Groundwater

8.5.51 The value of the groundwater receptors is given in table D8-5 which has identified that the value ranges from low (including the groundwater in the Secondary aquifers) up to high for some secondary receptors including the SSSIs and the services and ancillary buildings at the Existing Power Station. This section presents the findings of the assessment of potential effects from works within the Wylfa Newydd Development Area to the identified groundwater receptors with any effects identified as being moderate or greater, pre-additional mitigation, summarised in table D8-11.

8.5.52 The assessment for several of the identified receptors relies on the output of the groundwater model presented in appendix D8-7 (Application Reference Number: 6.4.32).

Tre'r Gof SSSI

8.5.53 For the Tre'r Gof SSSI, the assessment for shallow groundwater effects has been included in the surface water section of this report as shallow groundwater and surface water are intrinsically linked. The assessment of the SSSI monitoring data and formulation of the conceptual model has not identified a significant bedrock groundwater input directly to the SSSI, although there is some uncertainty regarding this and there could be small areas within the SSSI where bedrock groundwater influx is important. However, the streams that flow into the SSSI are supported by groundwater and the focus of this assessment is therefore on potential effects of groundwater on these.

8.5.54 Whilst it is noted that the groundwater model has not been established to model the water inputs to Tre'r Gof in detail, the model output can be used to provide indicative impacts on groundwater levels and flows in the vicinity of the SSSI. The groundwater modelling work (appendix D8-7, Application Reference Number: 6.4.32) predicts that drawdown compared to baseline on the SSSI's western boundary at a point closest to the dewatered excavation varies from 0.5m to 0.9m (for the wet and dry periods respectively). The model also predicts that a decrease of flow from groundwater to surface water within the SSSI boundary to be between 4.5m^3/day and 7.8m^3/day. This represents, compared to baseline, a reduction of bedrock groundwater input to the SSSI of 12% for the wet period and 46% for the dry period although it should be borne in mind that the bedrock groundwater only makes up a very small

component of the total flows into the SSSI and that deep bedrock groundwater is not significant in maintaining the wetland.

8.5.55 The bedrock groundwater model shows that during construction the groundwater flow direction beneath the SSSI would not be reversed from the baseline conditions. Bedrock groundwater would continue to flow to the coast, i.e. groundwater would not be drawn into the dewatered deep excavations from within the SSSI boundary.

8.5.56 The groundwater model overestimates the dewatering requirements and extent of drawdown and the effect on groundwater discharges to surface water. This is due to it being assumed in the model that the conditions modelled extend for an indefinite period of time (in reality dewatering is likely to only last for up to three years) and the model for this phase does not allow for the sealing of major inflows to the excavation once encountered by the use of shotcrete. As such, the magnitude of change of the construction works on bedrock groundwater inputs to streams that flow into the high value Tre'r Gof SSSI is considered to be small with an overall minor adverse effect, meaning it is not significant.

Cae Gwyn SSSI

8.5.57 The key issue in relation to potential groundwater effects on the Cae Gwyn SSSI during the construction works relates to the dewatering of deep excavations and construction of landscape mound and a temporary car park to the east of the SSSI's Primary Outflow Basin. This dewatering has the potential effect of drawing down groundwater levels at the Cae Gwyn SSSI and either reducing any groundwater input to the SSSI, or increasing leakage to groundwater from the SSSI. The car park has the potential to reduce groundwater recharge adjacent to the SSSI and reduce groundwater levels in the SSSI.

8.5.58 The bedrock groundwater model shows that the groundwater drawdown for the construction phase dewatering (appendix D8-7, Application Reference Number: 6.4.32) would be up to 0.02m at the north of the SSSI. The results also show that groundwater to surface water flows decrease by up to 2.2m^3/day (during a wet period) which is 4% of the predicted baseline groundwater to surface water flows of 55m^3/day. This reduction in groundwater input to the SSSI's surface water drains compares to the estimated total outflow from the SSSI calculated in the SSSI's water balance in appendix D8-6 (Application Reference Number: 6.4.31) of approximately 235m^3/day and represents a very small proportion (approximately 1%) of the total outflow. The magnitude of change for the construction works on the groundwater input to the high value Cae Gwyn SSSI is assessed as negligible with the resultant effect being minor adverse and therefore is not significant.

8.5.59 In addition to dewatering, the construction would include creation of a landscape mound and car parking adjacent to the east of the Cae Gwyn SSSI. The car park would collect surface water runoff and discharge it via an oil interceptor to the watercourse downstream of the SSSI. This mound and car park would result in a reduction of direct groundwater recharge and hence change in groundwater levels near the SSSI. However, the small scale of this

effect means that the magnitude of change for mound creation near the Cae Gwyn SSSI would be small for recharge to the deep groundwater. As such, the effects would be minor adverse and therefore are not significant.

8.5.60 Leaks of fuels and oils associated with the works near the Cae Gwyn SSSI and from cars using the car park have the potential to locally affect groundwater quality in this area. However, the car park is designed to collect infiltrating rainwater and discharge it to surface waters via an oil interceptor. As such, the magnitude of change is negligible as are the effects, which therefore are not significant.

Cemlyn Bay SSSI

8.5.61 With respect to the effects of change in groundwater inputs to the Cemlyn Bay SSSI and Nant Cemlyn (which flows into the SSSI) this has been considered with the aid of the groundwater model (appendix D8-7, Application Reference Number: 6.4.32). Groundwater dewatering has the potential to alter either direct flows into Cemlyn Lagoon or via groundwater recharge into Nant Cemlyn and this has been considered with the aid of the groundwater model results.

8.5.62 The model results show that the maximum drawdown in the area of aquifer in the vicinity of the Cemlyn Bay SSSI and Nant Cemlyn is up to 0.5m. The groundwater flow direction does not change appreciably and groundwater continues to flow into the Nant Cemlyn and Cemlyn Lagoon with no drawdown predicted adjacent to the lagoon or Nant Cemlyn.

8.5.63 The bedrock groundwater flow model shows that groundwater discharging to surface waters in the Cemlyn Bay SSSI does not significantly change during the construction phase, with the model showing a reduction in flow of only 0.1m^3/day. This compares to a total modelled bedrock groundwater inflow into the Cemlyn Bay SSSI of between 82m^3/day and 170m^3/day so a change of less than 0.1% of the total inflow.

8.5.64 On the basis of the groundwater modelling assessment, the magnitude of change for dewatering and changes to groundwater levels on the high value Cemlyn Bay SSSI is considered to be small with an overall minor adverse effect. This is not a significant effect.

Private water supplies

8.5.65 A change in groundwater levels, principally due to groundwater dewatering for deep basements, has the potential to result in the drawdown of water levels at the PWSs closest to the Wylfa Newydd Development Area. This could then cause the wells to dry out and lead to a loss of water supply. Groundwater modelling (appendix D8-7, Application Reference Number: 6.4.32) has been used to assess the potential effects of the dewatering on the water levels at the PWSs identified by the IACC at Foel Fawr, Cae Gwyn and Caerdegog Uchaf. The model results predict that there would be no significant change to groundwater levels for all the PWSs with the maximum predicted drawdown being 0.02m for the Foel Fawr and Caerdegog Uchaf PWSs. This change would be significantly less than is recorded for seasonal fluctuations (in the order of 2.5m) and would not be discernible from natural fluctuations. As such,

the magnitude of change for construction (including dewatering) on the water supply for the PWSs identified by the IACC would be negligible with the effect also being negligible. This effect is not significant.

8.5.66 As noted previously, as the PWSs are situated up hydraulic gradient of the Wylfa Newydd Development Area, if contamination were to occur it would not flow towards the wells. As such, the effects of the construction works on water quality in the PWSs identified by the IACC have been assessed as negligible and the effect would also be negligible, and therefore is not significant.

8.5.67 For properties outside the Wylfa Newydd Development Area which may be reliant on groundwater supplies, but not known to the IACC, the effects of dewatering on the water levels have also been considered by assessment of the drawdown predicted by the groundwater model. The only areas identified by the model where there could be a reduction in groundwater levels are to the south-east, primarily around Tregele, and to the west. In these two areas the dry period model predicts a drawdown of less than 1m, whilst the wet period model predicts a drawdown of less than 0.2m. These predicted drawdowns are highly conservative due to the way the model has been built and run and in reality any drawdown would be significantly less than predicted.

8.5.68 There are approximately 27 properties shown on Ordnance Survey maps for the south-east area within the 1m zone of drawdown, with all of these properties being in the village of Tregele to the east. DCWW service plans show there is a mains water supply in this area and it is very unlikely that these properties rely on groundwater for supply. The only property identified in the west area is Felin Gafnan which is an isolated farm to the west of the Wylfa Newydd Development Area. DCWW service plans show a water main running along the road to which the farm track joins and no well is shown on historical plans as being present at this farm. As such, it is considered unlikely that the property relies on groundwater.

8.5.69 Therefore, in the unlikely event of there being properties with water supply wells in the two areas within the predicted zone of drawdown, the magnitude of groundwater level change predicted by the model is assessed as small. Any change would be short-term, reversible and less than 1m in the dry period and less than 0.2m in the wet period. The potential effect is therefore considered to be minor adverse, and is not significant.

Historical public wells

8.5.70 The construction works would remove two of the three identified historical public wells within the mounding area in the Tre’r Gof Catchment. During a walkover survey in May 2017, the two wells were visited and, based on visual appearance, have not been used for many years as a water supply. There is no record held by the IACC of these being in current use, and the vast majority of properties in the area are now on mains water. As these two historical public wells are located within Horizon’s land holding, they would not be used in the future. As the wells have a low value, even though their loss would result in a large magnitude of change, this would only represent a minor adverse effect, which would not be significant.

8.5.71 The third identified historical public well within the Wylfa Newydd Development Area (to the west of Penrhyn and also identified as being disused) would be outside the mounding area and physically would not be affected by the construction works. The magnitude of change would therefore be negligible, which with a low value receptor, would not result in a significant effect.

Existing buildings

8.5.72 Lowering of groundwater levels for construction of the deep basement and the cut-and-cover sections of tunnel construction has the potential to cause settlement of the ground as water in pore spaces in sands, gravels and clays is removed. This ground settlement then has the potential to cause subsidence of existing buildings outside the Wylfa Newydd Development Area. Given that the nature of the rock which would be dewatered within the Wylfa Newydd Development Area is a hard bedrock with flow in fractures, the effects of dewatering would be due to removal of pore pressure in the overlying superficial deposits fractured bedrock where these are in hydraulic continuity with the bedrock. As such, potential effects would be to larger buildings constructed on raft foundations on the superficial deposits or fractured bedrock or houses or other smaller structures constructed on shallow foundations. Smaller structures may be less susceptible to subsidence as it is differential settlement (that is the difference in which the earth moves more on one side of the building compared to the other) that is important and with smaller buildings this differential settlement would be less. This differential settlement can be caused by significant differences in water levels on either side of the structure or where structures are constructed on ground which has significant variability in composition and compactness is encountered. Based on the observed ground conditions and information in [RD33], where the predicted drawdown is less than 2m, settlement related issues are unlikely to be of significance unless the ground conditions are poor.

8.5.73 The Wylfa Newydd Development Area bedrock groundwater model (appendix D8-7, Application Reference Number: 6.4.32) has assessed the extent of drawdown that there could be at the Existing Power Station during construction and the model predicts that the effects are such that there could be up to around 10m of drawdown (this being for a dry period). The safety-critical buildings at this location are likely to be founded on the bedrock and as such would not be susceptible to subsidence. However, other smaller ancillary buildings or below ground services may be more susceptible to subsidence.

8.5.74 Discussions with Magnox has identified the following buildings and structures as being potentially at greatest risk from subsidence:

- Million Gallon Reservoir – failure could lead to a flooding event and also reduce fire-fighting capability.
- Fire-fighting systems within Turbine hall.
- Secondary Dry Cells (contaminated facilities constructed on piles).
- Active Incinerator Building used as an active waste facility with associated tall stack.

- Active Effluent Discharge line running along overhead gantry (North of Reactor Building).

8.5.75 These buildings and structures are not on the Existing Power Station's southern boundary, where drawdown from pumping would be greatest, and the model shows that the drawdown at these locations would be in the order of 1.5m to 3.5m.

8.5.76 The magnitude of change for subsidence on the Existing Power Station site from drawdown due to groundwater dewatering is considered to be small. Given the value of the Existing Power Station (high) the effect on ancillary buildings and services is considered to be moderate adverse and is significant.

8.5.77 For the off-site properties (including houses and farms) the bedrock groundwater modelling results show the predicted maximum drawdown at properties to the west of the Wylfa Newydd Development Area (situated between the Wylfa Newydd Development Area and Cemlyn Bay) to be approximately 0.75m with the maximum drawdown being around 1m in the village of Tregele to the east. Given the small size of these properties, the conservative nature of the model which predicts less than 2m of drawdown and the relatively shallow bedrock groundwater table gradients produced at these points by the dewatering, the settlement over the length of the buildings would be negligible. As such, the magnitude of change is considered to be negligible. Given the value of these properties (high) the effects are considered to be minor adverse and are not significant.

Secondary aquifers

Groundwater quality – saline intrusion into the aquifer

8.5.78 There is the potential that groundwater dewatering could cause the drawdown of water at the coast such that groundwater flow direction is reversed from that currently observed with the result that sea water would be drawn into the aquifer (a process known as 'saline intrusion'). This saline water would then cause contamination of the aquifer and affect its resource potential. Effects on the WFD water body status are assessed separately in the WFD Compliance Assessment (Application Reference Number: 8.26).

8.5.79 The likelihood of saline intrusion has been assessed by consideration of the groundwater model, which has modelled the direction of groundwater flow during the construction period, when there would be dewatering of deep excavations, the MOLF and for the construction of the cut-and-cover sections of the cooling water tunnels. The model results predict that saline intrusion would occur although the quantities of saline water drawn into the excavation would be small at around 6.5m^3/day. Compared to the estimated total groundwater abstraction from the seaward and inland excavations of around 175m^3/day it can be seen that this is a relatively small quantity of the total abstraction.

8.5.80 The excavation phase of construction, when groundwater dewatering would be at its peak, would be in the region of two years' duration. Groundwater dewatering would continue after the excavation is completed, but following shotcreting of the excavation walls the groundwater inflow is likely to be

minimal. As such, the effects of saline intrusion would be short-term. Furthermore, they would be reversible as, following cessation of the dewatering, the groundwater flow regime would be re-established with groundwater discharging to the sea as shown in the groundwater model (appendix D8-7, Application Reference Number: 6.4.32) for the operational Power Station.

8.5.81 The construction phase bedrock groundwater model indicates, as would be expected, that the water drawn into the aquifer would all be captured by the dewatering system and this water would then be discharged back to the sea. The model results show only a small length of coast (approximately 200m long) to the north of the MOLF would draw water into the aquifer before that water discharges into the excavation. It is recognised that if a fracture (or fractures) connects the area of dewatering to the coast, then the volume of saline water drawn into the aquifer may be greater. However, even under this scenario, as the saline water would only affect a small volume of aquifer (i.e. only that within the fracture zone) and would ultimately be discharged back to sea, the environmental effects would remain negligible. Furthermore, the embedded mitigation of spraying concrete onto the walls of the excavation would seal these fractures and as such, any flows through fractures would be temporary.

8.5.82 Even with the mitigation described above for sealing fractures, inflow through the base of the excavation would occur until the excavation reached full depth and the concrete slab was laid. However, the hydrogeology is such that at greater depths, fracture density and permeability reduce and flows through the base when the excavation is at full depth would be relatively small (appendix D8-3, Application Reference Number: 6.4.28 and D8-7, Application Reference Number: 6.4.32 provides data and an assessment of the reduction of permeability with depth).

8.5.83 Due to all saline water being captured in the excavation, no saline groundwater would be drawn into PWSs or local surface waters and the magnitude of change in groundwater quality for saline intrusion is considered to be medium. Given the low value of the aquifer, the effect of saline intrusion would be minor adverse and it would be short-term (in the order of 2 to 3 years) and reversible. This is not a significant effect.

Groundwater quality and quantity in the aquifer during Site Preparation and Clearance Works due to demolition of existing buildings, clearance of vegetation and formation of contractor's compounds

8.5.84 The demolition of buildings and vegetation removal would not have a direct effect on groundwater quality. Due to the proposals for engineered containment of fuel storage in the compound and management procedures for use, the magnitude of any change in groundwater quality from fuel or oil leaks from plant for the Site Preparation and Clearance Works would be negligible and there would be a negligible effect. This is not significant.

8.5.85 There could potentially be changes to groundwater recharge rates and areas due to the removal of trees and hedges. This could potentially be a small increase in recharge as tree removal would reduce water loss from the soil by transpiration, or it could be a decrease if vehicle movements compact the soil

surface such that rainfall runs off to surface waters rather than infiltrating the soil. However, given the limited activities of the Site Preparation and Clearance Works, the magnitude of change for recharge to the low value aquifer is considered negligible and the effect is also negligible and therefore not significant.

Groundwater quality in the aquifers and secondary receptors (local watercourses and PWSs) – leaching from exposed soils and rock during Site Preparation and Clearance Works

8.5.86 Protection of groundwater and surface water would be provided by targeted remediation of known contaminated land. The land would be remediated mainly due to its asbestos content (which does not affect the water environment), but it also contains other contaminants, albeit at relatively low concentrations. Remediation for a small area of land and groundwater contaminated with trichloroethene would also be undertaken. Due to segregation of contaminated soils from clean soils, control of runoff and control of drainage there would be limited potential for changes in groundwater quality. Once completed, the remediation would have a beneficial effect to the water environment (see chapter D7, Application Reference Number: 6.4.7 for further details of the remediation works) as there would no longer be any contaminant migration in groundwater.

8.5.87 Removal of topsoil and exposure of subsoil or rock, and the associated storage of the excavated material in mounds, has the potential to lead to increased leaching of substances such as nutrients or metals from the soils and rock. Leaching of substances may occur in areas where contaminated land is exposed during the soil remediation works. This leaching could in turn lead to deterioration in groundwater quality and effects on associated receptors such as PWSs and local watercourses.

8.5.88 Soil leaching tests have been undertaken to determine how much leaching of nutrients and metals there could be from the exposed soils (see chapter D7, Application Reference Number: 6.4.7 for further details). The results of the leaching tests show that in a small number of cases, metal and nutrient concentrations are higher than the concentrations commonly used as water quality standards for assessing the impacts of water quality on surface waters and groundwater. However, as the bulk of the rock does not have elevated metal and nutrients, as not all rainfall (and any associated contaminants that it may pick up) would reach the groundwater (a proportion would runoff to surface waters) and as there would be dilution of any contaminants leached in the underlying groundwater body. Furthermore, any change would be short-term and temporary as it would be limited to the period of excavation, movement and placement. Once soils and rock are placed, mounded and vegetated, leaching would return to that currently occurring. As such, for the low value aquifer, the magnitude of change for contaminants leaching from some of the exposed soils is considered to be small to medium and the effect would be minor adverse and therefore is not significant.

8.5.89 The PWSs are some distance from and up hydraulic gradient of the Wylfa Newydd Development Area and as such the effects of leaching from exposed soils and rock would have no effect on the PWSs. For the local watercourses,

which all have limited hydraulic continuity with the groundwater, the magnitude of change is considered to be small to negligible. This is largely due to the relatively small contribution of groundwater-supporting watercourses, with the majority of flow coming from direct rainfall runoff and/or shallow through flow in soil and subsoil. The resultant effect is therefore minor adverse and not significant.

Groundwater levels and flow direction in the aquifer– changes due to deep excavation, construction of tunnels, mounds and platforms, and hardstanding and building construction (including dewatering)

8.5.90 Lowering of groundwater levels for basement construction would cause the groundwater levels in the aquifer to fall. This would then cause a change to the groundwater flow direction. The effects of construction works (including groundwater dewatering) have been modelled (appendix D8-7, Application Reference Number: 6.4.32) and show that the change in groundwater level due to the construction activities does not extend greatly outside the Wylfa Newydd Development Area.

8.5.91 The removal of vegetation, the construction of rock and topsoil mounds and hardstanding (roads, car parks, storage compounds and buildings as they start to be constructed), and installation of the drainage system all have the potential to change groundwater recharge rates and therefore groundwater levels. However, the magnitude of change due to these activities would be considerably smaller than the effect of groundwater dewatering which the model shows to dominate the groundwater flow regime during the construction period.

8.5.92 In terms of platform construction, where the platforms are cut into the ground but remain above the groundwater level, there is the potential for higher groundwater recharge rates with a subsequent rise in the groundwater level as the unsaturated zone thickness would be reduced and potentially low permeability materials overlying the bedrock (which encourage surface water runoff) would be removed. In some cases, the removal of the overlying deposits may result in local perched groundwater horizons in the glacial till Secondary (Undifferentiated) aquifer deposits being totally removed such that all recharge would then reach the bedrock aquifer. Where platforms are constructed, there is the potential that platform construction would also compact the ground surface and reduce recharge to the underlying bedrock aquifer. The construction of an extensive drainage system across the building platform may also encourage rainfall to move away from the construction area in surface water, potentially leading to a reduction in groundwater recharge and levels. There is therefore some uncertainty as to how recharge would change and it is likely that it would vary greatly during construction.

8.5.93 As construction progresses, there is the potential that structures constructed below the shallow or bedrock groundwater tables would form a barrier to groundwater flow. This could potentially lead to higher groundwater levels up hydraulic gradient and lower levels down hydraulic gradient and locally alter the groundwater flow direction. Inputs of groundwater to local surface water features could then be affected. Buildings and structures that have been

identified which are likely to be built below the bedrock groundwater table include:

- deep basements associated with the reactor and generator buildings;
- cooling water inlet and outlet tunnels;
- cooling water intake and outlet structures; and
- the land-based elements of the MOLF.

8.5.94 In terms of effects on the aquifer for changes to groundwater levels due to the construction works (including dewatering, changes to recharge rates and presence of below ground structures), the magnitude of change is considered to be medium due to the temporary nature of the dewatering works (it is dewatering which would have the principal impact on groundwater levels and flow direction during the construction phase). Given the low value of the aquifer, the effects of the construction works (including dewatering, changes to recharge rates and presence of below ground structures) on the water levels and flow direction in the aquifer are considered to be minor adverse. This is not a significant effect.

8.5.95 With respect to the cooling water outfall tunnel, it is assumed that this would be constructed at an elevation of about 4mAOD near to the reactor and generator basement, falling gently to the coast to the north of the Existing Power Station. GI information [RD34] shows that the rockhead elevation along the majority of the cooling water outfall tunnel varies between 10mAOD and 15mAOD. A low point in the rockhead of 5mAOD is reached towards the northern end of the tunnel where the tunnel is close to its lowest elevation. As such, the majority of the cooling water outfall tunnel is likely to be constructed beneath the higher permeability fractured zone where groundwater flow is greatest. This would mean that there would be limited inflows of groundwater into the tunnel during construction. Furthermore, as the tunnel would only be some 5m to 7m in diameter, groundwater could easily move over and below it, such that it would not form a significant barrier to groundwater flow.

8.5.96 The construction technique of the tunnel would include the use of shotcreting to ensure tunnel wall stability and reduce groundwater inflow to the tunnel during construction and also the use of in situ cast permanent concrete lining. With this construction method, the tunnel is unlikely to form a high permeability flowpath for groundwater movement or act as a drain for groundwater.

8.5.97 The northern extent of the cooling water outfall tunnel would be constructed within the Gwna Group bedrock (rather than the New Harbour Group for the remainder of the tunnel) and at this location the tunnel may be constructed by cut-and–fill methods, with local dewatering. The Gwna Group bedrock at this location has been identified as being more fractured and broken than the New Harbour Group in the remainder of the study area. Drawdown from dewatering for the northern section of the cooling water outfall tunnel, if required, would be local due to the limited drawdown required to get the water levels to the required elevation (approximately 10m drawdown at the tunnel) and the relatively short time that the dewatering would be required. As such, the effects of dewatering in this area would not be widespread.

8.5.98 In terms of effects from construction of the cooling water outfall tunnel for changes to groundwater levels and flows, the magnitude of change is considered to be medium, principally due to dewatering works which would be local and temporary in nature. Given the low value of the aquifer, the effects of the cooling water outfall tunnel construction on the water levels and flow direction in the aquifer are considered to be minor adverse and therefore are not significant.

8.5.99 The hydrological studies have shown that the groundwater component of flow (base flow) in the streams is small due to the low permeability of the soils and bedrock. However, lowering of the bedrock groundwater table for construction works could reduce the amount of bedrock groundwater discharging to local watercourses which are considered as secondary receptors for groundwater. The groundwater model shows that the greatest effect of this would potentially be to the upper reaches of the medium value Nant Caerdegog Isaf and lower reaches of Afon Cafnan. For Nant Cemaes, the bedrock groundwater model shows that there would be drawdown of up to 0.5m in a stretch of the stream near to Cemaes. The model shows there would be no discernible effect for Nant Cemlyn in terms of drawdown at this watercourse. Measurements of groundwater and stream levels shown in appendix D8-3 (Application Reference Number: 6.4.28) indicate that during drier periods, groundwater levels in boreholes completed near to watercourses do fall below the base of the local streams, at least at certain locations. As such, during these drier periods, as groundwater levels are already below the base of the watercourses, drawdown from dewatering would not affect groundwater flow into the watercourses.

8.5.100 The groundwater model shows that over the whole model area (which is larger than the groundwater study area in order to avoid boundary effects in the modelling assessment), the groundwater dewatering would remove approximately 130m^3/day from the groundwater system. This compares to a total average stream outflow for the four major catchments (Cemaes, Cemlyn, Cafnan and Tre'r Gof) of around 15,000m^3/day (calculated from the 4R model results detailed in appendix D8-7, Application Reference Number: 6.4.32). As such, compared to the total stream flow, a reduction of 130m^3/day throughout the surface water system represents a reduction of 1% of the total flow (and this estimate does assume all the groundwater removed from the system was discharging to watercourses, whereas in reality a proportion of the 130m^3/day would have been discharging to the sea via the coast). The magnitude of the effect of changes to groundwater recharge and dewatering on watercourse flows is therefore considered to be small and with the watercourses potentially affected having a medium value, the effect of changes to stream flow due to reduction in groundwater levels is considered to be minor adverse and not significant.

Groundwater quality – spills and leaks of fuel and chemicals to the aquifer and secondary receptors

8.5.101 The potential effects include those associated with storage of fuel in the compound, fuel for generators, chemicals, refuelling operations/use of chemicals and leaks from plant and machinery. These can affect groundwater quality, and surface water via groundwater migration. As the PWSs are some

distance away and up hydraulic gradient of the Wylfa Newydd Development Area there is no potential to affect these.

8.5.102 The construction works would require large quantities of fuel to be stored within the Wylfa Newydd Development Area for site plant, with the potential for leaks from the tanks and spillage when fuel is being delivered. However, the fuel would be stored in tanks within areas with containment systems conforming to the Oil Storage Regulations. This would include the use of secondary containment systems and impermeable hardstanding in areas where fuel is stored. The tanks would be inspected on a regular basis with a record maintained of all inspections. Oils, such as engine oil and hydraulic oil, would be stored in smaller quantities on-site, but they would also be in areas with secondary containment systems and on hardstanding.

8.5.103 Where refuelling on permeable surfaces has to take place, then this would take place in line with good practice such as in CIRIA report C741 [RD22] as set out in the water management strategy in the Wylfa Newydd CoCP (Application Reference Number: 8.6) to include the use of drip trays or on impermeable surfaces (e.g. plant nappy) which provides protection to underground strata and watercourses.

8.5.104 There is the potential for leaks of fuels (and oils) from plant during the course of the construction works, but these incidents would be localised and good practice such as vehicle maintenance, the use of spill kits and drip trays would limit the potential for groundwater contamination. In line with good practice, such as in CIRIA report C741 [RD22], records of any incidents would be maintained in line with the environmental emergency management strategy in the Wylfa Newydd CoCP (Application Reference Number: 8.6).

8.5.105 For the aquifer which is considered to have a low value, the magnitude of change on groundwater quality due to storage, refuelling and leaks and spills of fuel and oil is considered to be small and as such the effect is considered negligible. The local watercourses, which form a secondary receptor for groundwater, have a value of up to high (for Nant Cemlyn). With the embedded and good practice mitigation measures, including storage and refuelling practices listed above, and the use of buffer zones adjacent to the watercourses, the magnitude of change for discharges of fuel to local watercourses via the groundwater pathway is considered to be negligible. The effect is also considered to be negligible and therefore is not significant.

8.5.106 A wide range of chemicals would be required for the construction works such as paints, cleaning solutions, and bituminous materials. The quantities of these chemicals would be relatively small (in comparison to fuels) and storage would generally be in tins or drums rather than in bulk containers (i.e. less than $1m^3$). Where practicable, the chemicals would be stored indoors and on hardstanding to protect the underlying groundwater. Due to the relatively small quantity of chemicals being used at any one place at any one time, and good practice such as spill response, the magnitude of change to groundwater quality from any spills of chemicals is considered to be negligible. The environmental effect on the aquifer (and secondary receptors) is also negligible and therefore is not significant.

8.5.107 The construction works would require a large quantity of concrete to be used and a concrete batching plant to be installed. The storage of cement and use of concrete has the potential to change groundwater quality locally, with the most likely effect being to change the groundwater's pH by making it more alkaline, and affecting major ion concentrations. This is most likely to occur when wet concrete is used in fractured bedrock as there is potential that cementitious material and affected water would move within the fractures (although in most cases it is likely that fractures would need to be dewatered prior to concrete pours which would mitigate the effect). Any leaks or spills of cement could affect the quality of water in the aquifer with migration of the groundwater affecting secondary receptors such as local watercourses.

8.5.108 The magnitude of change to groundwater in the aquifer from the storage and use of cementitious materials is considered to be small and given the low value of the aquifer, the effects are considered to be minor adverse and not significant. For the local watercourses (secondary receptors), due to the small inputs of groundwater to the watercourses, the magnitude of change for the watercourse quality is considered to be small. The value of the watercourses in areas where concrete is likely to be used in large quantities is up to medium in the Afon Cafnan Catchment. No significant usage of cement would take place in the Cemlyn Catchment, Cemaes Catchment or Tre'r Gof Catchment. As such, the environmental effect from the use and storage of cementitious material on all watercourses in the study area is considered to be minor adverse and is not significant.

Groundwater quality – spills and leaks of sewage to the aquifer and associated local watercourses

8.5.109 Two principal foul water (sewage) streams would be produced during the construction phase of the works; one associated with the construction area and one with the Site Campus. The foul water produced in the construction area would be diverted to a temporary treatment plant (package plant) near the coast at Porth-y-pistyll and that from the Site Campus would be treated in the existing DCWW Cemaes Waste Water Treatment Works. The DCWW plant would need to be upgraded and depending on the number of workers staying in the Site Campus may need to be supplemented by a package plant, although the discharge may be routed via the DCWW plant. Treated water would be discharged to the marine environment rather than the freshwater environment and is discussed in chapter D13 (Application Reference Number: 6.4.13).

8.5.110 There is potential for collection and treatment of foul water during the construction works to affect groundwater quality due to leaks or spills of sewage associated with the temporary sewage treatment plant and associated pipework. Contaminated groundwater could then flow to the local watercourses and also affect these.

8.5.111 Whilst the full design of the temporary sewage treatment plant is still to be undertaken (this would be the responsibility of the contractor undertaking the construction works), in accordance with good practice measures as set out in the water management strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) the package treatment plant would be

maintained in line with the manufacturer's specifications. Appropriate protection in line with good practice would be put in place to protect the sewage pipeline and treatment plant from accidental damage to prevent the leakage of sewage to groundwater. This would include above-ground pipework being properly supported and underground pipework protected from physical damage and subject to adequate leakage detection. The magnitude of change for leakage of sewage to groundwater is assessed as small and for the aquifer, the effect is assessed as minor adverse and is therefore not significant. With respect to the potential for effects on local watercourse secondary receptors in the study area, the watercourses have a medium value (no sewage infrastructure is proposed for the Cemlyn Catchment, Cemaes Catchment or Tre'r Gof Catchment) and with a negligible magnitude of change the effects of leaks of sewage on local watercourses due to groundwater discharges are assessed as being negligible and are not significant.

Groundwater quality – dewatering causing inflow of contamination from existing contaminated land and groundwater

8.5.112 As stated above, areas of known contaminated land present in the Wylfa Newydd Development Area would be remediated prior to the Main Construction works, or during the construction works if contamination were identified during the soil stripping. However, the dewatering required for construction of the basements and cut-and-cover section of the cooling water tunnel could potentially draw in contaminated groundwater from areas outside the Wylfa Newydd Development Area if there were ground or groundwater contamination.

8.5.113 A review of historical potential contaminant sources in chapter D7 (Application Reference Number: 6.4.7) identified potential areas of contaminated land. However, groundwater monitoring detailed in appendix D8.3 (Application Reference Number: 6.4.28) has not identified groundwater contamination, other than the trichloroethene contamination which would be remediated, and to the north east of the Existing Power Station, where hydrocarbons have previously been detected in groundwater. By following the good practice mitigation (monitoring, assessment and appropriate remediation) detailed in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), the magnitude of any change on water quality in the aquifer is considered to be medium and with the low value of the aquifer the effect is assessed as minor adverse and so is not significant.

8.5.114 It is possible that there is unknown contamination beneath the Existing Power Station from when it was built. The groundwater modelling studies suggest that, during dewatering, groundwater could be pulled into the excavation from areas beneath the Existing Power Station, and any contamination could be drawn through the aquifer. Any contaminated groundwater drawn into the Wylfa Newydd Development Area from dewatering would be captured in the dewatering pumping system and would not cause contamination to secondary groundwater receptors such as the local watercourses and the PWSs. Discharges from the dewatering system would be subject to testing and if contamination were identified then it would be treated to mitigate any potential effects on the marine environment. However, there is the potential that the aquifer could become contaminated at locations where there is currently no

contamination. The magnitude of change on the aquifer is considered to be medium and with the low value of the aquifer the effect is assessed as minor adverse and so is not significant.

Operation

Surface water

8.5.115 The key potential effects of the operation of the Power Station and changes to the surrounding area, such as the landscape mounds and associated drainage, on the surface water environment include issues relating to water quality, water availability and changes in flood risk.

8.5.116 During the operational period the landscape mounds would all have well established vegetation cover and haul roads would have been removed (although any existing farm tracks are likely to remain) so there would no longer be a source for suspended sediment in the catchments, other than that which occurs naturally. There would therefore not be an effect on water quality from the landscape mounds and this is not considered any further in this assessment.

8.5.117 Due to the presence of highly engineered structures associated with the Power Station there would not be any pathway from any of the facilities storing or using radioactive substances to the surface water environment and so this potential effect is not considered further in the chapter.

8.5.118 The Overarching National Policy Statement for Energy (EN-1) [RD35] notes that a particular effect of air emissions (particularly NOx and ammonia) from some energy infrastructure may lead to eutrophication (the excessive enrichment of nutrients in the water environment). The effects on ecosystems can be short-term or irreversible, and can have a large impact on ecosystem services such as pollination, aesthetic services and water supply.

8.5.119 Whilst the operation of the Power Station is unlikely to have large emissions of NOx and ammonia emissions compared to other forms of energy generating infrastructure powered by fossils fuels, the use of combustion plant (such as the standby generators and boilers required for operation of the Power Station) would lead to emissions of NOx. Chapter D5 (air quality) (Application Reference Number: 6.4.5) assesses the deposition rates at ecological receptors for nitrogen during the operation of the Power Station. This shows that compared to the predicted future background deposition rates, the increases in nitrogen deposition due to operation of the Power Station would be very small (1% or less for the long-term scenario). As such, for all catchments the magnitude of change would be negligible and the effect would be negligible which is not significant. The effects of eutrophication on each catchment are therefore not considered further below.

Tre'r Gof Catchment

8.5.120 The changes to the environment which could affect this receptor include the presence of landscape mounds and associated drainage system. Potential effects on surface water within the Tre'r Gof Catchment are summarised below.

- The presence of landscape mounding and drainage would reduce the catchment area of the Tre'r Gof outflow by 9% (appendix D8-7, Application Reference Number: 6.4.32), resulting in lower flows within the catchment. The mounding and drainage could also alter the rainfall/runoff response and result in a decrease in the long-term base flow to the Tre'r Gof SSSI. The hydrological 4R model has quantified the changes to water availability within the Tre'r Gof drains, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results show that the mean change in flow duration from the baseline to the operation scenario for the Tre'r Gof drains is a reduction in flow at all five model nodes within the SSSI. There is a decrease of 74m^3/day (0.86l/s) at the outflow from Tre'r Gof SSSI (VN5). Based on the percentage impact of operation on the flow duration curve, this decrease presents a long-term change equivalent to +/-10% or more of the Q_{95}. This equates to a large magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8). However, given the small size of the Tre'r Gof drains and intermittent flows which range throughout the year from dry to flood conditions, variable flow conditions are a key hydrological function of the Tre'r Gof SSSI. The criteria for water availability in table B8-12 in chapter B8 (Application Reference Number: 6.2.8) are less applicable to such small, intermittent watercourses and therefore the magnitude of change on water availability within the Tre'r Gof SSSI is considered to be medium. This magnitude takes into account the fact that the change would be long-term/permanent, in comparison to the construction scenario when it would be temporary and short-term. This change would result in a major adverse effect, which is significant. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach.
- Landscape mounding could locally increase the steepness of land surfaces and the drainage would provide preferential flow pathways for surface water. This could increase overland flow rates, resulting in increased flooding. The use of ditches at the bottom of the landscape mounds, allowing flows to be captured and discharged to the drainage system, means that the magnitude of change is considered to be small and the effect is considered to be minor adverse. This is not significant.

Afon Cafnan Catchment and Cae Gwyn SSSI

8.5.121 The changes to the environment within the Afon Cafnan Catchment that could affect the receptors include:

- presence of landscape mounds and associated drainage system;
- presence of impermeable surfacing; and
- parking of cars and vehicular movements.

8.5.122 Potential effects from the above activities on surface water within the Afon Cafnan Catchment are summarised below.

- The presence of landscape mounding and drainage would reduce the catchment area of the most downstream modelled point (Caf11) by 6% (appendix D8-7, Application Reference Number: 6.4.32) resulting in slightly lower flows within the catchment. The landscape mounding and associated drainage could also alter the rainfall/runoff response and result in a decrease in the long-term base flow to watercourses within the catchment. The hydrological 4R model has quantified any changes to water availability within the Afon Cafnan Catchment, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results predict that the mean change in flow duration from the baseline to the operation scenario across the Afon Cafnan Catchment is a decrease of 537m^3/day (6l/s) at the most downstream modelled point (Caf11). Based on the percentage impact of operation on the flow duration curve, this decrease presents a long-term change equivalent between +/-5% and +/-10% of the Q_{95}. This equates to a medium magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8) which is larger than during construction. This is because it takes into account the fact that the change would be long-term/permanent, in comparison to the construction scenario when it would be temporary and short-term. This change would result in a moderate adverse effect, which is significant. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach.
- The modelling results indicate that there are increases to flood depths where Cemlyn Road crosses the Afon Cafnan and to land adjacent to the realigned section of Nant Caerdegog Isaf. The increases in fluvial flood depths during the 1 in 100 year event are 0.6m and 0.01m, respectively. The surface water flood depth during the 1 in 100 year event at Cemlyn Road decreases by 0.13m, whilst the flood depth at land adjacent to the realigned section of Nant Caerdegog Isaf increases only at the upstream end of the watercourse and only by 0.08m (appendix D8-4, Application Reference Number: 6.4.29). The magnitude of change associated with the depth increases is medium, which would result in a major adverse significance of change at Cemlyn Road and a minor adverse significance of effect for the land adjacent to the watercourse realignment. However, after the granting of the Development Consent Order the property at Cafnan affected by this increased flood risk would be owned by Horizon and only leased if appropriate. Use of Cemlyn Road and exposure to this increased flood risk is therefore expected to be reduced and no additional mitigation measures are currently proposed. No additional mitigation measures are required for land at Nant Caerdegog Isaf as the effect occurs within the existing floodplain.

8.5.123 The use of the car parking areas, and vehicular movements around the Power Station Site on roads, could result in leaks and spillages of fuels or oils, resulting in effects on water quality. This would be mitigated through the use of oil interceptors in the drainage system which would result in a negligible magnitude of change and a negligible effect and is not significant.

Cae Gwyn SSSI

8.5.124 No works would take place within the boundary of the Cae Gwyn SSSI. However, the construction of the car parking and simulator and training building; to the immediate east of the Cae Gwyn SSSI, and the presence of landscape mounds and associated drainage system, could affect the SSSI during Power Station operation.

8.5.125 Only a small area (approximately 300m^2) of the primary outfall basin of the Cae Gwyn SSSI falls within the Wylfa Newydd Development Area. The drainage from the simulator and training building, as well as Mound C, would discharge into toe drains prior to an outfall into Nant Caerdegog Isaf to the north, and downstream of the Cae Gwyn SSSI. The hydrological 4R model has quantified any changes to water availability within the Afon Cafnan and includes a point (Caf2) on Nant Caerdegog Isaf at its outfall from the Cae Gwyn SSSI (and upstream of the drainage outfall). The summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results do not predict any change in flow duration from the baseline to the operation scenario at Caf2. On this basis the magnitude of change on water availability is considered to be negligible, with the resulting effect also being negligible and is not significant.

Cemaes Catchment

8.5.126 The changes to the environment that could affect surface water within the Cemaes Catchment include the presence of landscape mounds and associated drainage system. The potential effects of these on surface water within the Cemaes Catchment are summarised below.

- The presence of landscape mounding and drainage would increase the catchment area of the most downstream modelled point (Cae7) by 2% (appendix D8-7, Application Reference Number: 6.4.32) resulting in slightly higher flows within the catchment. The mounding and drainage could also alter the rainfall/runoff response and result in a decrease in the long-term base flow to Nant Cemaes. The hydrological 4R model has quantified any changes to water availability within the Cemaes Catchment, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results predict that the mean change in flow duration from the baseline to the operation scenario across the Cemaes Catchment is an increase of 54m^3/day at the most downstream model node (Cae7). Based on the percentage impact on the flow duration curve, this increase presents a long-term change equivalent between +/-5% and +/-10% of the Q_{95}. As it is a long-term/permanent change this equates to a medium magnitude of change (see criteria for water availability in table B8-12 in chapter B8, Application

Reference Number: 6.2.8) which would result in a moderate adverse effect and is significant. It should be noted that due to uncertainty in the assessment of changes to water availability caused by the drainage scheme, the assessment of effect has taken a precautionary approach.

- The fluvial and pluvial modelling results indicate that there are changes in flood depths to the Nant Cemaes near to Brookside Garages and residential properties upstream of Cemaes village. Fluvial flood depths on the Nant Cemaes upstream of Cemaes are predicted to increase by 0.04m during the 1 in 100 year event, whilst surface water flood depths are predicted to increase by 0.01m (appendix D8-4, Application Reference Number: 6.4.29). This increase in flood depth is considered to have a medium magnitude of change. Given the high sensitivity of the receptor to flood risk, the effect is considered to be major adverse, which is significant.

Cemlyn Catchment and the Cemlyn Bay SSSI

8.5.127 The changes to the environment that could affect surface water within the Cemlyn Catchment include the presence of landscape mounds and associated drainage system. The potential effects of these on surface water within the Cemlyn Catchment are summarised below.

- The presence of landscape mounding and drainage would increase the catchment area of the most downstream modelled point (Cem4) by 1% (appendix D8-7, Application Reference Number: 6.4.32) resulting in slightly higher flows within the catchment. The mounding and drainage could also alter the rainfall/runoff response and result in a decrease in the long-term base flow to Nant Cemlyn. The hydrological 4R model has quantified any changes to water availability within the Cemlyn Catchment, and the summary of this can be found within appendix D8-7 (Application Reference Number: 6.4.32). The modelling results predict that the mean change in flow duration from the baseline to the operation scenario across the Cemlyn Catchment is an increase of 27m^3/day (or 0.3l/s) at the most downstream model node (Cem4). This node is located at the outfall of the Nant Cemlyn into the Cemlyn Lagoon. Based on the percentage impact on the flow duration curve, this increase presents a long-term change equivalent of between +/-5% and +/-10% of the Q_{95}. As the change is long-term/permanent this equates to a medium magnitude of change to the Nant Cemlyn Catchment (see criteria for water availability in table B8-12 in chapter B8, Application Reference Number: 6.2.8) which would have a major adverse effect and is considered to be significant. Although an increase in water flow is often seen as beneficial (so long as it does not cause flooding) in this instance there is uncertainty in the effect of the change on the environment and therefore a precautionary approach has been adopted such that any change from baseline is considered to have an adverse effect.

- The Cemlyn Lagoon is a high value surface water receptor as the Nant Cemlyn discharges into it. Cemlyn Lagoon is part of the Cemlyn Bay SSSI, SPA and SAC, and so the effect of the mounding on the lagoon has been considered as well as the direct effect on the Nant Cemlyn (considered above). However, as stated in chapter D13 (Application Reference Number: 6.4.13), the Nant Cemlyn discharge is small in comparison to the size of the lagoon, therefore the magnitude of change on the lagoon is predicted to be small, with the significance of effect being minor adverse. This is not a significant effect. As it is not clear whether an increase in water availability would be beneficial or not it has been treated as an adverse effect as it is a move away from baseline, although this is not a significant effect. It should be noted that due to uncertainty in the assessment of changes to water availability, the assessment of effect has taken a precautionary approach.
- The fluvial modelling results indicate that there is an increase in flood risk (increase in water depth of 0.02m in the 1 in 100 year event) at the outfall of the Nant Cemlyn into Cemlyn Lagoon. The increase in surface water flood depth is 0.01m. As detailed in the FCA (appendix D8-4, Application Reference Number: 6.4.29) as the stream is small and Cemlyn Lagoon is large, the potential magnitude of change in water level in the lagoon is negligible and the flood risk to Cemlyn Lagoon is also negligible. The significance of effect is therefore negligible which is not a significant effect.

Power Station Catchment

8.5.128 Following construction, the Power Station Catchment (in the form referred to in section 8.3) would no longer exist due to the loss of Nant Porth-y-pistyll and its natural catchment. There would be a new and artificial operational plant drainage system which would drain the majority of surface water to the coast. Toe drains around the Power Station would also take runoff away from the Power Station and into the toe drains of landscape mounds surrounding the Power Station. These include Mound B (Tre'r Gof drains), Mound C (Nant Caerdegog Isaf) and Mound D (Afon Cafnan). For this reason, the Power Station Catchment would no longer be a surface water receptor during operation.

Other areas

8.5.129 There are no activities within the coastal areas that could affect the (freshwater) surface water receptors.

Fluvial geomorphology

8.5.130 This section presents the findings of the assessment of potential effects from the Power Station operation and changes to the environment within the Wylfa Newydd Development Area to the identified fluvial geomorphology receptors with any effects identified as being moderate or greater, pre-additional mitigation, summarised in table D8-10.

8.5.131 During operation all fluvial geomorphology receptors could potentially be affected by permanent site drainage (including outfalls). The Nant Porth-y-pistyll is not assessed as part of the operation of the Power Station as it would be removed during construction.

Tre'r Gof SSSI drains

8.5.132 The discharge from the outfall has the potential to alter flow (through deflection and changes to flow patterns) and sediment processes locally within one of the watercourses forming the Tre'r Gof SSSI drains. However, as the outfall is proposed to discharge into an existing culvert, these changes would not cause a direct effect on the channel bed and banks. Taking this into consideration alongside good practice and embedded mitigation, this would result in a small magnitude of change. When combined with a low receptor value, this would result in a negligible effect on the Tre'r Gof SSSI drains which is not a significant effect.

8.5.133 The permanent changes to the topography (mainly as a result of mounding) and site drainage within the Wylfa Newydd Development Area could also alter overland flow paths during operation of the Power Station. This could potentially alter flow and sediment processes within the Tre'r Gof SSSI drains. By taking into consideration the embedded mitigation (i.e. implementation of a surface water and groundwater strategy as set out in the Wylfa Newydd CoOP, Application Reference Number: 8.13) the magnitude of change on fluvial geomorphology is considered to be small. When combined with a low receptor value, this would result in a negligible effect, and so is not significant.

Afon Cafnan

8.5.134 The discharges from the three outfalls along the Afon Cafnan have the potential to increase water entering the channel causing flow and sediment processes to alter locally within the channel. This could lead to ongoing scour of the bed around the outfall structures and of the opposite bank. The changes in flow (through deflection and changes to flow patterns) could locally alter deposits or sediment build-up, with potential for changes to the morphological features present. For the Afon Cafnan, the magnitude of change is considered to be small, due to the local nature of the changes and taking into consideration embedded and good practice mitigation in the form of outfall design and controlled discharge rates. When combined with a medium receptor value, this would result in a minor adverse effect, and so is not significant.

8.5.135 The Afon Cafnan would be altered further by two toe drains running parallel to the watercourse on either side for an approximate distance of 580m, eventually discharging into the watercourse. This, along with the potential for changes in overland flow along the entire length of the channel, could potentially cause a localised change in the flow processes and consequently the morphological features. Due to the small proportion of the total length of the river affected, and the nature of the changes, this is considered to have a medium magnitude of change on the watercourse and therefore, when combined with a medium receptor value, a minor adverse effect. This is not a significant effect.

Nant Caerdegog Isaf

8.5.136 The discharge from the outfall proposed on the Nant Caerdegog Isaf has the potential to alter flow and sediment processes locally within the channel. This could lead to ongoing scour of the bed around the outfall structure and of the opposite bank. The changes in flow could locally alter deposits or sediment build-up, with potential for changes to the morphological features present. For the Nant Caerdegog Isaf, the magnitude of change is considered to be small, due to the local nature of the changes and taking into consideration embedded and good practice mitigation. When combined with a low receptor value, this would result in a negligible effect, which is not significant.

8.5.137 The changes to the topography and drainage (including newly created channels and discharge points) within the Wylfa Newydd Development Area could also alter overland flow paths. This could potentially alter flow and sediment processes within the Nant Caerdegog Isaf. By taking into consideration the buffers along the stream, the magnitude of change on fluvial geomorphology is considered to be small, which, when combined with a low receptor value, would result in a negligible effect. This is not a significant effect.

Nant Cemaes

8.5.138 The discharges from the outfall proposed on the Nant Cemaes have the potential to alter flow and sediment processes locally within the channel. This could lead to ongoing scour of the bed around the outfall structure and of the opposite bank. The changes in flow could locally alter deposits or sediment build-up, with potential for changes to the morphological features present. For the Nant Cemaes, the magnitude of change is considered to be small, due to the local nature of the changes, and taking into consideration mitigation such as angling the outfall pipe downstream and attenuation of stream flow. When combined with a low receptor value, this would result in a negligible effect and so is not significant.

8.5.139 The changes to the topography and drainage (including newly created channels and discharge points) associated primarily with Mound A could also alter overland flow paths. This could potentially alter flow and sediment processes within the Nant Cemaes. By taking into consideration the embedded mitigation, including a buffer along the stream and implementation of the drainage strategy, the magnitude of change on fluvial geomorphology is considered to be small. When combined with a low receptor value, this would result in a negligible effect and so is not significant.

Nant Cemlyn

8.5.140 The discharge from the outfall proposed on the Nant Cemlyn has the potential to alter flow and sediment processes locally within the channel. This could lead to ongoing scour of the bed around the outfall structure and of the opposite bank. The changes in flow could locally alter deposits or sediment build-up, with potential for changes to the morphological features present. For the Nant Cemlyn, the magnitude of change is considered to be small, due to the local nature of the changes and taking into consideration embedded and good practice mitigation (including angling the outfall downstream and

attenuation of stream flow). When combined with a low receptor value, this would result in a minor adverse effect and so is not significant.

8.5.141 The changes to the topography and site drainage (including newly created channels and discharge points) within the Wylfa Newydd Development Area could also alter overland flow paths. This could potentially alter flow and sediment processes within the Nant Cemlyn. By taking into consideration the embedded mitigation, including a buffer along the stream and implementation of the drainage strategy, the magnitude of change on fluvial geomorphology is considered to be small. When combined with a low receptor value, this would result in a negligible effect and so is not significant.

Groundwater

8.5.142 This section presents the findings of the assessment of potential effects from the Power Station operation and changes to the environment within the Wylfa Newydd Development Area to the identified groundwater receptors. Any effects identified as being moderate or greater, pre-additional mitigation, are summarised in table D8-11. In many instances the results of groundwater modelling have been used to assess the effect on groundwater levels, flow and discharge. The model assumes that during operation any major groundwater inflows to the deep basements would have been sealed by shotcreting during construction and that a drain would be installed around the deep basement at 6mAOD.

Tre'r Gof SSSI

8.5.143 For the Tre'r Gof SSSI, the assessment for shallow groundwater effects has been included in the surface water section of this chapter as the two are intrinsically linked. The assessment of the SSSI monitoring data has not identified a significant bedrock groundwater input to the SSSI, although it is recognised that bedrock groundwater inflows might be locally important to certain vegetation assemblages in the SSSI.

8.5.144 The groundwater modelling work (appendix D8-7, Application Reference Number: 6.4.32) predicts a reduction in water level during operation on the western boundary of the Tre'r Gof SSSI of up to 0.43m (this being for a dry period). The model predicts the bedrock groundwater discharging to surface water within the SSSI boundary increases by about 0.2m^3/day during the wet period and reduces by 2.6m^3/day during the dry period. This compares to a baseline outflow from the SSSI of around 800m^3/day so a predicted overall change of less than 0.5% of all flows. As noted above, the bedrock groundwater flowing towards the SSSI does not form a major component of the inputs to the Tre'r Gof SSSI. The 4R and MODFLOW results support this conceptual understanding as the 4R results show that the total average discharge from the SSSI (at VN5) is in the order of 800m^3/day. Therefore, the groundwater inputs estimated from the model as being between 17m^3/day and 37m^3/day for the dry and wet periods respectively represent a small component of the overall flow (around 3% of the total discharging from the SSSI). As such, the magnitude of change from the operational phase on bedrock groundwater inputs to the high value Tre'r Gof SSSI is considered to be negligible with a negligible effect, which is not significant.

Cae Gwyn SSSI

8.5.145 Drainage installed around the deep basements has the potential to reduce groundwater levels at the Cae Gwyn SSSI and reduce the bedrock groundwater input to the SSSI. The bedrock groundwater model (appendix D8-7, Application Reference Number: 6.4.32) predicts that there would be no significant reduction in water level at the Cae Gwyn SSSI compared to baseline. The model results predict that the maximum decrease of flow into the SSSI is 3.2m^3/day (this being for a wet period). This reduction in groundwater input to the SSSI's surface water drains compares to the estimated total outflow from the SSSI calculated in the SSSI's water balance in appendix D8-6 (Application Reference Number: 6.4.31) of approximately 235m^3/day and represents a small proportion (approximately 1.5%) of the total outflow. The magnitude of change for the operational works on the groundwater input to the high value Cae Gwyn SSSI is therefore assessed as small with the resultant effect being minor adverse, which is not significant.

8.5.146 A landscape mound would be constructed adjacent to the east of the Cae Gwyn SSSI. Long-term, through the Power Station's operation, this mound may result in a reduction of direct shallow groundwater recharge through the superficial deposits and hence change in groundwater levels near the SSSI. However, the scale of this effect is local and as such, the magnitude of change from mound creation near the Cae Gwyn SSSI would be small. The effect would therefore be minor adverse, which is not significant.

Cemlyn Bay SSSI

8.5.147 With respect to the effects of change in groundwater inputs to the Cemlyn Bay SSSI and Nant Cemlyn (which flows into the SSSI) during operation, this has been considered with the aid of the groundwater model (appendix D8-7, Application Reference Number: 6.4.32). The passive drainage system associated with basements and changes to groundwater recharge for the operational phase has the potential to alter direct flows into either Cemlyn Lagoon or Nant Cemlyn.

8.5.148 The bedrock groundwater model predicts the maximum reduction in groundwater level compared to baseline in the aquifer in the vicinity of Cemlyn Bay SSSI and Nant Cemlyn of up to 0.5m, but with no discernible reduction adjacent to the SSSI itself. The groundwater flow direction does not change and groundwater continues to flow into the Nant Cemlyn and Cemlyn Lagoon.

8.5.149 The bedrock groundwater flow model predicts that groundwater discharging to the Cemlyn Lagoon during the operation phase would reduce by 0.1m^3/day and 0.2m^3/day (for the dry and wet period respectively). This compares to a total bedrock groundwater inflow into the Cemlyn Bay SSSI of 81m^3/day and 170m^3/day for the two scenarios (so a change of 0.1% of the total inflow for both scenarios).

8.5.150 On this basis of the groundwater modelling results, the change in flows is unlikely to be measurable and the magnitude of change for groundwater flows into the SSSI for the operational phase on the high value Cemlyn Bay SSSI is considered to be negligible with an overall negligible effect. This is not significant.

Private water supplies

8.5.151 A change in groundwater levels, principally due to the passive drainage system used for deep basements and changes to groundwater recharge rates, has the potential to result in a reduction of water levels at the PWSs closest to the Wylfa Newydd Development Area. Groundwater modelling (appendix D8-7, Application Reference Number: 6.4.32) has been used to assess the effects of the operational phase on the water levels at the PWSs identified by the IACC at Foel Fawr, Cae Gwyn and Caerdegog Uchaf. The model results show that there would be no significant change to groundwater levels for all the PWSs for all modelled scenarios (the maximum predicted reduction in groundwater level compared to baseline is 0.01m for the Foel Fawr PWS). As such, the magnitude of change during operation on the water supply for the PWSs identified by the IACC would be negligible with the effect also being negligible, and so not significant.

8.5.152 As noted previously, as the PWS wells are situated up hydraulic gradient of the Wylfa Newydd Development Area, if contamination were to occur during operation of the Power Station it would not flow towards the wells. As such, there could be no effect from the operation of the Power Station and changes to the environment within the Wylfa Newydd Development Area on water quality in the PWSs.

8.5.153 For properties outside the Wylfa Newydd Development Area reliant on groundwater supplies but not known to the IACC, the effects of the passive drainage system and changes to recharge mechanisms on the water levels have been considered by assessment of the changes in groundwater levels predicted by the groundwater model. The only area of potential drawdown identified by the model is to the south-east, primarily around Tregele. In this area the dry period model predicts a decrease in groundwater level of less than 1m, whilst the wet period model predicts a decrease of less than 0.2m. All of the properties in the area of drawdown are within the village of Tregele and would appear to be served by mains water. As such, the magnitude of change from lowering of groundwater levels affecting PWSs is negligible with the effect also being negligible and therefore not significant.

Existing buildings

8.5.154 The Wylfa Newydd Development Area bedrock groundwater model (appendix D8-7, Application Reference Number: 6.4.32) has been used to assess the change in groundwater levels that could occur at the Existing Power Station during operation. The model predicts that there could be up to around 2m reduction in groundwater levels compared to the baseline (this being for a dry period). As significant subsidence effects are unlikely with less than 2m of drawdown unless the ground conditions are poor, ancillary buildings and services are unlikely to be susceptible to subsidence from the change in groundwater level (and this is assuming these structures are still present at the Existing Power Station at the time of operation). As such, the magnitude of change for subsidence at the Existing Power Station from reduction in groundwater level during the operational phase is considered to be small. Given the value of the ancillary buildings and services at the Existing Power

Station (high), the effects are considered to be minor adverse, and are not significant.

8.5.155 For properties other than the Existing Power Station, the bedrock groundwater modelling results show that the predicted maximum reduction in groundwater level compared to baseline at properties to the north-east of the Wylfa Newydd Development Area is less than 0.5m with the maximum reduction being less than 1m in the village of Tregele to the east. Given that the model is extremely conservative for the operational scenario, the small size of these properties, and that there would be less than 1m of drawdown, the settlement over the length of the buildings would be negligible. As such, the magnitude of change is considered to be negligible. Given the value of these properties (high), the effects are considered to be minor adverse and are not significant.

Secondary aquifers

Groundwater quality – saline intrusion to the aquifer

8.5.156 The bedrock groundwater model shows that during the operational phase, there would be no saline intrusion to the aquifer. Reduction of groundwater levels caused by the passive drainage system at 6mAOD could potentially cause upwelling of deeper, saline groundwater to shallower groundwater over the long term. However, from the groundwater quality monitoring (appendix D8-3, Application Reference Number: 6.4.28) there is no evidence of a saline wedge extending significantly into the aquifer. As such the magnitude of change for saline intrusion, or movement of any saline wedge beneath the Power Station, is considered negligible and the effects of saline intrusion for the operational phase is also assessed as negligible. These effects are not significant.

Groundwater levels and flow direction in the aquifer – changes due to the presence of mounds and platforms, hardstanding and buildings and passive drainage system

8.5.157 The presence of the completed landscape mounds and hardstanding (including roads, car parks, storage compounds and buildings) plus the presence of the passive drainage system around the reactor and generator buildings have the potential to change groundwater recharge rates and associated groundwater levels.

8.5.158 The groundwater model (appendix D8-7, Application Reference Number: 6.4.32) predicts that groundwater would continue to flow in broadly the same direction as the baseline conditions with no groundwater being pulled in from the coast. However, due to the reduction in water levels (compared to baseline) due to the drainage system, locally groundwater direction does change with groundwater from the west and east of the deep basements being captured in the drains, rather than flowing to the coast. As such, the magnitude of the effect of the Power Station operation and changes to the environment within the Wylfa Newydd Development Area for groundwater levels and flow direction in the aquifer is medium and the effect on the low value aquifer is assessed as being minor adverse. This effect is not significant.

8.5.159 For local watercourses, the model shows that the presence of the hardstanding and passive drainage system would not cause bedrock groundwater levels to alter significantly at the locations of most of the watercourses. The modelling results show that in relation to the local watercourses, the greatest reduction in groundwater level compared to baseline would occur in the Nant Caerdegog Isaf at the point closest to the deep basements and the lower reach of the Afon Cafnan. No discernible effects would be seen for Nant Cemlyn or Nant Cemaes. The groundwater model predicts that an average of 27m^3/day of water would be removed by the drainage system. Compared to flows in the streams (the total baseline flows from the 4R model for the four major catchments is 15,000m^3/day) this represents the removal of groundwater from the system of 0.2% of the total stream flow.

8.5.160 As noted previously, the groundwater component of surface water flows is small. Therefore, for the medium value watercourses, the magnitude of change is small and the overall effect of changes in groundwater levels to the local watercourses during the operation of the Power Station is considered to be minor adverse. This effect is not significant.

8.5.161 The presence of structures constructed below the bedrock groundwater table, including deep basements and the cooling water tunnels, could form a partial barrier to groundwater flow, particularly where these pass through the more fractured zone at the rockhead surface. This could potentially lead to higher groundwater levels up hydraulic gradient and lower levels down hydraulic gradient and locally alter the groundwater flow direction. Inputs of groundwater to surface water features could then be affected.

8.5.162 The largest features to be constructed below the bedrock groundwater table are the basement to house the reactor and generators and the cooling water outfall tunnels. For the deep basements, these would be surrounded by permeable rock fill which would provide a pathway for groundwater to move around the outside of the below ground structures and not affect groundwater flow levels either side of the building significantly. Where necessary, shotcrete would have been used on the walls of the excavation during construction of the basements to reduce groundwater inflow, and in this case the presence of the deep excavation would continue to locally affect the groundwater flow direction by acting as a local barrier to groundwater flow.

8.5.163 With respect to the cooling water outfall tunnels, as noted in the construction section of this assessment, the tunnels would be constructed largely beneath the principal fractured section of rockhead and the significant flowpaths would not be intercepted by the majority of the tunnel and construction techniques are such that a flowpath is unlikely to be created by the tunnel. As such, the cooling water outfall tunnel would not significantly affect groundwater flow levels or direction.

8.5.164 On the basis of the above, the magnitude of the change due to below ground structures affecting groundwater flow and levels during the operation of the Power Station would be small and when considering the aquifer as a whole and associated effects on the watercourses (i.e. secondary receptors) within the study area the effect would be negligible, and so not significant.

Groundwater quality – spills and leaks of hydrocarbon fuel and chemicals to the aquifer

8.5.165 Operation would require hydrocarbon fuel to be stored on-site for emergency diesel generators and other generators and for fuelling site vehicles and plant. To meet the nuclear safety case requirement for the Power Station, the emergency diesel generators are required to have seven days' supply of fuel.

8.5.166 There is the potential for leaks from the tanks or when fuel is being delivered to the Power Station. However, the emergency diesel generator tanks would be within buildings with impermeable hardstanding. The back-up building bulk diesel tanks and the standby generator bulk diesel tanks would be located above ground, along with all associated pipework and diesel delivery systems. As set out in the Wylfa Newydd CoOP (Application Reference Number: 8.13) all fuel would be stored in tanks with secondary containment systems (such as bunds) conforming to the Oil Storage Regulations. As such, the magnitude of the effect on groundwater quality from the potential for leaks and spills of fuel would be negligible with the effect on the low value aquifer also being negligible, and therefore not significant.

8.5.167 As with fuels, oils (such as engine oil and hydraulic oil) and waste oil would be stored on-site. It is estimated that there would be approximately 28m^3 of lubricating oil stored on the Power Station Site associated with the emergency generators and auxiliary boiler building, with further storage of associated waste lubricating oil. Further oil would be required for the plant (including turbines and pumps) within the reactor and turbine building. Oil tanks would be situated in buildings or on hardstanding with secondary containment systems conforming to the Oil Storage Regulations. As such, the magnitude of the effect on groundwater quality from leaks or spills of oil would be negligible with the effect on the low value aquifer also being negligible and therefore not a significant effect.

8.5.168 A wide range of chemicals would be required for the operation of the Power Station including for operation, routine maintenance and water treatment. The most substantial would be 600m^3 of sodium hypochlorite, used for biocide dosing. Where practicable the chemicals would be stored indoors and on hardstanding to protect the underlying groundwater. Procedures for storage of chemicals is included in the surface water and groundwater strategy of the Wylfa Newydd CoOP (Application Reference Number: 8.13). All chemical storage at the Power Station would be within engineered containment facilities, including (where appropriate) suitably bunded tanks. Furthermore, chemical storage would comply with guidance including that in NRW's How to Comply with Your Environmental Permit [RD32]. This guidance indicates that chemical storage areas must be designed and operated to minimise the risk of releases to the environment. The bulk storage of chemicals would also be subject to the arrangements set out in the Power Station's operational Environmental Permit, including routine inspections of tanks and secondary containment systems. As such, the magnitude of effects on groundwater receptors due to leaks or spills of chemicals would be negligible and the effect would also be negligible and therefore not a significant effect.

8.5.169 With the likelihood that the majority of chemical use would be indoors on plant located on hardstanding areas, the magnitude of effects from the use of chemicals on groundwater receptors would be negligible and the effect would be negligible. This effect is not significant.

8.5.170 For the operational phase, car parking would be on-site at the locations outlined in chapter D1 (Application Reference Number: 6.4.1). All car parks would be on hardstanding with drains to the Power Station Site's drainage system via oil interceptors. As such, the magnitude of change on groundwater quality from leaks of oil or fuel from parked cars would be negligible and the effect would also be negligible which is not significant. This would be the same for traffic using the Power Station, with road drainage and other hardstanding draining to surface water.

Groundwater quality – spills and leaks of sewage

8.5.171 It is proposed that sewage from the operational phase would be treated in the existing DCWW Cemaes Waste Water Treatment Works (these works would be upgraded to accommodate the extra discharge). During the Power Station operations, there would be potential for leaks of untreated sewage from below-ground pipework to affect groundwater quality although given that the sewers would be new and installed in line with good practice, they are unlikely to leak, particularly during the early years of operation. Any large leaks, if they were to occur, would likely be quickly noted due to changes of flows into the sewage treatment works. However, smaller leaks may go unrecorded although a management strategy in the surface water and groundwater strategy in the Wylfa Newydd CoOP (Application Reference Number: 8.13) would be in place so that below-ground pipes and drainage would be subject to regular inspection and maintenance.

8.5.172 As such, the magnitude of change of sewage leaking to the groundwater in the low value aquifer is considered to be small and the effects are considered to be negligible and not significant.

8.5.173 Given the location of the Power Station, the groundwater flow direction and location of local watercourses, the leakage of sewage and subsequent groundwater base flow would not affect local watercourses or PWSs.

Groundwater quality – effects during construction of the Spent Fuel Store

8.5.174 The potential effects on groundwater quality from the construction of the spent fuel store, approximately 10 years after the construction of the remainder of the Power Station is complete, would be similar to those from the construction of the Power Station, albeit on a much smaller scale. However, groundwater dewatering would not be required. The potential effects on groundwater quality would therefore be from the spills and leaks of fuel used in construction plant and the potential for cementitious material used below ground to contaminate groundwater. However, due to the relatively small scale of the works, and with the embedded and good practice mitigation that would be in place, including following the strategy set out in the water management strategy in the Wylfa Newydd CoCP (Application Reference Number: 8.6) produced for these construction works, the magnitude of effects on groundwater levels and quality in the aquifer from the construction of the

facility would be small and the effects would be minor adverse which is not significant.

8.5.175 The groundwater model for the operational phase (appendix D8-7, Application Reference Number: 6.4.32) shows that near the spent fuel store the groundwater would be flowing to the north-east, away from the local watercourses and towards the passive drainage system associated with the deep basements. As such, there would be no pathway in the groundwater to the local watercourses. Therefore, the magnitude of change of construction of the spent fuel store on local watercourses via a groundwater pathway would be negligible, and the effect would not be significant.

Decommissioning

8.5.176 The assessment of effects during decommissioning has been made against the current baseline. The works required to decommission the Power Station would be subject to a separate Environmental Impact Assessment produced at the time of decommissioning. This would assess in detail the effects against the baseline conditions at that time. The decommissioning activities are currently not known. Therefore, specific activities, and how they would affect the surface water and groundwater receptors, can only be assessed generically and based on the methods and equipment that would be used today. It is likely that by the time of decommissioning more environmentally friendly methods and equipment could be available, e.g. battery-operated plant and machinery.

Surface water

8.5.177 Some of the effects on the surface water receptors are likely to be similar to those identified in the construction process, with the key potential effects likely to include the following.

- Release of sediment during works associated with removal of hardstanding and operational drainage infrastructure within the Power Station Site and Afon Cafnan Catchment, and exposure and movement of soil associated with the Power Station Site restoration. This could affect the water quality of the Afon Cafnan Catchment. With application of similar pollution prevention practices applied during the construction process and a detailed restoration plan, that would be prepared as part of a future Environmental Impact Assessment, the magnitude of change is considered to be small, with an overall minor adverse effect. This effect is not significant.
- Spills or leaks of fuel and oils associated with plant could affect water quality. With application of pollution prevention practices, as well as secondary containment systems in fuel, oil and chemical storage areas, the magnitude of change is considered to be negligible, with the overall effect also negligible. This effect is not significant.
- Similarly, the magnitude of change of spillages of cementitious materials from removal of civil structures to 1m below site grade level is considered to be negligible by virtue of implementation of the pollution prevention

practices and as the material would be solid rather than liquid. Therefore, the potential effects would be negligible and not significant.

- The risk of flooding upstream of Cemaes village remains unchanged from the construction and operation scenarios (i.e. it is significant) at decommissioning as it is driven by the landscape mound / drainage designs.
- Changes in runoff associated with the decrease in the impermeable areas due to removal of hardstanding could restore a rainfall/runoff response similar to the baseline, increase recharge to groundwater and reduce flood risk. With application of a detailed restoration plan, the overall magnitude of change is considered to be small and beneficial, with an overall minor beneficial effect. This effect is not significant.

Fluvial geomorphology

8.5.178 This section presents the findings of the assessment of potential effects from the Power Station decommissioning to the identified fluvial geomorphology receptors which could potentially be affected through removal of existing structures (primarily outfalls) from within the channels.

8.5.179 The removal of any structure that has been *in situ* for a long period of time (i.e. decades) could lead to the local destabilisation of the channel, with potential for erosion and deposition in response.

8.5.180 Due to the type and nature of the watercourses within the Wylfa Newydd Development Area, the response to the structures could mean that the channel is in a state of adjustment (i.e. disturbed and moving towards a new equilibrium) for a long period of time. The types of channel found within the study area could take more than 1,000 years to adjust to a more natural form due to low channel slopes and water discharges, with low energies. This suggests that at the time of the decommissioning the channels would still be adjusting following the construction and operation of the Power Station.

8.5.181 The works to remove infrastructure and re-landscape the Power Station Site would likely lead to similar effects to those identified during construction and operation. These include: exposed bare earth surfaces causing high silt loadings; changes to flow patterns in watercourses receiving drainage (e.g. Afon Cafnan); in-channel working disturbing existing morphological features and changes to lateral connectivity of the channel with the floodplain.

8.5.182 The magnitude of change as a consequence of decommissioning is considered to be small taking into account the embedded and good practice mitigation. This includes implementing buffer zones along channels and undertaking a detailed restoration plan that would be prepared as part of a future Environmental Impact Assessment. This would lead to a minor effect for all fluvial geomorphology receptors. This effect is not significant.

Groundwater

8.5.183 This section presents the findings of the assessment of potential effects from the Power Station decommissioning to the identified groundwater receptors with any effects identified as being moderate or greater, pre-additional mitigation, summarised in table D8-11.

Groundwater levels and flow

8.5.184 Decommissioning would include removal of buildings, drainage and ducting to 1m below ground level, flushing and grouting of uncontaminated drains below 1m from ground level, removal of the majority of hardstanding, puncturing of existing basements to allow groundwater ingress and restoration of the land use to pre-construction conditions (as far as practicable). The groundwater level would then, over time, return to its pre-development level and flow directions would also be re-established. As such, the effect of decommissioning would be to restore the groundwater levels and flow to their pre-construction condition and the magnitude of change (from baseline conditions) would be negligible with the effects also being negligible and therefore not significant.

Groundwater quality – Storage, spills and leaks of hydrocarbon fuel and oils

8.5.185 There is the potential for changes to groundwater quality from leakage or spills due to the storage and use of fuels and oils used for demolition plant. To protect the underlying groundwater, fuels would be stored in line with the regulations and guidance documents pertaining at that time. As such, the magnitude of effect on groundwater quality from leaks or spills of fuel and oils associated with storage facilities would be negligible with a negligible effect and therefore not significant.

8.5.186 There is the potential for leaks of fuels (and oils) from plant during the course of the decommissioning works, but these incidents would be localised and good practice such as vehicle maintenance, the use of spill kits and drip trays would limit the potential for groundwater contamination. With respect to secondary receptors for groundwater, there would be no effects on the existing PWSs, as these are some distance up hydraulic gradient of the Power Station Site.

8.5.187 For the aquifer, which has a low value, the magnitude of the effect of leaks and spills of fuel and oil from decommissioning plant is considered to be small and as such the effect is considered negligible and not significant. For the local watercourses, these have a value of up to medium (for the Afon Cafnan; no decommissioning works would take place within the Cemlyn Catchment) and with the embedded and good practice mitigation measures including the use of spill kits and drip trays, the magnitude of the effect of leaks and spills of fuel from plant is considered to be negligible. The effect is also considered to be negligible and therefore is not significant.

Groundwater flooding

8.5.188 Following decommissioning of the Power Station's drainage system, including the passive drainage system used to control the groundwater levels around the reactor and generator buildings, groundwater levels would rise to 'natural' levels (likely to be similar to the groundwater levels identified in the baseline conditions). However, as ground levels would have been lowered in parts of the Power Station Site during the construction works to create the construction platform (with the proposed elevation of the platform for the reactors being in the region of 6mAOD to 22mAOD), there is the potential that groundwater levels could rise above the created platforms if the drainage channels on the platform could not drain water away quickly enough.

8.5.189 A groundwater model has not been run for the decommissioning scenario. Therefore, the baseline groundwater model (appendix D8-7, Application Reference Number: 6.4.32) has been used to assess whether groundwater levels are likely to rise above the platform when there is no artificial control of groundwater levels (i.e. the current scenario, but without reduced ground levels associated with development platforms). The model results predict that groundwater levels would be above the future platform level following decommissioning (this being the southern and western portion of the 22mAOD (post-construction) platform or the entire platform if this were created to 6mAOD) and so there is a risk of groundwater flooding. The magnitude of the effect is therefore assessed as medium and given the high value of the receptor (the land at the Power Station) the effect of decommissioning on groundwater flooding is assessed as moderate. This effect is significant.

Transboundary effects

8.5.190 There is the potential for the flow and quality in surface watercourses in the study area to be modified by the Power Station and to subsequently discharge to the marine environment. However, a drainage system would be designed as part of the construction of the Power Station to manage flows so that as far as practicable natural conditions can be maintained. Therefore, any changes to surface water quality and flow are likely to be limited and the marine modelling shows that any contaminants in the discharge are very rapidly diluted in the marine environment in the immediate vicinity of the Power Station Site such that there would not be any transboundary effects associated with the surface water environment.

8.5.191 Fluvial geomorphology effects would be restricted to within the 1km fluvial geomorphology study area due to the scale and nature of the proposed activities and the size and nature of the relevant receptors, with no transboundary effects possible.

8.5.192 The aquifers within the Wylfa Newydd Development Area are designated as Secondary B and Secondary (Undifferentiated) aquifers for the bedrock and superficial deposits respectively which have relatively low permeability and which are of local rather than regional or national importance. As shown by the groundwater modelling study, groundwater effects would therefore be restricted to the groundwater study area defined at the start of this chapter. No effects on groundwater would be seen beyond the study area and there

would not be any effects on the groundwater environment of another Member State of the European Economic Area.

8.5.193 In terms of the freshwater environment as a whole, taking into consideration the potential combined effects from changes to the groundwater and surface water environment, no transboundary effects would arise.

8.6 Additional mitigation

8.6.1 In accordance with chapter B1 (introduction to the assessment process) (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to surface water and groundwater were taken into account when determining the 'pre-mitigation' significance of effects. These are detailed in the design basis and activities section of this chapter.

8.6.2 Additional mitigation measures would be implemented to address potential significant effects identified in the assessment of effects section. These additional mitigation measures are summarised in table D8-6, table D8-7 and table D8-8 for construction, operation and decommissioning respectively.

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Construction

Table D8-6 Additional mitigation measures – construction

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Monitoring of the water environment will continue across the Wylfa Newydd Development Area up to the start of construction in order to improve the robustness of the baseline data. These monitoring data will then be used during detailed design to refine the drainage system to reduce potential effects on watercourse catchments in the Wylfa Newydd Development Area. Active management of the drainage system to include monitoring of every discharge point (a mixture of in situ sampling and laboratory analysis) and monitoring upstream and downstream of all outfall points to surface watercourses. Frequency will be a mix of continuous (using turbidity meters which will be calibrated to suspended solids concentrations), daily, weekly or monthly and dependent on the nature of the works and the weather (e.g. mounding would increase demands) but will continue into operation. Depending on the findings, additional mitigation may be required as agreed with the regulator. Options could include: (1) implementing dosing using polyelectrolytes, (2) installation of additional treatment capacity, (3) greater manual intervention/management of the system, (4) new drainage channels, (5) new pumping systems, (6) automated treatment and/or pumping systems. The drainage system has been designed to be as flexible as possible within the constraints of the current and future topography. This will allow changes to be made relatively easily and increase the potential for baseline conditions to be matched.	Reduce sediment loading to sensitive surface water features and prevent deterioration of surface waters.	Sampling of discharge water to check that concentration post-treatment does not exceed baseline water quality.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Pre-construction building surveys and monitoring during construction to determine need for further mitigation. Options for further mitigation, as appropriate, will be discussed and agreed with Magnox.	Prevent subsidence of ancillary buildings and services at the Existing Power Station	No subsidence
The outline landform and drainage scheme would be revised at detailed design stage so as not to exacerbate any existing flood risk.	No significant flood risk to sensitive receptors	Hydraulic modelling to demonstrate that there is no significant flood risk

Operation

Table D8-7 Additional mitigation measures – operation

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Horizon will develop a passive engineered drainage system for the landform area. The system will match baseline conditions as closely as practicable, as part of the final landform design.	Match the flow and water quality in the watercourses during operation to that measured for the baseline conditions.	Monitoring of discharge water.

Decommissioning

Table D8-8 Additional mitigation measures – decommissioning

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
At decommissioning, monitoring will be undertaken for a period of two years to establish if groundwater flooding has the potential to occur. If following monitoring, potential for groundwater flooding is identified, land drains could be used to drain the groundwater to either the sea or local watercourses. Alternatively, if functional and appropriate, the existing drainage from the operational stage could be left in place.	Keep the created platforms dry and prevent groundwater flooding.	No groundwater flooding.

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8.7 Residual effects

8.7.1 This section describes the residual effects for surface water and groundwater having taken into account the embedded, good practice and additional mitigation described above. Tables D8-9, D8-10 and D8-11 provide a summary of significant residual effects identified either prior to or post application of additional mitigation for surface water (construction and operation) and groundwater (construction and decommissioning).

8.7.2 No significant adverse effects were identified for fluvial geomorphology, surface water (decommissioning) and groundwater (operation).

8.7.3 Additionally, all effects of minor significance or greater identified in the assessment of effects section are summarised in appendix I3-1 (master residual effects table) (Application Reference Number: 6.9.8).

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Table D8-9 Summary of residual effects – surface water

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Construction								
Tre'r Gof Catchment and water within the Tre'r Gof SSSI	High	Change in natural catchment area through landscape mounding and managed drainage, which could alter the rainfall/runoff rates and base flow from groundwater leading to changes to water availability	Adverse Local Temporary Short-term	Small	Moderate adverse	Monitoring would be undertaken to determine if there is a significant departure from baseline conditions. If the monitoring shows effects from the works then additional mitigation as shown in table D8-6 would be implemented.	Small	Moderate adverse (no change in residual effect due to high level of uncertainty in the likelihood of success of changes in this complex environment)

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Tre'r Gof Catchment and water within the Tre'r Gof SSSI	High	Changes to surface water/ shallow groundwater inflows at seeps and flushes affecting water availability and quality due to managed drainage system.	Adverse Local Temporary Short-term	Small	Moderate adverse	Monitoring would be undertaken to assess the actual effect and if required the drainage system would be modified as detailed in table D8-6.	Small	Moderate adverse (no change in residual effect due to high level of uncertainty in the likelihood of success of changes in this complex environment)

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Tre'r Gof Catchment and water within the Tre'r Gof SSSI	High	Effects of increased suspended sediment in runoff from landscape mounding prior to full vegetation growth could affect water quality.	Adverse Local Temporary Short-term	Medium	Major adverse	Monitoring would be undertaken and if required the drainage system would be modified as detailed in table D8-6 in order to reduce suspended solids concentrations.	Negligible	Minor adverse (high level of certainty that suspended solids can be reduced by active management once monitoring has identified the effect)

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Afon Cafnan Catchment and Cemaes Catchment	Medium	Effects of increased suspended sediment in runoff from landscape mounding prior to full vegetation growth could affect water quality.	Adverse Local Temporary Short-term	Medium	Moderate adverse	Monitoring would be undertaken and if required the drainage system would be modified as detailed in table D8-6 in order to reduce suspended solids concentrations.	Negligible	Minor adverse (high level of certainty that suspended solids can be reduced by active management once monitoring has identified the effect)
Residential properties (Cemaes Catchment)	High	Increase in flood depth	Adverse Local Short-term	Small to medium	Major adverse	The outline landform and drainage scheme would be revised at detailed design stage so as not to exacerbate any existing flood risk.	Negligible	Negligible
Operation								
Tre'r Gof Catchment	High	Change in natural	Adverse	Medium	Major adverse	Horizon will develop a passive	Medium	Major adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Afon Cafnan Catchment	Medium	catchment area through landscape mounding and drainage, which could alter flow rates.	Local Permanent	Medium	Moderate adverse	engineered solution of the drainage system. The system will match baseline conditions as closely as practicable, in agreement with the regulator as part of the final landform design.	Medium	Moderate adverse
Cemaes Catchment	Medium			Medium	Moderate adverse		Medium	Moderate adverse
Cemlyn Catchment	High			Medium	Major adverse		Medium	Moderate adverse
Residential properties (Cemaes Catchment)	High	Increase in flood depth and increased risk to local receptors.	Adverse Local Permanent	Medium	Major adverse	Landform and drainage at detailed design to be modified to avoid any increase in flood risk	Negligible	Negligible
Decommissioning								
No residual effects anticipated (potential effect from groundwater flooding considered in table D8-11).								

Table D8-10 Summary of residual effects – fluvial geomorphology

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Construction								
No residual effects anticipated.								
Operation								
No residual effects anticipated.								
Decommissioning								
No residual effects anticipated.								

Table D8-11 Summary of residual effects – groundwater

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Construction								
Existing Power Station ancillary buildings and services	High	Subsidence due to drawdown caused by dewatering.	Adverse Local Permanent Long-term	Small	Moderate	Pre-construction building surveys and monitoring during construction to determine need for further mitigation. Options for further mitigation, as appropriate, will be discussed and agreed with Magnox.	Small	Minor
Operation								
No residual effects anticipated.								
Decommissioning								

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Decomm-issioned area of Power Station	High	Groundwater flooding caused by removal of artificial drainage systems.	Adverse Local Permanent Long-term	Medium	Moderate	To control any flooding from groundwater, land drains could be used to drain the groundwater to either the sea or local watercourses. Alternatively, if functional and appropriate, the operational phase drainage could be left in place.	Negligible	Negligible

8.8 References

Table D8-12 Schedule of references

ID	Reference
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RD2	British Geological Survey. 2016. *Geological maps at 1:50,000 scale, (NERC)*. [Online]. [Accessed: 15 June 2016). Available from: www.bgs.ac.uk/products/digitalmaps/digmapgb_50.html.
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ID	Reference
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HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.9 ES Volume D - WNDA Development D9 - Terrestrial and freshwater ecology

PINS Reference Number: EN010007

Application Reference Number: 6.4.9

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00041

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Contents

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9 Terrestrial and freshwater ecology

9.1 Introduction

9.1.1 This chapter describes the assessment of potential terrestrial and freshwater ecology effects resulting from the construction, operation and decommissioning of the Power Station, other on-site development (as described in chapter A1 introduction, Application Reference Number: 6.1.1), Marine Works and the Site Campus within the Wylfa Newydd Development Area.

9.1.2 Please refer to chapter B9 (terrestrial and freshwater ecology) (Application Reference Number: 6.2.9) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the terrestrial and freshwater ecology assessment; and assessment methodologies and criteria.

9.2 Study area

9.2.1 This section describes the study area relevant to the terrestrial and freshwater ecology assessment for the Wylfa Newydd Development Area.

9.2.2 The Wylfa Newydd Development Area covers marine terrestrial and freshwater habitats within which the proposed construction, operation and decommissioning of the Power Station, other on-site development, Marine Works and the Site Campus would take place. Since 2009, the terrestrial and freshwater areas of the Wylfa Newydd Development Area and, subsequently (from 2013) a 500m buffer around its boundary, have been surveyed to determine the terrestrial and freshwater ecology baseline. The 500m buffer was influenced by the results of the desk study, good practice guidelines (e.g. [RD1]), and professional judgement and is considered to be an appropriate distance beyond which most development related impacts would not extend. This study area is shown in figure D9-1 (Application Reference Number: 6.4.101).

9.2.3 The study area for background data searches was based on a 2.5km radius from the Wylfa Newydd Development Area. This search area was based on professional judgement and good practice guidelines (e.g. [RD2]), and was considered to be sufficient to account for the majority of ecological receptors that would be potentially vulnerable to effects arising from construction, operation and decommissioning activities within the Wylfa Newydd Development Area (although the search area was subsequently extended as part of the assessment of air quality changes, see below).

9.2.4 In addition, relevant ecological receptors within the study areas of other topic chapters were considered if these extended beyond the 500m study area described above and if the receptors were potentially vulnerable to effects beyond this distance. The extent of these areas and how they were selected is discussed in the relevant topic chapters (see air quality chapters B5 and D5 (Application Reference Numbers: 6.2.5 and 6.4.5); noise and vibration chapters B6 and D6 (Application Reference Numbers: 6.2.6 and 6.4.6); surface water and groundwater chapters B8 and D8 (Application Reference

Numbers: 6.2.8 and 6.4.8); and chapter B9 (Application Reference Number: 6.2.9), although a summary is provided below.

9.2.5 Where a designated site is divided by either a field survey or a desk study buffer zone, the designated site as a whole has been included within the assessment. Information relating to the specific study areas for individual receptors is provided in the respective baseline reports (see appendices) and in section 9.3.

9.2.6 The effects of changes to air quality were assessed based on best practice study areas described in chapter B5 (Application Reference Number: 6.2.5) (50m for the effects of dust; 200m for the effects of traffic emissions; and 2km for emissions from construction plant, machinery and marine vessels (increased to 15km for European Designated Sites)). The effects of changes to surface and ground water are assessed based on an identification of all sensitive receptors with hydrological connectivity to an affected waterbody (see chapter B8) (Application Reference Number: 6.2.8). Chapter C4 (air quality effects of traffic) (Application Reference Number 6.3.4) also discusses the project-wide effects of traffic emissions.

9.2.7 Additional study areas were also considered for possible road traffic-related effects (project wide) (volume C) (Application Reference Number: 6.3) and cumulative effects (volume I) (Application Reference Number: 6.9); further details relating to these study areas are provided within the respective volumes. European Designated Sites considered within the Shadow Habitats Regulations Assessment (HRA) Report (Application Reference Number: 5.2) (hereafter referred to as the 'Shadow HRA') are also included in this assessment.

9.2.8 All relevant receptors potentially vulnerable to changes in baseline conditions were identified and assessed. Within the study areas, specific surveys and assessments were defined by appropriate best practice guidelines, consultation responses and professional judgement (e.g. based on the habitat preferences of the target species). Discussions over the scope of surveys took place with Natural Resources Wales (NRW) and the Isle of Anglesey County Council (IACC) as part of the Scoping Opinion and Pre-Application Consultation processes. Further details of methodologies and the consultation process are provided in chapter B9 (Application Reference Number: 6.2.9).

9.3 Baseline environment

9.3.1 This section provides a summary of the baseline conditions for terrestrial and freshwater ecology within the study areas described in section 9.2. Values have been attributed to receptors in line with the criteria presented in table B9-12.

Statutory and non-statutory designated sites

9.3.2 The background data search included all statutory and non-statutory designated sites for nature conservation with the potential to be affected by activities within the Wylfa Newydd Development Area, and was completed in conjunction with the Shadow HRA Report (Application Reference Number:

5.2). These designated sites are illustrated in Table D9-1, figure D9-1 and figure D9-2 (Application Reference Number: 6.4.101).

9.3.3 The following sites have been classified as marine receptors and have therefore been assessed as part of chapter D13 (the marine environment) (Application Reference Number 6.4.13):

- Bae Cemlyn/Cemlyn Bay Special Area of Conservation (SAC) (excluding perennial vegetation of stony banks);
- Glannau Aberdaron and Ynys Enlli/Aberdaron Coast and Bardsey Island Special Protection Area (SPA) (excluding chough (*Pyrrhocorax pyrrhocorax*));
- Gogledd Môn Forol/North Anglesey Marine candidate Special Area of Conservation (cSAC); and
- Morwenoliaid Ynys Môn/Anglesey Terns SPA.

9.3.4 The potential effects on perennial vegetation of stony banks (a qualifying feature of Bae Cemlyn/Cemlyn Bay SAC, but not a primary reason for selection of the site) are assessed in this chapter.

9.3.5 In this chapter, chough is assessed separately as a receptor. Where effects on chough are identified, the potential influences of those effects on SPAs for which chough is a qualifying feature are also described.

9.3.6 As discussed in chapter B9 (Application Reference Number: 6.2.9), the baseline for statutory and non-statutory designated sites includes all relevant sites considered by the assessments of other relevant topic chapters, i.e. chapter D5 (Application Reference Number: 6.4.5), chapter D8 (Application Reference Number: 6.4.8) and chapter D12 (coastal processes and coastal geomorphology) (Application Reference Number: 6.4.12). The baseline also accounts for European Designated Sites considered in the Shadow HRA Report (Application Reference Number: 5.2).

9.3.7 All statutory designated sites and ancient woodland have been assigned a ‘high’ value. Non-statutory designated sites have been assigned a ‘medium’ value, (see table B9-12 in chapter B9 (Application Reference Number: 6.2.9). for an explanation of valuing receptors).

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Table D9-1 Statutory and non-statutory sites[1] included in the assessment

Site	Approximate position to the Wylfa Newydd Development Area	Primary reasons for designation relevant to terrestrial and freshwater ecology
Tre'r Gof Site of Special Scientific Interest (SSSI)	Within the Wylfa Newydd Development Area	A hydrologically dependent alkaline basin mire/fen habitat with a wide range of wetland plant species, including blunt-flowered rush (*Juncus subnodulosus*) and the scarce marsh fern (*Thelypteris palustris*).
Cae Gwyn SSSI	Adjacent to the Wylfa Newydd Development Area	Two wetland areas separated by an area of heathland. Wetland areas contain bog mosses (*Sphagnum* spp.), common wetland herbs and royal fern (*Osmunda regalis*). Other notable species are cranberry (*Vaccinium oxycoccos*) and mud sedge (*Carex limosa*).
Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site	Within the Wylfa Newydd Development Area	A mixture of coastal grassland with areas of bracken (*Pteridium aquilinum*) and heather (*Calluna vulgaris*). The site is notable for chough which breed on the cliffs, a colony of gulls which nest near Porth Wnal, and harbour porpoise (*Phocoena phocoena*) that frequent the waters around the headland. For the purposes of the assessment presented herein, Horizon is treating this site as a Wildlife Site.
Trwyn Pencarreg Wildlife Site	50m to the west	Coastal and semi-improved grassland adjacent to Porth-y-pistyll and Cemlyn Bay.
Morwenoliaid Ynys Môn /Anglesey Terns SPA	60m to the west	Breeding bird assemblage comprising Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*) and Sandwich tern (*Thalasseus sandvicensis)*.

[1] Excluding ancient woodland, which is described separately in table D9-2.

Site	Approximate position to the Wylfa Newydd Development Area	Primary reasons for designation relevant to terrestrial and freshwater ecology
Bae Cemlyn/Cemlyn Bay SSSI	110m to the west	Breeding bird assemblage comprising Arctic tern, common tern, roseate tern and Sandwich tern. Vegetated shingle, which is characterised by sea kale (*Crambe maritima*), sea radish (*Raphanus raphanistrum* subsp. *maritimus*) and yellow horned poppy (*Glaucium flavum*).
Bae Cemlyn/Cemlyn Bay SAC	110m to the west	Primary reasons for selection: • Coastal lagoons. Other qualifying features: • Perennial vegetation of stony banks.
Afon Wygyr Wildlife Site*	520m to the southeast	A small river with species-rich bankside vegetation, marshy grassland and small woodlands.
Cors Cromlech Wildlife Site*	700m to the east-southeast	A species-rich basic mire with fen and marshy grassland.
Arfordir Trwyn y Buarth – Porth Wen Wildlife Site*	900m to the northeast	The site is made up of coastal cliff grassland and heathland with several species-rich flushes. The grassland is floristically rich. The ornithological interest of this site is considerable.
Llyn Llygeirian SSSI*	1.5km to the south	Moderately base-rich lake. The flora of the lake as a whole includes a range of aquatic macrophyte species. Additionally, important for the occurrence of several nationally uncommon aquatic species: the two waterworts (*Elatine hydropiper*) and (*Elatine hexandra*), needle spike-rush (*Eleocharis acicularis*), spring quillwort (*Isoetes echinospora*) and pillwort (*Pilularia globulifera*).

Site	Approximate position to the Wylfa Newydd Development Area	Primary reasons for designation relevant to terrestrial and freshwater ecology
Cors Cae-Owen Wildlife Site*	1.6km to the east-northeast	A small but important wetland, in a basin between scrub-covered outcrops. In the centre of the site is an area of herb-rich fen, containing a large colony of the scarce marsh fern.
Rhostir Mynydd Mechell Wildlife Site*	1.6km to the south-southeast	This site consists of five separate blocks of heathland with associated areas of marshy grassland which are designated because of their size and also because they represent the most intact part of a once much larger area of acid dry heath now much fragmented.
Tir Gwlyb Teilia Neuadd Wildlife Site*	1.7km to the east-northeast	A base rich valley mire surrounded by herb-rich wet meadows, with a few small areas of willow carr.
Cors Mynachdy Wildlife Site*	1.9km to the west-southwest	A species-rich valley mire surrounded by a large area of marshy grassland.
Glannau Ynys Gybi/Holy Island Coast SPA**	13km to the southwest	Breeding and wintering chough.
Glannau Ynys Gybi/Holy Island Coast SAC*	13km to the southwest	Primary reasons for selection: • vegetated sea cliffs of the Atlantic and Baltic coasts; and • European dry heaths. Other qualifying features: • Northern Atlantic wet heaths with *Erica tetralix*.

Site	Approximate position to the Wylfa Newydd Development Area	Primary reasons for designation relevant to terrestrial and freshwater ecology
Corsydd Môn/Anglesey Fens SAC*	14km to the southeast	Primary reasons for selection: • calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*; • hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp; • alkaline fens; and • Geyer's whorl snail *(Vertigo geyeri)*. Other qualifying features: • *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils; • Northern Atlantic wet heaths with *Erica tetralix*; • southern damselfly *(Coenagrion mercuriale)*; and • marsh fritillary butterfly *(Euphydryas aurinia)*.
Corsydd Môn a Llyn /Anglesey and Llyn Fens Ramsar*	14km to the southeast	The site supports a suite of base-rich, calcareous fens which is a rare habitat type within the United Kingdom's biogeographical zone. The site supports a diverse flora and fauna with associated rare species and is of special value for maintaining the genetic and ecological diversity of the region.
Llyn Dinam SAC*	14km to the south	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation.
Glannau Aberdaron and Ynys Enlli/Aberdaron Coast Bardsey Island SPA**	63km to the south	Breeding and wintering chough.

Site	Approximate position to the Wylfa Newydd Development Area	Primary reasons for designation relevant to terrestrial and freshwater ecology
Mynydd Cilan, Trwyn y Wylfa ac Ynysoedd Sant Tudwal/Mynydd Cilan, Trwyn y Wylfa and the St. Tudwal Islands SPA**	65km to the south	Breeding and wintering chough.
Craig yr Aderyn (Bird's Rock) SPA**	89.3km to the southeast	Breeding and wintering chough.

* Site is within the air quality study area and is potentially sensitive to air quality changes;

** Site is designated for breeding and wintering chough and is included in the baseline as there may be functional links to the chough population within the Wylfa Newydd Development Area.

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9.3.8 Due to their proximity to the Wylfa Newydd Development Area, National Vegetation Classification (NVC) surveys of plant communities have been carried out to provide additional baseline information at the Tre'r Gof SSSI, the Cae Gwyn SSSI, the Cemlyn Bay SSSI, the Trwyn Pencarreg Wildlife Site and the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site (see appendix D9-8 National Vegetation Classification Technical Summary Report, Application Reference Number 6.4.41). A summary of this information is provided below, together with NVC classification codes in accordance with Rodwell (2006) [RD3].

Tre'r Gof SSSI

9.3.9 The Tre'r Gof SSSI comprised mostly:

- M13 *Schoenus nigricans – Juncus subnodulosus* mire;
- M22 fen meadow and M23 *Juncus effusus – Juncus acutiflorus* rush pasture;
- S2 *Cladium mariscus* swamp and sedge beds; and
- W1 Salix cinerea – Galium palustre sallow woodland.

9.3.10 Species of notable interest recorded during the survey included tufted sedge (*Carex elata*), slender-leaved sedge (*Carex lasiocarpa*), saw-sedge (*Cladium mariscus*), black bog rush (*Schoenus nigricans*) and marsh fern.

9.3.11 The hydrological regime that supports the wetland plant communities at the Tre'r Gof SSSI has also been extensively studied in order to produce a hydrological/hydrogeological Conceptual site model (CSM). The methods, baseline data and conclusions of the CSM are described in chapter D8 (Application Reference Number: 6.4.8).

9.3.12 A full description is provided in appendix D9-8 (Application Reference Number: 6.4.41).

Cae Gwyn SSSI

9.3.13 The Cae Gwyn SSSI comprised mostly:

- W23 *Ulex europaeus – Rubus fruticosus* scrub community;
- M5 *Carex rostrata – Sphagnum squarrosum* mire;
- M9 *Carex rostrata – Calliergonella cuspidatum* mire;
- M21 *Narthecium ossifragum – Sphagnum papillosum* mire;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- M23 *Juncus effusus/acutiflorus – Galium palustre* rush pasture; and
- M29 *Hypericum elodes – Potamogeton polygonifolius* soakway.

9.3.14 The notable species royal fern and cranberry were recorded. On the south-eastern side of the higher ground was a larger area of very high quality mire containing slender-leaved sedge and mud sedge.

9.3.15 A full description is provided in appendix D9-8 (Application Reference Number: 6.4.41).

Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site

9.3.16 The Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site comprised:

- MC9 *Festuca rubra – Holcus lanatus* maritime grassland community;
- MG5 *Cynosurus cristatus – Centaurea nigra* mesotrophic grassland;
- H7 *Calluna vulgaris – Scilla verna* heath; and
- MC8a *Festuca rubra – Armeria maritima* maritime grassland.

9.3.17 A full description is provided in appendix D9-8 (Application Reference Number: 6.4.41).

Trwyn Pencarreg Wildlife Site

9.3.18 Trwyn Pencarreg Wildlife Site comprised:

- H8d *Calluna vulgaris – Ulex gallii* heath, *Scilla verna* sub-community;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MC8 *Festuca rubra – Armeria maritima* and MC9 *Festuca rubra – Holcus lanatus* maritime grassland;
- MG5 *Cynosurus cristatus – Centaurea nigra* and MG6 *Lolium perenne – Cynosurus cristatus* grasslands;
- S27 *Carex rostrata – Potentilla palustris* fen; and
- U4 *Festuca ovina – Agrostis capillaris – Galium saxatile* grasslands.

9.3.19 A full description is provided in appendix D9-8 (Application Reference Number: 6.4.41).

Bae Cemlyn/Cemlyn Bay SAC and Cemlyn Bay SSSI

9.3.20 The terrestrial elements of the Cemlyn Bay SSSI and Bae Cemlyn/Cemlyn Bay SAC were restricted to the vegetation present on the shingle bar separating Cemlyn Lagoon from the sea. The vegetation comprised sea kale, sea campion (*Silene uniflora*) and sea beet (*Beta vulgaris* ssp. *maritima*). The grassland on the landward side of the shingle bar was dominated by rough grassland species, including false oat-grass (*Arrhenatherum elatius*), Yorkshire fog (*Holcus lanatus*), and common ragwort (*Senecio jacobaea*).

9.3.21 The NVC communities assigned to areas of the SSSI comprised:

- SD1 *Rumex crispus – Glaucium flavum* shingle community; and
- MC6 *Atriplex prostrata – Beta vulgaris* ssp. *maritima* sea-bird cliff community.

9.3.22 The communities were consistent with the designation description. A full description is provided in appendix D9-8 (Application Reference Number: 6.4.41).

Ancient Woodland Inventory

9.3.23 There are three areas of ancient woodland within the Wylfa Newydd Development Area as shown in appendix D9-18 (Ancient Woodland Summary Report) (Application Reference Number: 6.4.41). These comprise two areas of ancient semi-natural woodland (ASNW) and one restored ancient woodland site (RAWS) [RD4]. A further 12 areas of ancient woodland are located within the 2km study area for air quality (chapter D5. Application Reference Number: 6.4.5)

Table D9-2 Ancient woodland within the study area

Inventory number	Site name	Grid ref	Size (ha)	Category	Phase 1 habitat type[2]	NVC affinity
26060	Manor Garden	SH 356 938	0.3	ASNW	Mixed plantation woodland	W8 or W9
26059	Simdda-Wen	SH 353 932	0.32	ASNW	Broadleaved woodland (plantation) and broadleaved parkland	W8 or W9
26075	The Firs Hotel	SH 352 929	0.52	RAWS	Mixed plantation woodland	W8 or W9
26076		SH 375 932	0.42	RAWS	Not known	Not known
26058		SH 375 927	1.37	ASNW	Not known	Not known
26074		SH 377 923	0.59	RAWS	Not known	Not known
26057		SH 375 917	0.39	ASNW	Not known	Not known
26073		SH 375 916	0.87	RAWS	Not known	Not known
26072		SH 374 912	1.23	RAWS	Not known	Not known
26053		SH 372 912	0.28	ASNW	Not known	Not known
26051		SH 342 908	0.29	ASNW	Not known	Not known
26052	Old Rectory,	SH 325 909	0.81	ASNW	Not known	Not known

[2] Phase 1 habitat type is only provided for ancient woodland sites located within the field survey study area.

Inventory number	Site name	Grid ref	Size (ha)	Category	Phase 1 habitat type[2]	NVC affinity
	Llanfairyng hornwy					
26054		SH 322 913	0.33	ASNW	Not known	Not known
26055		SH 321 916	0.7	ASNW	Not known	Not known
26056		SH 319 917	0.31	ASNW	Not known	Not known

9.3.24 The three areas of ancient woodland within the Wylfa Newydd Development Area were surveyed as part of a Phase 1 habitat survey completed in 2013, and were identified according to the habitat types in table D9-2 (appendix D9-7. Phase 1 Habitat Survey Technical Summary Report, Application Reference Number: 6.4.40). During these surveys, the ancient woodland sites did not present features or species that were considered representative of ancient woodland and were identified as ASNW and RAWS from background data information only. More detailed surveys in accordance with the NVC methodology were undertaken in 2016 with the results provided in appendix D9-18 (Application Reference Number: 6.4.51). The NVC surveys did not identify evidence for ancient ecological continuity and recorded a high frequency of non-native tree, shrub and herb species in all three woodlands. Based on the field surveys, it is considered that there is insufficient evidence to regard any of the three woods as ancient in origin. However, as they are listed on the Ancient Woodland Inventory, they will be treated as such, and so have been assigned a high value.

Terrestrial habitats and species

9.3.25 The potential terrestrial ecological receptors that have been identified within the study areas are summarised below.

Terrestrial habitats

9.3.26 The field survey study area was approximately 392ha, and dominated by low-quality agricultural land comprising improved grassland (approximately 43%) and poor semi-improved grassland (approximately 18%). Appendix D9-7 (Application Reference Number: 6.4.40) describes all of the habitats present that have been determined using the *Joint Nature Conservation Committee Phase 1 habitat survey approach* [RD5]. The Phase 1 habitat survey results are provided on figure D9-3 (Application Reference Number: 6.4.101).

9.3.27 Other habitats present included isolated areas of arable land, gorse (*Ulex europaeus*) scrub, and pockets of marshy grassland associated with hollows and drainage features. Additionally, the areas immediately south and east of the Existing Power Station were largely conifer plantations dominated by pine species (*Pinus* spp.).

9.3.28 The field boundaries within the Wylfa Newydd Development Area and surrounding area were generally traditional cloddiau: earth banks faced with

stone, which are often colonised with gorse and hawthorn (*Crataegus monogyna*) scrub. Where the banks had collapsed, the vegetation more closely resembled hedges, but none were recorded as being potentially 'important' under the ecological criteria of the *Hedgerows Regulations 1997*. An assessment of the importance of hedgerows against cultural heritage criteria within the *Hedgerows Regulations 1997* has been provided in chapter D11 (cultural heritage) (Application Reference Number 6.4.11).

9.3.29 There were only a very small number of standard trees present in the Wylfa Newydd Development Area and no tree preservation orders were placed on these, (made under Part VIII of the *Town and Country Planning Act 1990* and the *Town and Country Planning (Trees) Regulations 1999*).

9.3.30 In addition to the designated sites, a number of areas were identified from Phase 1 habitat surveys as having the potential to support rarer plant communities, and these were subject to NVC surveys. These included grassland habitats near Mynydd Ithel (a property immediately adjacent to the southern boundary of the Wylfa Newydd Development Area that would be used as a reptile receptor site), and coastal grasslands. Detailed survey results are set out in appendix D9-8 (Application Reference Number: 6.4.41).

9.3.31 Grassland habitats at Mynydd Ithel were floristically rich and differed significantly from the surrounding grasslands. All three agricultural grazing fields were closest to the mesotrophic grassland NVC sub-community MG5a *Cynosurus cristatus – Centaurea nigra* grassland, *Lathyrus pratensis* NVC sub community (appendix D9-8) (Application Reference Number: 6.4.41).

9.3.32 NVC surveys have also been completed in all areas of the field survey study area that have the potential to support habitats listed by Annex I of the European Community Directive of the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (the 'Habitats Directive'). Within the field survey study area, Annex I habitats comprised calcareous fens with *Cladium mariscus* and species of *Caricon davallianae* (located in the Tre'r Gof SSSI) and perennial vegetation of stony banks (present within the Cemlyn Bay SSSI/SAC and Porth-y-pistyll).

9.3.33 These surveys recorded two NVC types at seven locations outside the Wylfa Newydd Development Area that constituted perennial vegetation of stony banks; the recorded NVC types being SD1 *Rumex crispus – Glaucium flavum* shingle community and MC6 *Atriplex prostrata – Beta vulgaris* ssp. *maritima* sea-bird cliff communities (see appendix D9-8. Application Reference Number: 6.4.41).

9.3.34 Surveys also recorded sea kale (a designating feature of the Cemlyn Bay SSSI) around Porth-y-pistyll, indicating that there may be some interaction between similar vegetation types within and outside the designated sites.

9.3.35 Desk studies, Phase 1 habitat surveys and NVC surveys have identified a number of terrestrial habitats present within the Wylfa Newydd Development Area that are listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016 and/or are listed on the *Anglesey Local Biodiversity Action Plan (LBAP)* [RD6]; these are shown in figure D9-10 (Application Reference Number: 6.4.101).

9.3.36 With the exception of habitats associated with designated sites (which are assessed separately), terrestrial habitats taken together are considered to be of low value as they are dominated by agricultural grassland and are abundant in the wider landscape.

Fungi

9.3.37 The combined results from the fungi surveys and gathering of incidental data are described in the fungi technical summary report (appendix D9-1) (Application Reference Number 6.4.34). The results show that there are three sites with negligible value, and six survey sites in which the numbers of species found are indicative of assemblages with medium (three) or high value (three). Survey sites are shown in figure D-11 (Application Reference Number: 6.4.101).

9.3.38 At survey sites 1, 2 and 3, all of which lie within the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, the combined counts from all survey data were 16, 16 and 17 *Hygrocybe* spp. respectively. These counts would represent areas of grassland fungi of national importance, and would be of high value. Although the basis for determination of national importance is a threshold of 17 species or more being found, analysis in appendix D9-1 (Application Reference Number 6.4.34) suggests that it is highly likely that additional species would be found in survey sites 1 and 2, and therefore the higher level of conservation value has been assigned. Both survey sites also met the criteria for national importance based on numbers of species recorded in a single visit.

9.3.39 At survey sites 4, 5 and 6, the combined counts from all survey data were seven, 11 and eight *Hygrocybe* spp. respectively. These counts would represent areas of grassland fungi of regional importance, and would represent a receptor of medium value.

9.3.40 Based on the highest level of conservation importance, fungi have been given an overall valuation of high.

Lichen

9.3.41 Data from Cofnod, the North Wales Environmental Information Service, covering a 2.5km search around the Wylfa Newydd Development Area returned a list of 14 species that had previously been recorded within 2.5km of the Wylfa Newydd Development Area [RD7]. These species were all common and widespread, with the exception of *Caloplaca granulosa*, which is an International Union for Conservation of Nature (IUCN) Red Data Book (near threatened) species [RD8].

9.3.42 Two-hundred and sixty-two taxa of lichen were recorded during field surveys in 2013, of which one is listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016: *Schismatomma graphidioides*. Of the remaining taxa, 26 are considered Nationally Scarce, two are Nationally Rare, three are Red Data Book Vulnerable listed [RD8], four are International Responsibility and 21 were new vice county records for Anglesey (see appendix D9-2 Lichen Technical Summary Report, Application Reference Number: 6.4.35).

9.3.43 The marine, supra-littoral and rock outcrop communities around Trwyn Pencarreg Wildlife Site are considered the most valuable, being representative of the hard-rock coastal habitats typical of Anglesey, and are recognised as among the best in the British Isles. The Trwyn Pencarreg habitats are outside the Wylfa Newydd Development Area but could be subject to effects from the Wylfa Newydd Project, notably changes to air quality.

9.3.44 Areas in the northern part of the Wylfa Newydd Development Area supported notable species listed in accordance with Section 7 of the Environment (Wales) Act 2016 (see appendix D9-2, Application Reference Number: 6.4.35). These areas comprised woodland at survey location 5 and a rock outcrop at survey location 6 (see appendix D9-2, Application Reference Number: 6.4.35).

9.3.45 Of note, *Ramalina fraxinea* was recorded at survey locations 13 and 21. This species is listed as being of international significance [RD9], although it is widespread in coastal areas in Wales (appendix D9-02, Application Reference Number: 6.4.35).

9.3.46 Due to the diversity and number of notable species, the value of lichen in the field survey study area is considered to be medium.

Invasive non-native plant species

9.3.47 Invasive non-native plant species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) have been recorded at several locations within the Wylfa Newydd Development Area and are listed below:

Aquatic species:

- Curly waterweed (*Lagarosiphon major*);
- Waterweed (*Elodea* spp.);
- New Zealand pigmyweed (*Crassula helmsii*);
- Parrot's-feather (*Myriophyllum aquaticum*); and
- Water fern (Azolla filiculoides).

Terrestrial species:

- Cotoneaster (*Cotoneaster* spp.);
- Japanese knotweed (*Fallopia japonica*);
- Japanese rose (*Rosa rugosa*);
- Montbretia (Crocosmia x crocosmiiflora);
- Rhododendron (Rhododendron ponticum);
- Three-cornered leek (*Alium triquetrum*); and
- Variegated yellow archangel (Lamiastrum galeobdolon subsp. argentatum).

9.3.48 These species do not form important ecological receptors, but are a constraint to construction within the Wylfa Newydd Development Area. They are therefore not assigned a value, but are discussed in terms of the mitigation

required for their successful removal, the prevention of their spreading, and their classification as contaminated waste.

Protected and notable plant species

9.3.49 The Phase 1 habitat and NVC surveys did not record any plant species that receive legal protection (appendices D9-7 and D9-8) (Application Reference Numbers: 6.4.40 and 6.4.41). Cornflower (*Centaurea cyanus*) is listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016 but was recorded within a recently planted wildflower area and so was assumed to be introduced.

9.3.50 Other notable species have been recorded in the field survey study area. These include those species listed in LBAPs [RD6]; IUCN *Red Data Book Species* [RD8]; and ancient woodland indicator species (see appendices D9-7 and D9-8, Application Reference Numbers: 6.4.40 and 6.4.41). The majority have only been recorded within designated sites (the Cae Gwyn SSSI, the Cemlyn Bay SSSI and the Tre'r Gof SSSI). As such, these species are considered as part of the assessment of those sites as a whole, and are not treated individually. This includes notable plants that feature on citations of the SSSIs, e.g. cranberry, royal fern and sea kale.

9.3.51 Notable species recorded outside designated sites include Anglesey LBAP species such as sea pink (*Armeria maritima*) in coastal grassland and water mint (*Mentha aquatica*) in wetland areas. The presence of notable species is not surprising in the context of such a large study area. Each notable species is therefore not individually assessed in this chapter, as they form important constituent parts of whole habitats, and are of low value themselves.

Terrestrial invertebrates

9.3.52 Cofnod returned a total of 536 species of invertebrate within 2.5km of the Wylfa Newydd Development Area, of which 76 are notable, i.e. listed in the Red Data Book [RD8], listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016 and/or have an associated LBAP.

9.3.53 The field surveys completed between 2011 and 2014 have produced a species list which totals 717, of which 88 were of increased conservation status (including representatives of the following orders: *Coleoptera* – beetles, *Diptera* – true flies, *Hemiptera* – true bugs, *Lepidoptera* – butterflies and moths, and *Odonata* – damselflies and dragonflies) (appendix D9-4. Terrestrial Invertebrate Technical Summary Report, Application Reference Number: 6.4.37). The species recorded included four listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016: grayling butterfly (*Hipparchia semele*); small heath butterfly (*Coenonympha pamphilus*); wall brown butterfly (*Lasiommata megera*); and the cinnabar moth (*Tyria jacobaeae*), all of which have an affinity to heathland habitats.

9.3.54 Wetter habitats were found to support the greatest number of species (including the greatest number of notable species), with grassland habitats supporting the second highest diversity of species, although this is likely to be the result of the predominance of this habitat.

9.3.55 Overall, terrestrial invertebrates are considered to be of low value due to the relatively small number of notable species recorded over such a wide survey area.

Amphibians

9.3.56 Cofnod returned records of common frog (*Rana temporaria*), common toad (*Bufo bufo*) and palmate newt (*Lissotriton helveticus*) within 2.5km of the Wylfa Newydd Development Area, with no records of great crested newt (GCN) (*Triturus cristatus*) [RD7]. There was a single GCN incidentally recorded at the Cae Gwyn SSSI during NVC surveys in 2013 (see appendix D9-9 Great Crested Newt Technical Summary Report, Application Reference Number: 6.4.42).

9.3.57 Field surveys have been carried out between 2010 and 2017. Full details of the survey types and results for surveys up until 2016 are set out in appendix D9-9 (Application Reference Number: 6.4.42). The results for the 2017 surveys are provided in appendix D9-22 (Great Crested Newt Technical Summary Report 2017) (Application Reference Number: 6.4.55). GCN have been recorded within the Cae Gwyn SSSI (ponds 11a, 11b and 12), and these were considered to support a low population (peak count of seven based on six survey visits).

9.3.58 During the GCN field surveys, common frog and palmate newt were recorded as present, and common toad was recorded breeding in numerous ponds throughout the field survey study area (see appendix D9-9) (Application Reference Number: 6.4.42). Phase 1 habitat surveys suggest that there is abundant terrestrial habitat for common toad within the Wylfa Newydd Development Area, including field boundaries, marshy and rank grassland, areas of scrub and over-grown gardens around the curtilages of demolished and existing properties.

9.3.59 The value for the GCN populations in the Wylfa Newydd Development Area is considered to be medium based on their importance and rarity on a regional scale, legal protection status and their predicted low population size.

9.3.60 Common toad is listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016, and has been assigned a low value. Common frog and palmate newt have been given a negligible value and are therefore scoped out of the assessment based on their commonality and conservation status.

9.3.61 Figure D9-4 (Application Reference Number: 6.4.101) shows the location of the GCN and toad populations.

Adder and common lizard

9.3.62 Cofnod returned records of adder (*Vipera berus*) and common lizard (*Zootoca vivipara*) within 2.5km of the Wylfa Newydd Development Area [RD7]. No records for the two other common reptile species (grass snake (*Natrix natrix*) and slow worm (*Anguis fragilis*)) were returned.

9.3.63 There were three areas in the Wylfa Newydd Development Area in which reptiles were found during surveys (sites 2, 7 and 22 (see appendix D9-10

Reptile Technical Summary Report, Application Reference Number: 6.4.43)) and the peak counts have been summarised in Table D9-3. There have also been incidental records of adder within Dame Sylvia Crowe's Mound and at Wylfa Head during other field surveys.

Table D9-3 Summary of reptile survey results

Site	Location	Species recorded	Peak count
Site 2	Un-grazed grassland immediately east of the Existing Power Station	Adder	5
		Common lizard	1
Site 7	Un-grazed area of grassland to the immediate south of the existing Visitor Centre	Adder	2
Site 22	Immediately west of and part of the Tre'r Gof SSSI	Common lizard	1

9.3.64 There is suitable habitat with the potential to support reptiles scattered throughout the Wylfa Newydd Development Area, e.g. un-grazed grassland, drystone walls, coastal grassland and scrub.

9.3.65 Adder and common lizard are assigned a low value based on these species being relatively widespread and common on a regional level; this valuation takes into account their legal protection and listing in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. Given the relatively low numbers present in areas of suitable habitat throughout the Wylfa Newydd Development Area, any effects to adder and common lizard would likely be experienced at the site level only.

Chough

9.3.66 A comprehensive discussion of baseline information for chough is provided in appendix D9-14 (Chough Baseline Report) (Application Reference Number: 6.4.47).

9.3.67 The baseline data show that, between November 2009 and March 2017, chough numbers within the chough study area have varied relatively little. The peak count was ten birds in the breeding season and six birds in the non-breeding season. Within the data up to 2015, there was no discernible pattern or trend showing an increasing or decreasing population, nor any pattern shown in the number of chicks that have been produced since 2009, the year in which monitoring started. More recently, in 2016 and 2017, the number of breeding birds at Wylfa Head has reduced to one pair.

9.3.68 The results indicated a summer population within the Wylfa Newydd Development Area comprising up to two breeding pairs and their offspring, and in winter a population of up to six birds.

9.3.69 Data from Cofnod covering a 2.5km search around the Wylfa Newydd Development Area showed that chough were well recorded in the area, with over 70 sightings of the species between 1981 and 2015 [RD7]. An additional search was completed of records held by Cofnod for the whole of Anglesey in

2017 and returned 2,170 records [RD10]. These are summarised in appendix D9-14 (Application Reference Number: 6.4.47). The peak counts of chough from desk study and field surveys suggest that the Wylfa Newydd Development Area does not form one of the locations of non-breeding-season flocking by the species which, as described by Cross and Stratford (2015) [RD11], can be upwards of 80 birds. This would also suggest that the Wylfa Newydd Development Area does not form a staging post on the regular routes taken by chough from North Wales to over-wintering sites 60km away in Snowdonia.

9.3.70 Habitats of particular importance to chough are the areas of short coastal grassland formed on thin soils in the northern areas of the Wylfa Newydd Development Area. The most extensive areas of coastal grassland are found on Wylfa Head, which itself comprises two distinct areas – the west side of Wylfa Head supports short maritime grassland grazed by common rabbits (*Oryctolagus cuniculus*), and the east side consists of a mosaic of at least four plant communities, including maritime heath, cliff and grassland habitats. These areas are particularly important as they are the closest areas of foraging habitat to the chough nest sites on the cliffs at Wylfa Head and in buildings within the Existing Power Station complex. Survey and desk study records also showed that chough currently forage along the coastline south-east of Wylfa Head towards Porth y Wylfa, and do forage further inland, albeit much more infrequently.

9.3.71 Chough is given a medium value rating because of its restricted geographical range and its listing on Annex I of Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive'), Schedule 1 of the Wildlife and Countryside Act 1981 (as amended), and in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016.

Breeding birds

9.3.72 Cofnod provided records of bird species from within a 2.5km search area between 1994 and 2013 [RD12]. One hundred and seventy-five species were returned in the data, of which 83 species had increased levels of legal protection, had associated LBAPs [RD6] or were species listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. These, and other rarely recorded notable species, are discussed in greater detail in appendix D9-11 (Breeding Bird Technical Summary Report) (Application Reference Number: 6.4.44).

9.3.73 Surveys recorded 104 species of birds over five breeding seasons (2010 to 2014 inclusive) during transects, targeted vantage point surveys and incidental observations (appendix D9-11, Application Reference Number: 6.4.44). In terms of annual species counts:

- 73 species were recorded in 2014;
- 71 species were recorded in 2013; and
- a total of 78 species from previous years of survey data (2010, 2011 and 2012 combined).

9.3.74 In total, 70 species of bird have been confirmed as breeding in the field survey study area. Of these species, 31 are 'notable', either being afforded special protection or being of conservation concern based on one of the following lists:

- species that are listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended);
- species that are listed on Annex I of the Birds Directive;
- species that are Red or Amber classified on the Birds of Conservation Concern 4 list [RD13];
- species listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016; and/or
- species that have associated LBAPs.

9.3.75 Surveys suggest that the field survey study area regularly supports at least two breeding pairs of barn owl (*Tyto alba*) with both breeding (at Cafnan Farm and Caerdegog Isaf) and non-breeding roosts present (see appendix D9-12 Barn Owl Technical Summary Report, Application Reference Number: 6.4.45). Despite being observed within the field survey study area, no evidence was recorded to suggest merlin (*Falco columbarius*) and peregrine falcon (*Falco peregrinus*) breed in the Wylfa Newydd Development Area.

9.3.76 In general terms, the most important habitats for breeding birds are considered to be those that are less intensively managed. Rough grassland, hedgerows, drystone walls, buildings and scrub all offer potential nest sites. Proportionally, improved grassland and managed hedges were found to support fewer species of nesting birds.

9.3.77 In determining the value of the breeding bird assemblage in the Wylfa Newydd Development Area, the quantitative approach suggested by Fuller (1980) [RD14] was taken into consideration. Based on the species diversity and numbers recorded in context with the large size of the field survey study area and the long period over which data has been collected, breeding birds are given a low value rating.

Over-wintering and passage birds

9.3.78 The desk study [RD12] results described previously for breeding birds are also applicable to over-wintering birds, as the information provided did not differentiate between resident species and those on passage or over-wintering.

9.3.79 During field surveys, 99 species of over-wintering and passage bird were recorded, of which 56 species were notable (see above and appendix D9-13 Over-wintering and Passage Bird Technical Summary Report, Application Reference Number: 6.4.46). However, many of the notable species records were of individual birds, low numbers of birds or species recorded only in one year, indicating that the Wylfa Newydd Development Area was not of particular importance for these species.

9.3.80 Flocks (i.e. aggregations containing more than five birds) of 21 notable species were recorded during surveys. The local populations of wintering

birds used almost all habitats present within the Wylfa Newydd Development Area, including grassland (semi-improved, improved and coastal), arable fields (areas of stubble), woodland/scrub (including hedgerows) and built up areas. This is set out in detail in appendix D9-13 (Application Reference Number: 6.4.46).

9.3.81 The value of the over-wintering bird species assemblage in the field survey study area has taken into account the quantitative assessment approach used by Fuller (1980) [RD14], as well as the large size of the field survey study area and the long period over which data have been collected (see appendix D9-13, Application Reference Number: 6.4.46). Over-wintering and passage birds are given a low value rating.

Bats

9.3.82 Cofnod data search records showed that brown long-eared bat (*Plecotus auritus*), common pipistrelle (*Pipistrellus pipistrellus*), noctule (*Nyctalus noctula*) and whiskered bat (*Myotis mystacinus*) have all been recorded in low numbers within 2.5km of the Wylfa Newydd Development Area [RD7].

9.3.83 There were seven species of bat recorded during the field surveys between 2009 and 2015: brown long-eared bat, common pipistrelle, Nathusius' pipistrelle (*Pipistrellus nathusii*), Natterer's bat (*Myotis nattereri*), noctule, soprano pipistrelle (*P. pygmaeus*) and whiskered/Brandt's bat (*M. brandtii*).

Building roosts

9.3.84 Survey data identified 16 buildings within the Wylfa Newydd Development Area with roosting bats as shown in figure D9-5 (Application Reference Number: 6.4.101) and summarised in table D9-4. With the exception of a maternity roost at the Lodge, the results indicate that the majority of roosts are small transitory or daytime summer roosts of common species (appendix D9-5 Bat Technical Summary Report, Application Reference Number: 6.4.38; and, appendix D9-20 Draft Bat Mitigation Licence, Application Reference Number: 6.4.53).

Table D9-4 Summary of bat roosts within the Wylfa Newydd Development Area

Property name	Number and species	Roost types[3]	Roost value
Back-up Office Facility Back-up Auxiliary Facility	3 x brown long-eared bats	Summer roosts for small numbers of rarer species.	Medium

[3] Rarer species include brown long-eared bats and Natterer's bats with a population in Wales of 10,000–100,000, common species include common and soprano pipistrelle bats with a population in Wales of over 100,000 and rarest species include whiskered/Brandt's bats with a population in Wales under 10,000 [RD15].

Property name	Number and species	Roost types[3]	Roost value
Wylfa Sports and Social Club Building 1	1 x common pipistrelle	Summer roost for small numbers of common species.	Low
Leisure Centre Building 2	1 x unknown	Summer roost for small numbers of (assumed) common species.	Low
Nantorman Building 1	1 x soprano pipistrelle	Summer roost for small numbers of common species.	Low
Nantorman Building 2	unknown x long-eared bat	Summer roost for small numbers of rarer species.	Medium
Nantorman Building 3	2 x soprano pipistrelles	Summer roost for small numbers of common species.	Low
The Firs Hotel	1 x Natterer's bat	Summer roost for small numbers of rarer species.	Medium
The Lodge	5 x brown long-eared bats 38 x Natterer's bat 2 x soprano pipistrelles 1 x whiskered/ Brandt's bat	Summer roost for small numbers of rarest and common species. Maternity roost for medium numbers of rarer species.	Medium
Tre'r Gof Uchaf Farm Buildings 2 and 4 (buildings are joined)	1 x brown long-eared bat 2 x common pipistrelles 2 x soprano pipistrelles	Summer roost for small numbers of rarer and common species.	Medium
Tyddyn Gele Building 1	1 x common pipistrelle 6 x soprano pipistrelles 1 x whiskered/ Brandt's bat	Summer roost for small numbers of common and rarest species.	Medium
Tyddyn Gele Building 3	1 x brown long-eared bat 1 x common pipistrelle 1 x soprano pipistrelle	Summer roost for small numbers of rarer and common species.	Medium
Tyddyn Gele Building 4	1 x soprano pipistrelle	Summer roost for small numbers of common species.	Low

Property name	Number and species	Roost types[3]	Roost value
Tyddyn Gele Building 6	2 x soprano pipistrelles	Summer roost for small numbers of common species.	Low
Tyddyn Goronwy Farm Building 1	1 x common pipistrelle 1 x soprano pipistrelle	Summer roost for small numbers of common species.	Low
Tyddyn Goronwy Farm Building 3	1 x soprano pipistrelle	Summer roost for small numbers of common species.	Low

9.3.85 Bat boxes and two buildings have been erected as compensation for the loss of roosts in buildings previously demolished within the Wylfa Newydd Development Area, as shown in figure D9-5 (Application Reference Number: 6.4.101). Demolition of these structures was not related to the Wylfa Newydd Project, being required for health and safety reasons and completed under a European Protected Species Mitigation Licence (EPSML). Surveys in 2015 show that one of these compensation buildings (Tyn-y-Maes bat barn) supported 50 bats of four different species (brown long-eared, common and soprano pipistrelles, and whiskered/Brandt's bats), and is therefore considered to be a successful design.

Tree roosts

9.3.86 The assessment of trees within the Wylfa Newydd Development Area to support roosting bats was undertaken in 2010, 2011, 2012 and 2013. These surveys identified 57 trees and some areas of plantation woodland with features that have the potential to support roosting bats. No tree roosts were confirmed.

Activity

9.3.87 Activity surveys recorded common and soprano pipistrelles and *Myotis* sp. bats (these have not been separated out into individual species due to the difficulty of distinguishing *Myotis* calls). Noctules, brown long-eared bats and Nathusius' pipistrelle bats were also recorded but at extremely low levels.

9.3.88 Activity surveys consistently showed the highest levels of activity around the following locations (see appendix D9-5, (Application Reference Number: 6.4.38):

- Cafnan Farm;
- Cemlyn Road;
- Cestyll Garden;
- Cemaes community woodland;
- Dame Sylvia Crowe's Mound;
- Foel Fawr farm;

- The Firs Hotel;
- Tyddyn Gele; and
- the Visitor Centre of the Existing Power Station.

9.3.89 The levels of activity recorded were considered typical for a site supporting the number of bats known to be roosting in the field survey study area. The activity surveys showed that field boundaries were important for commuting and foraging bats, which is characteristic of agricultural landscapes such as those found in the Wylfa Newydd Development Area. Slightly higher than expected activity levels were observed in the marine interface environments, a habitat that is often assumed to be used sparingly by bats, but which can support insects associated with unimproved grassland, rotting seaweed and driftwood which bats would prey upon [RD15].

9.3.90 In summary, bats have been assigned a medium value due to the size and species composition of the population that use the habitats within the Wylfa Newydd Development Area.

Otter

9.3.91 Cofnod returned four records of otter between 1981 and 2011 within 2.5km of the Wylfa Newydd Development Area [RD12]. These records included one live sighting and three records of spraint, all from around the Cemlyn Bay area.

9.3.92 Otter were also recorded around Cemlyn Lagoon by North Wales Wildlife Trust wardens in 2015 [RD16] and 2016 [RD17]. Anecdotal records of otter predating nesting terns in 2017 have also been received (pers. comm. Horizon Environmental Coordinator)

9.3.93 Surveys identified 29 individual watercourses within the field survey study area with the potential to support otter (including Cemlyn Lagoon), as numbered and shown in appendix D9-6 Otter and Water Vole Technical Summary Report (Application Reference Number: 6.4.39), and figure D9-6 (Application Reference Number: 6.4.101). The results also showed that the coastal areas either side of the Existing Power Station have the potential to support otter.

9.3.94 Otter activity was generally focused to the west of the Wylfa Newydd Development Area, around Cemlyn Lagoon and two sections of Afon Cafnan (watercourses 10 and 12). Field evidence recorded during the surveys was generally limited to spraints, although some prints were noted. No live sightings of otter were made during the surveys.

9.3.95 The watercourses where evidence of otters was recorded, adjacent to or within the Wylfa Newydd Development Area were Nant Cemaes (watercourse 3), Afon Cafnan (watercourse 10 and 12) and Nant Caerdegog Isaf (watercourse 13). There was considered to be a high likelihood that otter also use the habitats around Porth-y-pistyll for foraging and commuting, although tides may hide the evidence of this activity.

9.3.96 There is no evidence to suggest that otter is breeding in the Wylfa Newydd Development Area, and it is therefore the foraging resource that is considered of most value. Otter have been assigned a medium value.

Water vole

9.3.97 Cofnod provided seven records of water vole from between 1986 and 2005 within 2.5km of the Wylfa Newydd Development Area [RD7]. These records were all from the Cemlyn Bay area and included live sightings, prints and burrows.

9.3.98 Evidence of water vole, including burrows, latrines and feeding remains, was recorded during field surveys in five separate locations within the field survey study area (see appendix D9-6, Application Reference Number: 6.4.39) and figure D9-6 (Application Reference Number: 6.4.101)).

9.3.99 The survey data collected illustrate that the population of water vole within the study area is dynamic, but probably in decline. The evidence for this decline comes from the loss of isolated populations, such as those at the Tre'r Gof SSSI, which disappeared in 2010. The likely cause of the loss of this population has been attributed to deterioration in habitat quality, and the susceptibility of small populations to chance extinction events such as flooding. It is considered that the robustness of the population as a whole is restricted by the level of habitat connectivity throughout the field survey study area.

9.3.100 While it is not possible to determine population sizes in an area without using capture-mark-release-recapture methods, it is possible to estimate the number of territories by using the number of latrines as a guide. Strachan *et al.* (2011) [RD18] estimate that a minimum of six latrine sites would be representative of the territory of one adult female water vole. Based on the number and density of latrines found in the field survey study area, it is likely that the number of water vole using the watercourses is very low.

9.3.101 Based on the evidence described, water vole has therefore been given a medium value based largely on the legislation protecting them and their conservation status rather than the importance of the population present.

Red squirrel

9.3.102 Red squirrel were assumed to be absent from the desk survey study area based on a lack of historic records of the species provided by Cofnod in 2015 [RD7] and the scarcity of suitable habitat in the Wylfa Newydd Development Area and local landscape. However, since October 2015, the species has been recorded twice in the Wylfa Newydd Development Area [RD19] (pers. comm. with Horizon Environmental Coordinators). Based on these sightings, it is likely that red squirrels have spread from the reintroduction sites in the south of Anglesey.

9.3.103 Following these sightings, targeted surveys were undertaken in 2016. The subsequent field surveys recorded evidence of red squirrels within seven areas of woodland habitat. The evidence consisted of feeding signs in the form of chewed pine cones and one drey (see appendix D9-17 Red Squirrel Survey Report, Application Reference Number: 6.4.50). During the surveys, no live red squirrels were seen.

9.3.104 The value for the red squirrel population in the Wylfa Newydd Development Area is considered to be medium, based on their importance and rarity on a regional scale, legal protection status, and their predicted low population size.

Notable mammals

9.3.105 Brown hare, hedgehog and polecat are listed in accordance with Section 7 of the Environment (Wales) Act 2016 and have been recorded within the Wylfa Newydd Development Area. In this assessment they are referred to as 'notable mammals'. Notable mammals have been assigned a low value based on their population within the relevant study area and their conservation status.

9.3.106 A summary of the baseline conditions with respect to these species is provided in the following paragraphs, with more detail set out in appendix D9-15 Notable Mammals Technical Summary Report (Application Reference Number: 6.4.48).

Brown hare

9.3.107 Records of brown hare from transect surveys and incidental sightings suggest the species is common within the field survey study area and widely distributed through all areas of suitable habitat in the local area (appendix D9-15, Application Reference Number: 6.4.48).

9.3.108 Dedicated surveys did not record brown hare aggregations, but these were witnessed in May 2016 in the vicinity of the Tre'r Gof SSSI (pers. com. with Horizon Environmental Coordinators). Suitable areas of habitat in the Wylfa Newydd Development Area include large open fields for foraging and sheltering during the day and areas of thicker cover, e.g. hedges, scrub and woodland, for sheltering during the night.

9.3.109 Brown hare have highly variable population densities, so it is estimated that the terrestrial habitat lost as a result of the WNDA Development could support between 70 and 140 individuals based on one animal per two to four hectares (see appendix D9-15, Application Reference Number: 6.4.48 for population estimate calculations).

Hedgehog

9.3.110 Targeted surveys in 2011 identified that this species was common and widespread throughout the field survey study area (appendix D9-15, Application Reference Number: 6.4.48). This is supported by incidental sightings of live and dead individuals recorded during other surveys in subsequent years.

Polecat

9.3.111 Polecat was recorded in 2010 and 2012 but not in 2013 during targeted surveys (see appendix D9-15, Application Reference Number: 6.4.48). The maximum number of individuals recorded from within the field survey study area was four; these were recorded from within Dame Sylvia Crowe's Mound and Wylfa Head. Polecat have large territories (between 16ha and 500ha) [RD20], making them highly mobile and adaptable to localised changes. The

number of polecat recorded is considered to represent an average population [RD20].

Freshwater habitats and species

Freshwater habitats

9.3.112 A diverse range of freshwater habitats, including ponds, streams, ditches, wetland, coastal headland pools and seepages, many of which can be considered as ephemeral water bodies, have been recorded throughout the field survey study area, as shown in appendix D9-16 (Wylfa Freshwater Baseline Surveys 2011 to 2015) (Application Reference Number: 6.4.49).

9.3.113 There are four main watercourse catchments located within the Wylfa Newydd Development Area:

- Cemlyn Catchment;
- Afon Cafnan Catchment;
- Tre'r Gof Catchment; and
- Cemaes Catchment.

9.3.114 The physical habitat of the watercourses varied from natural streams to drainage ditches, many of which appeared to have been historically modified and had lost much of their natural character. Many of these alterations were associated with field boundaries and were typical of the local area. Many of the small tributaries were ephemeral, meaning they only flow during periods of elevated rainfall or high groundwater conditions. The detailed habitat descriptions are set out in appendix D9-16 (Application Reference Number: 6.4.49).

9.3.115 The ponds within the Wylfa Newydd Development Area included artificial drainage ponds and natural surface and groundwater-fed ponds, some with ephemeral characteristics. Ponds were typically noted as poor to moderate quality using the *Predictive System for Multimetrics* [RD21]. Tregele Pond and Power Station Pond were both given a poor ecological-quality rating. However, due to the presence of two macroinvertebrate species of high conservation importance, both ponds met priority pond status [RD22]. Due to the poor quality of the ponds themselves, they have not been drawn out as individual pond receptors. Instead, the species that trigger the priority pond status have been assessed as part of the macroinvertebrate receptor (see below).

9.3.116 The freshwater habitats within the study area are common and widespread on Anglesey and are therefore considered to be of low value.

Macroinvertebrates

9.3.117 No legally protected macroinvertebrate species were identified within the desk survey or field survey study areas.

9.3.118 Full results of the macroinvertebrate sampling can be found in appendix D9-16 (Application Reference Number: 6.4.49). A total of 308 macroinvertebrate species have been recorded across the field survey study area, 42 of which

had species conservation scores of 'local' or higher. In general, the macroinvertebrate community consisted of widespread and common species dominated by beetles, molluscs, crustaceans and true bugs. The majority of the species recorded were typical of slow-flowing water with soft-substrate habitat dominated by fine sediments. The species found across the field survey study area were generally tolerant of organic pollution.

9.3.119 Two near-threatened species [RD23] were identified within the Wylfa Newydd Development Area:

- *Hydraena palustris* (minute moss beetle) was recorded in Power Station Pond; and
- *Omphiscola glabra* (mud snail) was recorded in Tregele Pond.

9.3.120 Minute moss beetle is also listed in the Red Data Book [RD24] as Vulnerable. There was only one individual minute moss beetle recorded, suggesting the population is small.

9.3.121 *O. glabra* is declining in range in the UK and is listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. Forty-two individuals were recorded in 2014, with similar numbers recorded in 2015, indicating that Tregele Pond supports a sustainable population of *O. glabra*.

9.3.122 The macroinvertebrate receptor within the field survey study area has been given two values: one for the study area as a whole and one for two individual ponds where species of higher conservation interest were located. The value of the macroinvertebrate receptor for the overall study area is considered to be low value. The identification of species of higher conservation value at Power Station Pond and Tregele Pond has resulted in the macroinvertebrate receptor in these ponds being considered to be of medium value.

Freshwater fish

9.3.123 Full results of the fish sampling can be found in appendix D9-16 (Application Reference Number: 6.4.49). Four freshwater fish species were recorded within the field survey study area:

- brown trout (*Salmo trutta*) – found in low numbers in the Afon Cafnan only;
- European eel (*Anguilla anguilla*) – found across the study area in low numbers;
- nine-spined stickleback (*Pungitius pungitius*) – found in low numbers in the Afon Cafnan only; and
- three-spined stickleback (*Gasterosteus aculeatus*) – found to be abundant in the majority of the main watercourses across the study area.

9.3.124 The fish species observed were typical of small coastal stream systems. European eel migrates between the marine and freshwater environments as part of its lifecycle. The presence of European eel in all of the main catchments within the study area indicates there is suitable access into the catchments from the marine environment. Sticklebacks are tolerant of reduced oxygen conditions and very shallow water and do not have strong habitat preferences,

therefore they were considered likely to inhabit most stretches of watercourses across the study area.

9.3.125 The Afon Cafnan had the highest diversity of fish, with two species of conservation value present. The European eel receives protection via the Eels (England and Wales) Regulations 2009, is listed as critically endangered on the *Red List* [RD8] and is a species listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. The brown trout is a species listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016.

9.3.126 A number of migratory species, with freshwater life stages, are known from the adjacent coastal waters (appendix D13-4 Fish Surveys Report, Application Reference Number: 6.4.86):

- river lamprey (Lampetra fluviatilis);
- brown trout; and,
- Atlantic salmon (*Salmo salar*).

9.3.127 One river lamprey was recorded during 55 marine impingement surveys at the Existing Power Station between March 2011 and July 2012. Lamprey was also identified during the A5025 surveys in Afon Alaw and in historic records provided by NRW for the Afon Wygyr, to the east of the Wylfa Newydd Development Area. River lamprey is listed on Annex II of the Habitats Directive and in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. The watercourses within the Wylfa Newydd Development Area and wider Anglesey coastline are accessible to lamprey, although they were not observed within the field survey study area during freshwater fish surveys. Habitat conditions and the interconnectivity between habitats for different life stages are considered suboptimal for this species. As such, watercourses within the Wylfa Newydd Development Area do not represent a significant resource for river lamprey.

9.3.128 Atlantic salmon is also listed on Annex II of the Habitats Directive and in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016. Salmon has been recorded from main watercourses to the west of the Wylfa Newydd Development Area (Alaw and Crigyll), and there are historical records in the 1990 impingement surveys (see appendix D13-4, Application Reference Number: 6.4.86) and a single Cofnod record [RD7] within the coastal waters adjacent to Cemlyn Lagoon. However, they have not been identified during the freshwater surveys. The freshwater environments are considered sub-optimal for juvenile salmon life stages.

9.3.129 Brown trout, a species listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016, has been observed during the marine intertidal surveys and is known to migrate into freshwater environments, including the adjacent Wygyr catchment and the Crigyll catchment to the southwest.

9.3.130 The value of the fish receptors within the study area is considered to be high due to the presence of European eel and brown trout.

Summary of receptors

9.3.131 Only receptors of a low, medium or high value that would potentially be affected by construction activities associated with the Power Station, other on-site development, Marine Works and the Site Campus within the Wylfa Newydd Development Area are taken through to the impact assessment (see chapter B9, Application Reference Number: 6.2.9) with receptors of negligible value being scoped out of further consideration.

9.3.132 Also not included in this chapter are marine receptors that are features of designated sites as these are discussed in chapter D13 (Application Reference Number: 6.4.13), i.e. the Bae Cemlyn/Cemlyn Bay SAC (lagoon habitat), the Cemlyn Bay SSSI (terns) and the Morwenoliaid Ynys Môn/Anglesey Terns SPA (terns).

9.3.133 A summary of the value assigned to receptors is provided in table D9-5 below.

Table D9-5 Terrestrial and freshwater ecology receptors and assigned values

Receptor	Value
Tre'r Gof SSSI	High
Cae Gwyn SSSI	High
Cemlyn Bay SSSI	High
Bae Cemlyn/Cemlyn Bay SAC	High
Llyn Llygeirian SSSI	High
Glannau Ynys Gybi/Holy Island Coast SPA	High
Glannau Ynys Gybi/Holy Island Coast SAC	High
Corsydd Môn/Anglesey Fens SAC	High
Corsydd Môn a Llyn/Anglesey and Llyn Fens Ramsar	High
Llyn Dinam SAC	High
Glannau Aberdaron and Ynys Enlli/Aberdaron Coast Bardsey Island SPA	High
Mynydd Cilan, Trwyn y Wylfa ac Ynysoedd Sant Tudwal/Mynydd Cilan, Trwyn y Wylfa and the St. Tudwal Islands SPA	High
Craig yr Aderyn (Bird's Rock) SPA	High
Ancient woodland	High
Fungi	High
Freshwater fish	High
Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site	Medium
Trwyn Pencarreg Wildlife Site	Medium
Afon Wygyr Wildlife Site	Medium
Cors Cromlech Wildlife Site	Medium

Receptor	Value
Arfordir Trwyn y Buarth – Porth Wen Wildlife Site	Medium
Cors Cae-Owen Wildlife Site	Medium
Rhostir Mynydd Mechell Wildlife Site	Medium
Tir Gwlyb Teilia Neuadd Wildlife Site	Medium
Cors Mynachdy Wildlife Site	Medium
Lichen	Medium
GCN	Medium
Chough	Medium
Bats	Medium
Otter	Medium
Water vole	Medium
Red squirrel	Medium
Macroinvertebrates (individual ponds where species of higher conservation interest were located)	Medium
Terrestrial habitats	Low
Terrestrial invertebrates	Low
Common toad	Low
Adder and common lizard	Low
Breeding birds	Low
Over-wintering and passage birds	Low
Notable mammals (brown hare, hedgehog and polecat)	Low
Freshwater habitats	Low

Evolution of the baseline

9.3.134 The land use of the Wylfa Newydd Development Area is dominated by low-quality agricultural habitats of arable, improved grassland or poor semi-improved grassland. In the absence of the Wylfa Newydd Project, this is considered unlikely to change significantly over time. The only factors which are likely to change the predominant landscape are considered to relate to changes in the long-term economics of farming (which could be driven by changes in climate but are more likely to be influenced by farming policy), resulting in a change of land use.

9.3.135 There are a number of models covering the UK which simulate the possible change in climate. *The UK Climate Impact Programme* [RD25] indicates winters may become generally wetter and summers substantially drier for the whole of the UK. Data from *The National Assembly for Wales (2015)* [RD26] also suggest that there may be more variability from year to year, and the number of extreme years may increase e.g. more intense storms and severe

droughts. Over the medium and long-term these changes may affect terrestrial and freshwater receptor resources in the study area via changes in hydrology and land use.

9.3.136 Changes to coastal and marine processes arising through climate change are discussed in chapter D12 (Application Reference Number: 6.4.12). Such changes would influence coastal erosion and sea levels and so would affect the shingle ridge at Cemlyn Bay SSSI/SAC by encouraging a landward retreat, a flatter profile, and more frequent overtopping. In recognition of the long-term outlook, The Wales Coastal Group Forum (2011) Shoreline Management Plan 2 has recommended a number of management options, including managed realignment of the shingle ridge [RD27]. Although the assessment of effects to Cemlyn Bay SSSI/SAC is solely based on the Wylfa Newydd Project proposals, it is important to consider the long-term context of the site when determining any requirement for additional mitigation or monitoring.

9.4 Design basis and activities

9.4.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that would be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

9.4.2 As described in chapter D1 (proposed development) (Application Reference Number: 6.4.1), the application for development consent is based on a parameter approach. The assessment described within this chapter has taken into consideration the flexibility afforded by the parameters. The principal ecological effects are related to the development footprint within the Wylfa Newydd Development Area and this is not affected by the Parameter Plans and Works Plans (Application Reference Number: 2.3). Consideration has also been given to the outputs of the air quality, noise and vibration, and surface water and groundwater assessments in relation to potential implications of the Parameter Plans and Works Plans (Application Reference Number: 2.3) for ecology. Each of those topic chapters has selected and assessed parameter conditions which represent a worst case for their respective topic chapters from the range of parameter variables presented in chapter D1 (Application Reference Number: 6.4.1). The environmental effects reported in this chapter are therefore representative of a worst case taking into consideration the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction

Basis of assessment and assumptions

9.4.3 The assessment has been undertaken based on the design details and programme provided in chapter D1 (Application Reference Number: 6.4.1).

9.4.4 For ecology receptors, many of the key effects would occur during the vegetation removal and topsoil stripping phases as areas of habitat are

cleared. Once surface habitats have been removed from the site, most floral and faunal receptors within affected areas of the Wylfa Newydd Development Area would have been displaced or removed; as such, ongoing effects to many of the receptors identified would not arise following the initial site clearance works. However, all activities that could give rise to significant effects are identified and assessed.

9.4.5 Clearance works associated with Main Construction, Marine Works, the Site Campus and other on-site development, would affect approximately 276ha of the habitats within the Wylfa Newydd Development Area. Unless stated otherwise, the assessment of effects is based on an assumption that all vegetation, topsoil and other above ground features within the boundary of the temporary construction fencing would be completely removed before the onset of any other construction activity. Areas to be retained comprise the Tre'r Gof SSSI and buffer zones around it; a buffer zone alongside the boundary of Cae Gwyn SSSI; 15m buffer zones around both banks of the Afon Cafnan, Nant Caerdegog Isaf, Nant Plas Cemlyn, Nant Cemlyn, Nant Cemaes and the Tre'r Gof SSSI drains; and Dame Sylvia Crowe's Mound. The habitats within the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site would also be retained, with the exception of 1.1ha that would be affected during Main Construction. See the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) for these locations. Further information relating to these buffer zones is provided below.

9.4.6 Direct effects to riparian habitats would be limited to approximately 400m of the Nant Caerdegog Isaf that would be realigned, and approximately 200m of the Nant Porth-y-pistyll that would be lost to the footprint of a sediment pond. realignment of the section of Nant Caerdegog Isaf would be completed prior to the removal of the existing watercourse channel.

9.4.7 During the site clearance phase, there would not be any night working, and only the main site compound would be lit using passive infra-red, LED security lighting. Lighting across the site would be designed to meet the minimum standards required for health and safety only. Where lighting is used, light spill would be minimised as much as possible. Good practice mitigation would be delivered via the General Site Management Strategy in the Wylfa Newydd Code of Construction Practice (CoCP) (Application Reference Number: 8.6). The potential for lighting during this phase to disturb the behaviour of nocturnal receptors would therefore be localised and limited.

9.4.8 The assessment for the effects of habitat loss takes into account the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). The overarching aim of the Strategy is to deliver a net biodiversity benefit by restoring, creating, enhancing and providing for the ongoing management of habitats within the Wylfa Newydd Development Area. Whilst it is anticipated the habitats developed through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) could result in a net gain in biodiversity across the Wylfa Newydd Development Area, conclusions over its effectiveness in reducing potential adverse effects on ecological receptors are precautionary to reflect the length of time such habitats would take to become fully established and offer maximum value.

Assumptions for noise assessment on ecology receptors

9.4.9 The level of information available relating to the tolerance of ecological receptors to noise disturbance varies across receptors. There is a paucity of published literature for some receptors (e.g. terrestrial mammals, including bats), whilst others are well-represented by published scientific literature (e.g. birds). Where previous studies exist, there are also often conflicting opinions regarding how different species or species groups will react to acoustic stimuli. In this chapter, breeding birds, over-wintering birds, chough, bats, otter, water vole, red squirrel, notable mammals and fish have all been identified as receptors with the potential to be affected by noise disturbance.

9.4.10 For the purposes of this assessment and based on the guidance used in chapter D6 (Application Reference Number: 6.4.6), disturbance significance thresholds for ecological receptors were set at the same level as for human receptors, unless otherwise stated within the assessment. This was set at a precautionary low level of 55dB, whereby all noise effects below 55dB are predicted to be negligible. In terms of precedent, this threshold level was also adopted on the North Blyth Biomass Power Station, as described in the *Stage 1 Shadow HRA report* for the project [RD28].

9.4.11 Baseline noise levels have not been collected for every location where a sensitive ecological receptor may be present. However, based on baseline information obtained from representative locations elsewhere, a general assumption has been made that daytime noise levels are generally in the range 40-48 dB $L_{Aeq,T}$, and night time levels are generally in the range 30-40 dB $L_{Aeq,T}$ (see section 6.3, chapter D6, Application Reference Number: 6.4.6).

Assumptions for air quality assessment on ecology receptors

9.4.12 Chapter D5 (Application Reference Number: 6.4.5) and Appendix D5-2 (Main Site Construction Phase Air Dispersion EIA - Final Modelling Report) (Air Quality) (Application Reference Number: 6.4.21), detail the predicted changes in mean annual and 24-hour atmospheric concentrations of oxides of nitrogen (NO_x), and in nitrogen and acid deposition at key ecological receptors. The figures cover two periods: the peak period for bulk earthworks, rock excavation, landform creation and MOLF construction in 2020; and the peak period for the Power Station construction in 2023. These assessment years represent year 2 and year 5 of the construction programme as described in chapter A2 (project overview and introduction to the developments) (Application Reference Number: 6.1.2). The modelling and assessment work (and selection of the two scenario years) has been undertaken on the basis of an assumed implementation year of the Wylfa Newydd Project of 2019.

9.4.13 Evidence from experiments indicates that 200µg/m^3 of NO_x may be an appropriate critical level for a 24-hour mean exposure. However, interactions between NO_x, sulphur dioxide (SO_2) and ozone (O_3) can affect the assimilation of NO_x by plants, and in the presence of concentrations of the latter compounds near or above their critical loads, 75µg/m^3 of NO_x is considered a more appropriate critical level [RD29].

9.4.14 Given the potential negative additive effects from NO_x when combined with concentrations of SO_2 and O_3, the levels of SO_2 and O_3 in the vicinity of the

Wylfa Newydd Development Area were investigated [RD30]. The investigation found that background levels of SO_2 and O_3 were low, and that further contributions of SO_2 from the combustion activity at the Wylfa Newydd Power Station were likely to be low also.

9.4.15 On the basis of these findings, and as agreed with NRW [RD31], a critical level of 200µg/m^3 is considered appropriate for the purposes of the assessment of NO_x impacts to sites without lichens and bryophytes. For sites with important lichen and bryophyte assemblages, such as the Tre'r Gof SSSI and the Cae Gwyn SSSI, a critical level of 75µg/m^3 of NO_x has been used.

9.4.16 For the assessment of air quality effects to designated sites, it is assumed that the average emissions from all relevant land-based plant comply with the EU Stage IIIB Non-Road Mobile Machinery (NRMM) emission standards i.e. the majority of plant manufactured from 2011 onwards.

Embedded mitigation

9.4.17 Some measures to address the potential effects on terrestrial and freshwater ecology have already been incorporated into the design of the Power Station, Site Campus and all other construction works and infrastructure within the Wylfa Newydd Development Area. These are known as embedded mitigation measures and have been taken into account in the assessment in section 9.5. Embedded mitigation will be secured through volume 2 of the Design and Access Statement (Power Station Site) (Application Reference Number: 8.2.2), the Main Power Station Site sub-Code of Construction Practice (sub-CoCP) (Application Reference Number: 8.7), and the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). Embedded mitigation of relevance to this assessment is summarised below.

9.4.18 The drainage design detailed in the Landscape and Habitat Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.16) would reduce potential effects on receiving water bodies and ecological receptors, most notably the Tre'r Gof SSSI and the Cae Gwyn SSSI. Full details are provided in chapter D8 (Application Reference Number: 6.4.8) and appendix D8-8 Summary of preliminary design for construction surface water drainage (Application Reference Number: 6.4.33). Drainage from the construction areas and the landscape mounding works would be via sediment settlement lagoons and other water treatment facilities as required, to reduce total suspended solids concentrations to below 70mg/l during a 1 in 1-year storm event; final discharge standards would be implemented in accordance with the approved Environmental Permit.

9.4.19 The drainage design has incorporated the following features for the Tre'r Gof SSSI (see appendix D8-8 (Application Reference Number: 6.4.33) for further details):

- The use of a permeable drainage blanket made up of inert rock material beneath Mound A to the south and east of the Tre'r Gof SSSI. This would allow the shallow groundwater and surface water runoff flowing from the south and east of Mound A to flow under the mound into the SSSI as it

currently does. The use of inert rock would seek to ensure that the shallow groundwater chemistry did not change appreciably from the baseline conditions.

- The use of overflow pipes at intervals in the drainage ditch to the north and west of Mound A. This would mean that during times of higher rainfall, water would flow from the ditch to the ground adjacent to the drain, allowing overland flow to the SSSI to be maintained. Monitoring and control weirs in the overflow pipes would be used to control the flow to the SSSI.
- The drainage system has been designed to incorporate as much flexibility as possible so that changes can be made to drainage water treatment and to the volume of water being released at various discharge points during the construction period.

9.4.20 In choosing the location of compounds, the distance to noise-sensitive receptors (e.g. bat barns, chough nesting sites) has been taken into account so that stand-off distances between noise sources and receptors are increased as far as reasonably practicable.

9.4.21 The watercourse realignment (see figure D9-6 (Application Reference Number: 6.4.101) and the Landscape and Habitat Management Strategy (Application Reference Number: 8.16)) has been designed to provide habitats of greater value than the existing section by improving sinuosity and enhanced riparian planting. The phasing would allow maturation so that there would be no habitat fragmentation caused by the stream realignment.

9.4.22 Areas within the Wylfa Newydd Development Area not required as hardstanding following Main Construction would be landscaped and restored to an appropriate land use and, wherever practicable, to an enhanced ecological condition to that prior to construction. These landscaped and restored areas would be planted with native species and species-rich hedgerows.

9.4.23 Foul water discharge would be to an existing Dwr Cymru Welsh Water sewage treatment works and to on site package treatment plants. Foul water would not be discharged to the surface water environment.

Good practice mitigation

9.4.24 The good practice mitigation detailed below would be secured through the Wylfa Newydd CoCP and the Main Power Station Site sub-CoCP (Application Reference Numbers 8.6 and 8.7 respectively).

9.4.25 Pre-construction surveys would be completed before works affecting habitats potentially suitable for protected species, and where the results of baseline surveys require updating. This would be in accordance with the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), and as a DCO requirement, Draft Development Consent Order (Application Reference Number: 3.1). Pre-construction surveys would inform the need for and/or the detail contained within protected species licence applications. The results would also inform

construction decisions e.g. the micro-siting of ditch crossings to avoid water vole burrows. The provision of up to date (season before impact) information is standard practice for developments.

9.4.26 Good practice mitigation would address any effects on protected species within the Wylfa Newydd Development Area to meet the requirements of relevant legislation, as per the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number 8.7). Full details are set out within the Draft Bat Mitigation Licence and Draft Great Crested Newt Mitigation Licence method statements (see appendices D9-20 and D9-21. Application Reference Number: 6.4.53 and 6.4.54) and Draft Water Vole Conservation Licence method statement (see appendix D9-19, Application Reference Number: 6.4.52). These licences would be issued by NRW.

9.4.27 To secure an EPSML, the details within the licence applications must satisfy NRW that the activity authorised would not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status within their natural range (Regulation 55(9)(b) Conservation of Habitats and Species Regulations 2017). To secure a conservation licence for water vole, NRW must be satisfied that there is a local conservation benefit for the species. Mitigation proposals for all licences would be in accordance with the respective good practice guidance documents ([RD18]; [RD32]; [RD33]; [RD1]). Once granted, all works would be undertaken in accordance with respective licences.

9.4.28 Monitoring would be undertaken of species translocations, habitat creation and work undertaken as part of a protected species licence to assess efficacy of mitigation provided, such as chough habitat enhancement. In relation to the Wylfa Newydd Development Area, this is likely to be no greater than 2yrs of monitoring, according to the relevant guidance, although monitoring commitments would be undertaken in line with the requirements of the relevant protected species licence.

9.4.29 No works would take place within the Tre'r Gof SSSI or the Cae Gwyn SSSI boundaries (although see one exception, below). To protect the Tre'r Gof SSSI and the Cae Gwyn SSSI from topsoil stripping and other construction related activities, buffer zones would be implemented. These buffer zones would reduce effects on the habitats of the SSSIs from those likely to occur as a result of being adjacent to construction works (e.g. small-scale runoff or fugitive dust deposition) and would seek to ensure the avoidance of actions that would prevent the SSSIs from achieving favourable condition. Where practicable, no storage areas, vegetation clearance or construction would take place within the SSSI buffer zones. Where unavoidable small scale work is required to be undertaken within SSSI buffer zones, detailed methodologies and risk assessments would be developed by Horizon to ensure those works can be undertaken without adversely affecting the designated areas or their interest features. Methodologies and risk assessments for the small-scale works would be agreed with NRW prior to commencement. Small scale works might comprise the installation of appropriate types of fencing, vegetation management, or monitoring surveys. The buffer zones are outlined below, as described in the Ecology and Landscape Management Strategy and the

Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number 8.7):

- For the north and west of the Tre'r Gof SSSI adjacent to the Site Campus, the buffer zone would be 20m.
- To the south of the Tre'r Gof SSSI, the buffer zone would be 50m.
- For the more sensitive eastern end of the Tre'r Gof SSSI, the buffer zone would be 100m.
- At the Cae Gwyn SSSI, there would be a 15m buffer zone along the boundary ditch of the SSSI, separating construction activities from the designated habitats.
- Buffers around bat barns would be a minimum of 10m. Appropriate planting within this zone is required. This will be a hard buffer, with no works within it. The screening along the buffer zone will be proportionate to the potential noise and disturbance effects anticipated. Construction activities in areas adjacent to the buffer will reduce noise and visual disturbance, as far as practicable. These requirements apply to the two existing bat barns as well as the two barns currently under construction.

9.4.30 The Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and the Wylfa Newydd CoCP (Application Reference Number: 8.6), sets out the overarching pollution management principles to be applied throughout the construction period. Good practice mitigation during construction would include the following guidance on pollution control and relevant Construction Industry Research and Information Association (CIRIA) guidance on good construction practice:

- Control of Water Pollution from Construction Sites. Guidance for consultants and contractors (C532) [RD34];
- Environment Alliance Pollution Prevention Guidelines (PPG), in particular PPG01, PPG05, PPG06 and PPG13 ([RD35]; [RD36]; [RD37]; [RD38]);
- Environmental good practice on site guide (fourth edition) (C741) [RD39];
- The SuDS Manual (C753) [RD40];
- Environmental Handbook for Building and Civil Engineering Projects (3 Parts) (C512, C528, C529) [RD41]; [RD42]; [RD43];
- Land use management effects on flood flows and sediment – guidance on prediction (C719D) [RD44];
- Development and flood risk – guidance for the construction industry (C624) [RD45]; and
- Culvert Design and Operating Guide (C689) [RD46].

9.4.31 In line with CIRIA Guidance C741, *Environmental good practice on site guide* [RD39], buffer zones would be established adjacent to watercourses. This

would protect watercourses and associated receptors (e.g. bats, water vole, otter, fish, freshwater habitats) from the effects of water quality change and disturbance arising through construction activity, as per the Surface Water and Groundwater Management Strategy contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). The buffers would be as follows:

- A 15m buffer zone along the Nant Cemlyn and Nant Cemaes where the watercourses cross the Wylfa Newydd Development Area;
- A 15m buffer around watercourses draining into the Tre'r Gof SSSI;
- A 15m buffer zone along the Afon Cafnan and its main tributary (Nant Caerdegog Isaf). For the watercourse realignment works on the Nant Caerdegog Isaf a risk assessment method statement approach would be undertaken with relevant approval and consents for works from NRW;
- For other watercourses, which include drainage ditches, existing culverted watercourses, field drains and ponds within the Wylfa Newydd Development Area, no general buffer zone would exist and construction would be undertaken in accordance with good practice measures as set out in the Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

9.4.32 The necessary consents for working in proximity to watercourses would be obtained, as required.

9.4.33 Further detailed information relating to the protection of surface water and groundwater is provided in chapter D8 (Application Reference Number: 6.4.8).

9.4.34 Adherence to good practice mitigation would be monitored in accordance with the measures set out in the Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), which also defines the pollution management measures to be applied throughout the construction period. The construction principal contractor would implement the strategies as required by the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). The document provides guidance for contractors to plan safe methods of working that avoid incidents of sediment release into watercourses and would provide a pathway for reporting environmental pollution incidents and outline containment and remediation strategies for potential scenarios that could occur during the construction period.

9.4.35 Appropriate standards and measures regarding dust and air quality management would be adhered to, including measures such as dust suppression on haul roads and implementation of appropriate controls on emissions from construction plant [RD47]. Buildings within 50m of sensitive ecological receptors would be soft-stripped before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust). These measures are contained within the Air Quality Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and the Wylfa Newydd CoCP (Application Reference

Number: 8.6), (also see chapter D5 for further information) (Application Reference Number 6.4.5).

9.4.36 In addition to the good practice measures set out above, the Air Quality Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) outlines site-specific monitoring at the Tre'r Gof SSSI and the Cae Gwyn SSSI to determine the potential for harm via dust deposition before and during the construction period (also see appendix D5-1 Construction Dust Assessment – Main Construction, Application Reference Number: 6.4.20). Coupled with the dust deposition monitoring, these would be used to directly determine if dust soiling is causing significant effects to the vegetation within each site and identify if further action is required to prevent further dust deposition or damage to the vegetation. This would be achieved via additional mitigation, management within areas under Horizon control or alteration of the dust causing activities. These inspections could be extended to the other ecological sites of lower sensitivity, should there be concern that dust deposition was having an adverse effect at sites such as the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site or Trwyn Pencarreg Wildlife Site and ancient woodland.

9.4.37 Throughout the construction period, there would be activities that require the provision of suitably qualified and experienced personnel. For example, an Ecological Clerk of Works (ECoW) would monitor that the works proceed in accordance with good practice guidance and adhere to the mitigation measures as outlined here. The ECoW would also be integral to the delivery of many of the targeted additional mitigation strategies for species/groups described later in this document. This is detailed within the Wylfa Newydd CoCP (Application Reference Number: 8.6), and the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

9.4.38 The Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) would also ensure that buffer zones would be created around the Tyn-y-Maes bat barn, the Cafnan Farm Wildlife Tower and the two bat barns currently under construction (two new bat barns form part of the good practice mitigation proposals below). These zones would be a minimum of 10m in width and demarcated by fencing and/or planting, depending on location. The screening along the buffer zones would be proportionate to the potential noise and disturbance effects anticipated. There would be no construction works within the buffer zones. Construction activities in areas adjacent to the buffer would reduce noise and visual disturbance, as far as practicable, in line with the requirements of the Noise and Vibration Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). These buffer zones would protect retained features from effects likely to occur as a result of being adjacent to construction works (e.g. noise and light disturbance), and would seek to ensure the efficacy of existing mitigation and the conservation status of bats within the local area are not compromised.

9.4.39 To reduce effects on ecological receptors at particularly sensitive times of the year when effects could have proportionately greater effects on conservation status, the following would be implemented via the Wylfa Newydd CoCP

(Application Reference Number: 8.6), and as a DCO requirement, Draft Development Consent Order (Application Reference Number: 3.1):

- If practicable, hedges and scrub with the potential to support bird nests would not be removed during the breeding bird season (March to August inclusive). If it was not possible to avoid the breeding bird season, works would be supervised by an ECoW, with appropriate protection measures put in place should active nests be found. These would include exclusion zones around active nests until chicks had fledged or nests become inactive as determined by monitoring by the ECoW;
- Notable mammal species predominantly give birth in the period between March and August and so would be protected by the good practice mitigation designed to protect breeding birds. However, brown hare can give birth as early as February, and hedgehog can have a late birthing peak in September [RD20]. An ECoW would therefore supervise clearance of habitats with high potential to support juvenile or pregnant brown hare and hedgehog in February and September (respectively);
- If pre-construction surveys confirm the presence of active red squirrel dreys within, or immediately adjacent to trees that would be felled, felling works would be delayed to avoid the period when pre-weaned young are present (potentially mid-February to mid-September) [RD48];
- Habitat with the potential to support hibernating reptiles would not be removed between November and March. This would reduce the risk of killing or injuring these animals at a time when they are vulnerable and unable to move away from sources of danger, and would therefore reduce the risk of committing an offence under the legislation protecting these animals;
- Habitat with the potential to support hibernating reptiles, amphibians and hedgehogs would not be removed between November and March without supervision by the ECoW. This would also reduce the risk of killing or injuring these animals; and
- Retained sensitive areas would be fenced off from potentially damaging or disturbing works.

9.4.40 In order to mitigate the risk of disturbing any Schedule 1 bird species nest, the following approach would be taken, secured the Wylfa Newydd CoCP (Application Reference Number: 8.6):

- Habitats with the potential for use by Schedule 1 bird species will be identified and surveyed by the ECoW prior to site clearance.
- In the event that a Schedule 1 bird species is found during the nesting season, NRW will be consulted in order to identify and agree appropriate measures to be undertaken in respect of that species.
- Should a Schedule 1 species be discovered within an area to be disturbed, Horizon would implement the general measures set out above for birds with the added requirement that any Schedule 1 species or its

dependent young must not be disturbed while at or building a nest. Additional exclusion/protective measures may be required.

- It is noted that there is no legal provision under the Wildlife and Countryside Act 1981 (as amended) to obtain a licence to facilitate development which would disturb a Schedule 1 species.

9.4.41 A mitigation strategy for adder and common lizard would be in place throughout habitat clearance, as outlined in the Wylfa Newydd CoCP (Application Reference Number: 8.6). This would include trapping and translocation of individuals, phased and directional habitat manipulation, sensitive removal of suitable refuge features (e.g. dry stone walls and cloddiau), and supervision of works by an ECoW. The strategy would be informed by species records from the Wylfa Newydd Development Area and the presence of suitable habitats at the time of clearance, e.g. rank grassland. Trapped animals would be released in an area of habitat shown on figure D9-8 (Application Reference Number: 6.4.101). This area has been secured by Horizon for 15 years, which is designed to cover the full Project construction period and, although considered unlikely, Horizon would seek to extend this if necessary. The receptor area would also benefit terrestrial invertebrates, common toad, GCN, breeding birds, over-wintering and passage birds, bats, and protected and notable mammals. The mitigation strategy would prevent the death and injury of adder and common lizard and ensure the works would not undermine the conservation status of adder and common lizard in the local area.

9.4.42 A fish rescue would be carried out during the removal of freshwater habitat, such as the realignment of Nant Caerdegog Isaf (watercourse 13). Fish rescue would require a licence from NRW and authorisation under the Salmon and Freshwater Fisheries Act 1975. Fish would be returned to suitable habitat on the same waterbody unaffected by the works. No fish would be moved between waterbodies. The mitigation strategy would mitigate the death and injury of fish and ensure the works would not undermine the conservation status of valued species of fish in the local area.

9.4.43 To prevent the introduction and spread of plants listed on Schedule 9 of the Wildlife and Countryside Act 1981 (and any other relevant pernicious species not listed), a Biosecurity Risk Assessment and Method Statement, within the Wylfa Newydd CoCP (Application Reference Number: 8.6), sets out how areas with the presence of Schedule 9 plant species will be demarcated, and how the contaminated materials would be appropriately managed throughout the works. This includes details of appropriate disposal, and how the transfer of viable propagules of invasive non-native species by people or vehicles would be prevented. Prior to any workers going out on site, a tool-box talk from an ECoW experienced in identifying invasive non-native plant species would be provided, including photographs of the invasive non-native plant species known to be present on a site. Stands of invasive non-native plant species suspected to be present in areas outside of those already known would be reported as soon as is practicable so that the appropriate actions can be applied from the biosecurity risk assessment. This would avoid actions that would compromise the favourable conservation status of designated sites and sensitive freshwater and terrestrial habitat receptors.

9.4.44 To facilitate the safe passage of animals away from the Wylfa Newydd Development Area and to reduce the effects of habitat severance, boundary fencing would be permeable to mammal movement.

9.4.45 The Landscape and Habitat Management Strategy (Application Reference Number: 8.16) has been developed to provide biodiversity enhancements within the Wylfa Newydd Development Area and enhance ecological connectivity. Planting works would be scheduled to recreate areas of habitat as soon as practically possible, starting during the construction period, thereby reducing periods of temporary habitat loss.

Operation

Basis of assessment and assumptions

9.4.46 Commissioning and operation of the Power Station is scheduled to last 60 years. The assessment assumes that the Wylfa Newydd Development Area during the first year of operation would be as shown by the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.4.47 Potential effects due to operational activities could arise through disturbance (noise, light and recreation) and changes to air and water quality.

9.4.48 At the operational stage, the drainage system would be transitioned from the actively managed system during construction to a more natural system. This would include removal of all active treatment systems. However, the ditches/swales created for drainage for the construction works around the landscape mounds would remain for the operational phase with the discharge points remaining the same. Settlement ponds would remain but there would be no active treatment of the discharge. The concept design for surface water in the landscaped areas post-construction is contained in appendix D8-8 (Application Reference Number: 6.4.33).

9.4.49 The effects of construction of the spent fuel storage buildings would be limited to temporary disturbance (noise and vibration, lighting or visual) and hydrological changes during its construction.

Embedded mitigation

9.4.50 Embedded mitigation described in chapter D8 (Application Reference Number: 6.4.8) is of relevance to terrestrial and freshwater ecology receptors, notably aquatic habitats and species, and wetland designated sites. As described in chapter D8 (Application Reference Number: 6.4.8), embedded mitigation measures incorporated for the operational stage include the following, which would be secured through the Wylfa Newydd CoCP (Application Reference Number: 8.6), and volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2):

- Foul water discharge will be to the existing DCWW Sewage Treatment Works and to on site package treatment plants. Foul water would not be discharged to the surface water environment. The effects of this drainage discharge are considered in chapter D13 (Application Reference Number: 6.4.13).

- The spent fuel storage buildings and radioactive waste storage and processing facilities would be constructed within the Power Station Catchment, and would be sited a minimum of 15m away from any watercourse. These storage facilities would be designed and built with a very high level of engineering containment to prevent the release of any radiological contaminants to the surface water and groundwater environments.
- All hydrocarbon fuel, oil (including waste oil) and chemical storage areas would be within the Power Station Site. Appropriate controls would be in place to prevent the discharge of contamination to surface waters in the event of a spill or leak. As such, there would be no pathway to the surface water environment.

Good practice mitigation

9.4.51 Chapter D10 Landscape and visual (Application Reference Number: 6.4.10) and the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) describe good practice mitigation with respect to the landscape design. The design of the landscaping and associated habitat has been significantly influenced by the important receptors present within the Wylfa Newydd Development Area.

9.4.52 The provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) aim to mitigate the effects of habitat loss and fragmentation associated with construction by enhancing the habitats within the Wylfa Newydd Development Area. The proposed habitat creation would connect existing habitats in the wider landscape to facilitate the movement of species back into the Wylfa Newydd Development Area on completion of the construction phase. The long-term management of these habitats throughout the operational period would also be delivered through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) which would seek to ensure that the habitats are appropriately managed in accordance with the aim of achieving a net biodiversity benefit.

9.4.53 To adequately protect aquatic habitats and species, and wetland designated sites, good practice mitigation with respect to drainage would be implemented as described in chapter D8 (Application Reference Number: 6.4.8) and the Surface Water and Groundwater Management Strategy contained within the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13), as summarised below:

- Surface water drainage would discharge to the sea. Surface water drainage from all roads, car-parking areas or other areas of hardstanding where there is the potential for leaks of fuels, oils or other liquids would incorporate appropriate pollution treatment, such as oil separators.
- After construction, the mound drainage would be converted to a passive drainage system which would require no maintenance. Appropriate attenuation would be provided to prevent any increases to flood risk off-

site, including swales and other features to try to match current surface water flows and groundwater recharge.

- The Surface Water and Groundwater Management Strategy within the Wylfa Newydd CoOP (Application Reference Number: 8.13) sets out the overarching pollution management principles to be applied throughout the operation of the Power Station.

Decommissioning

Basis of assessment and assumptions

9.4.54 Decommissioning would be carried out in distinct phases (see chapter D1) (Application Reference Number: 6.4.1):

- There would be an initial phase of approximately 20 years during which the bulk of decommissioning would take place. At the end of this period, all Power Station structures except for the spent fuel storage buildings and their support facilities would have been decommissioned and demolished and the land remediated and de-licensed.
- A subsequent longer period, between 75 and 120 years (to allow for an appropriate cooling period), during which the only facilities on site would be the spent fuel storage buildings and ILW stores. During the cooling period, it is assumed that activities would be consistent with those during operation, except with fewer personnel and associated disturbance.
- The construction and operation (for an approximate 10-year period) of a facility to repackage spent fuel from its interim storage casks to canisters suitable for transport and final disposal.
- Demolition of the repackaging facility and the spent fuel storage buildings (around a year). Demolition activities would generate effects consistent with those undertaken during Main Construction, although these would be localised to the remaining buildings and associated compounds and access routes only.
- Remediation and de-licensing of the remainder of the site (around a year).

9.4.55 The effects of decommissioning would be similar to those experienced during construction with potential to affect terrestrial and freshwater ecology receptors.

Embedded mitigation

9.4.56 It is anticipated that embedded mitigation for decommissioning the Power Station would be similar to that implemented during construction, particularly with respect to the protection of designated wildlife sites and surface water and groundwater quality.

Good practice mitigation

9.4.57 Good practice mitigation would adhere to relevant guidelines and standards applicable at the time. It is expected that this would be consistent with those measures outlined above for construction and operation. The implementation of mitigation strategies would be in accordance with relevant good practice guidelines and would seek to avoid undermining the conservation status of the respective receptors at the local level.

9.4.58 It is anticipated that areas of the Wylfa Newydd Development Area that would be affected by decommissioning of the Power Station would be landscaped and restored primarily to sympathetically managed agricultural land. There would be a focus on habitat enhancement through the creation of species-rich habitats that contribute to the contemporary local biodiversity targets and that would be of value for the important species receptors present. New habitats would seek to provide connectivity to the wider landscape. All planting proposed would be appropriate for the prevailing conditions, of local provenance and cultivated within the UK. This would be secured through a DCO requirement, Draft Development Consent Order (Application Reference Number: 3.1).

9.5 Assessment of effects

9.5.1 This section presents the findings of the assessment of effects associated with the construction, operation and decommissioning of the Power Station, Site Campus, Marine Works and other on-site development.

Construction

Pathways to effects

9.5.2 Terrestrial and freshwater ecology receptors across the study areas may potentially be affected during construction activities via a number of pathways, as outlined in table D9-6 and the paragraphs below.

Table D9-6 Summary of pathways for environmental changes during construction to affect ecological receptors

Potential effect	Area in which the effects may influence ecological receptors	Ecological receptors potentially affected
Mortality and injury of species	Physical interaction between species and project infrastructure, machinery or activities would be limited to areas within the Wylfa Newydd Development Area only.	Terrestrial invertebrates Great crested newt Common toad Adder and common lizard Breeding birds Over-wintering and passage birds Bats Water vole Red squirrel Notable mammals Macroinvertebrates Freshwater fish
Habitat loss/gain, fragmentation or modification	Habitat loss/gain would be restricted to areas cleared to make way for Main Construction, Marine Works and the Site Campus within the Wylfa Newydd Development Area. There would be no additional habitat loss during operation (with the exception of construction of the spent fuel storage buildings). Retained habitats within the Wylfa Newydd Development Area would temporarily be fragmented from the wider landscape between the period when clearance works commence and habitat reinstatement and creation are completed. Habitats between the Wylfa Newydd Development Area and the sea would also be isolated during the	Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site Ancient woodland Terrestrial habitats Fungi Lichen Terrestrial invertebrates Great crested newt Common toad Adder and common lizard Chough

Potential effect	Area in which the effects may influence ecological receptors	Ecological receptors potentially affected
	construction period by activities associated with Main Construction, the Marine Works and the Site Campus e.g. habitats at Wylfa Head. Habitats outwith the construction footprints may be modified due to changes to air or hydrology and these are discussed below. Habitats outwith the construction fencing may be affected by habitat degradation e.g. trampling and erosion, caused by worker pressure.	Breeding birds Over-wintering and passage birds Bats Otter Water vole Red squirrel Notable mammals Freshwater habitats Macroinvertebrates Freshwater fish
Species disturbance (from changes to noise, vibration, visual and light stimuli)	The area subject to noise disturbance varies based on the activity being undertaken and the sensitivity of the individual receptor. All potentially sensitive receptors within the area likely to be exposed to noise level changes have been considered. Consideration was given to the effects of visual disturbance for all potentially sensitive receptors within 300m of the Wylfa Newydd Development Area. This was based on the work carried out by Cutts *et al.* [RD49] and using professional judgement. The effects of lighting were considered for areas within or adjacent to the Wylfa Newydd Development Area that are potentially used by sensitive species (Appendix D10-10. Environmental Lighting Impact Assessment. Application Reference Number: 6.4.67).	Terrestrial invertebrates Adder and common lizard Chough Breeding birds Over-wintering and passage birds Bats Otter Water vole Red squirrel Notable mammals Freshwater fish

Potential effect	Area in which the effects may influence ecological receptors	Ecological receptors potentially affected
	Species outwith the construction fencing may be affected by disturbance caused by worker pressure.	
Air quality changes (resulting in habitat loss/modification)	All sensitive receptors within 50m for the effects of dust; 200m for the effects of traffic emissions; and 2km for emissions from construction plant, machinery and marine vessels (increased to 15km for European Designated Sites).	Statutory and non-statutory designated wildlife sites Ancient woodland Lichen Fungi
Hydrological changes (resulting in mortality/injury of species and/or habitat loss/modification)	All sensitive receptors with hydrological connectivity to an affected waterbody.	Statutory and non-statutory designated wildlife sites Breeding birds Over-wintering and passage birds Otter Water vole Freshwater habitats Macroinvertebrates Freshwater fish
Introduction and spread of invasive non-native plant species (resulting in habitat loss/modification)	All areas directly affected by construction activities. Areas outwith the Wylfa Newydd Development Area may also be affected if contaminated vehicles, machinery, or spoil is introduced. Sensitive receptors with hydrological connectivity to contaminated areas may also be affected.	Statutory and non-statutory designated wildlife sites Terrestrial habitats Freshwater habitats

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Mortality and injury of species

9.5.3 During the construction phase, the following activities could result in mortality and injury of species receptors:

- vegetation clearance;
- topsoil clearance;
- demolition of buildings;
- removal of other above ground features (e.g. walls and cloddiau);
- watercourse diversion;
- construction of culverts;
- drainage installation;
- installation of construction site boundary/security fences; and
- utilities diversions.

9.5.4 A secondary potential source of mortality or injury of species comes from collision with construction related traffic on roads supplying construction activities within the Wylfa Newydd Development Area, particularly for species such as brown hare and hedgehog. However, the overall increase in traffic is considered to be minor (chapter C2 Traffic and transport, Application Reference Number 6.3.2), and the potential for effects is so low that a specific assessment for this pathway has not been undertaken.

Habitat loss/gain, fragmentation or modification

9.5.5 Construction works would take place over approximately 92% of the Wylfa Newydd Development Area with approximately 276ha of terrestrial habitat being directly affected by the works, primarily through vegetation and topsoil clearance.

9.5.6 Habitat fragmentation would result from the widespread loss of terrestrial habitat through vegetation and topsoil clearance, as well as activities such as installation of site boundary and security fences, installation of drainage and services, and construction of culverts, haul roads and bridges.

9.5.7 Freshwater habitat would be affected locally due to watercourse diversions, construction and excavation of culverts, construction of bridges and drainage installation; installation of culverts, outfalls, bridges (including piers); and any channel realignments which would potentially require in-channel working. This could disturb existing channel bed forms (such as pools, riffles, depositional features) and bank structure, removing, modifying or degrading in-stream habitat. This could also include temporary removal of riparian habitat and floodplain connectivity due to construction activities. Nine ponds would also be removed during topsoil stripping.

9.5.8 Habitat degradation could occur to retained terrestrial and freshwater habitat within and adjacent to the Wylfa Newydd Development Area. Hydrological changes resulting from vegetation clearance, topsoil clearance, associated drainage installation, construction of culverts, dewatering, earthworks and excavation activities could lead to long-term changes in the ecological

composition of hydrologically dependent habitats. Hydrological effects are addressed in chapter D8 (Application Reference Number: 6.4.8). Increased visitor numbers on retained terrestrial habitat, notably the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, could result from the use of these sites from recreation by workers residing in the Site Campus. This could lead to habitat degradation through vegetation trampling and soil compaction. Effects on Tre'r Gof SSSI were not assessed despite being in close proximity to the Site Campus as the habitats present offer no amenity function and do not have open access. The potential effects on all other receptors were considered to be negligible.

9.5.9 Changes in air quality due to dust and emissions of NO_x and SO_x from plant, machinery and shipping could also result in habitat degradation (see chapter D5, Application Reference Number: 6.4.5). Indirect effects, such as the reduction in quality of habitat for other receptors reliant upon it may also occur (e.g. chough foraging habitat at Wylfa Head).

9.5.10 During construction of the Power Station, the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would be implemented and the recreation and enhancement of habitats programmed as soon as practicable thereby reducing the duration of habitat loss and fragmentation. This would bring benefits to species previously displaced by vegetation clearance through re-establishing links within the wider landscape and creating replacement foraging and shelter habitats. Habitats proposed for restoration, creation and enhancement through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) include species-rich grassland, marshy wet grassland, woodland, coastal heath/grass mosaic, and hedgerow. In addition, stone walls would be created using original material retained following site clearance works. Further details are provided in the assessment of terrestrial habitats below.

Species disturbance (from changes to noise, vibration, visual and light stimuli)

9.5.11 Species disturbance effects could result from changes in noise, vibration or visual stimuli during construction activities (such as soil-clearance, blasting, drilling, earthworks, watercourse diversion, excavation, building demolition and security fence installation).

9.5.12 There could also be disturbance effects as a result of workers at the Site Campus using areas outside of the construction boundary for recreation e.g. in habitats at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, and the potential disturbance to chough that breed and forage in this area.

9.5.13 Chapter D6 (Application Reference Number: 6.4.6) assesses the effects of changes in noise and vibration. However, many of the most disturbing activities would occur after the completion of vegetation and topsoil clearance and so most terrestrial species receptors would have been displaced from the Wylfa Newydd Development Area. As such, disturbance would be limited to receptors in adjacent and retained habitats, or to receptors that may still be

present within the Wylfa Newydd Development Area following its clearance (e.g. foraging chough or roosting bats in retained structures).

9.5.14 The typical average noise levels anticipated to be generated by the construction works have been modelled with the results compared against the existing baseline conditions (see chapter D6, Application Reference Number: 6.4.6). As the effects of the works assessed in this chapter apply only to receptors in the terrestrial environment, only noise transmitted via the air is considered.

9.5.15 The assessment of noise effects uses as its primary measure the worst case noise levels averaged over the duration of each phase of the construction period (see chapters B6 and D6) (Application Reference Number: 6.2.6 and 6.4.6). For the purposes of this assessment, and based on the guidance used in chapters B6 and D6 (Application Reference Number: 6.2.6 and 6.4.6), noise disturbance significance thresholds for ecological receptors were set at the same level as for human receptors (see section 9.2).

9.5.16 Visual effects resulting in potential disturbance could occur as a result of the re-routing of public footpaths in the local area, potentially causing avoidance of areas by species previously subject to lower levels of recreational disturbance.

9.5.17 Lighting disturbance effects are most likely to affect nocturnal receptors such as fish, bats and otter.

Air quality changes

9.5.18 Air quality changes could occur through fugitive dust and changes in pollutant levels caused by construction plant activities and increased traffic in and around the Wylfa Newydd Development Area. The air quality assessment is presented in chapter D5 (Application Reference Number: 6.4.5) (although see chapter C4 (Application Reference Number: 6.3.4) for the project-wide assessment relating to air quality and traffic).

9.5.19 Retained terrestrial and freshwater habitat receptors may be affected through changes in air quality as the plant communities they support may experience reduced photosynthesis, respiration and transpiration caused by smothering from dust or via changes to chemical composition of soils or watercourses arising from deposition of acid or nutrients.

9.5.20 The deposition of nitrogen and acidic compounds may affect the flora of the study areas, including lichen. Species of flora and lichen that are adapted to live in substrates with low nutrient levels could be outcompeted by faster-growing species. This could result in populations being dominated by low numbers of generalist species, rather than diverse assemblages of specialists. The chemical composition of the substrates on which sensitive flora or lichen grow could also be changed. Lichens in particular are very sensitive to changes in pH, and both diversity and abundance could be negatively affected through air quality changes.

Hydrological changes (including water quality and quantity)

9.5.21 Hydrological changes are detailed in chapter D8 (Application Reference Number: 6.4.8) and include changes to both water quality and quantity within nearby watercourses and wetland areas. Changes in hydrology, fluvial geomorphology and hydrogeology are important in the context of terrestrial and freshwater ecology due to the following factors:

- water quantity has an important role in structuring the flora and fauna communities in watercourses, ponds and wetlands;
- sediment and other pollutant releases have the potential to adversely affect sensitive ecological receptors; and
- ecological receptors can be sensitive to modification of runoff regimes changing the quality of surface and groundwater.

Introduction and spread of invasive non-native plant species

9.5.22 Any introduction or spread of Invasive Non-native Species (INNS) would potentially cause significant adverse effects to sensitive habitats due to the dominance that INNS can have over native species.

9.5.23 During the construction works, substantial amounts of topsoil and subsoil would be moved around the Wylfa Newydd Development Area. There is therefore the potential for INNS to be introduced or spread via contaminated machinery or soil. There is also a risk of transferral from pedestrian movement and worker vehicles.

Receptor-based assessment

Tre'r Gof SSSI

9.5.24 The potential for significant effects on the Tre'r Gof SSSI have been identified via the following pathways:

- habitat loss, fragmentation or modification;
- air quality changes;
- hydrological changes; and
- introduction and spread of INNS.

Habitat loss and fragmentation

9.5.25 There would be no direct habitat loss within the SSSI as a result of the Wylfa Newydd Project.

9.5.26 Fragmentation effects as a result of construction activities (i.e. Main Construction and construction and operation of the Site Campus) are not considered likely. This is due to the designated habitats within the SSSI already being isolated from other areas with the potential to support a similar botanical assemblage. Therefore, there would be no risk of severing links with similar habitats nearby.

9.5.27 Habitat modification (excluding effects from air quality and hydrological changes) are not predicted as the management regime currently in operation for the SSSI would be maintained, including grazing within the livestock fencing surrounding the SSSI.

9.5.28 The SSSI would be almost entirely surrounded by construction activity and so, in the absence of mitigation, this may result in degradation of the habitats on the boundary of the site, e.g. due to littering, fugitive dust and changes to runoff regimes (the latter two are discussed separately, below).

9.5.29 To lessen this potential effect, good practice mitigation would include a buffer zone around the entirety of the SSSI, formed by a fence erected to provide extra livestock grazing areas. An additional buffer zone outside the livestock fence would be included on the southern, northern and eastern sides of the SSSI to protect the sensitive near surface flows which support the designated features of the SSSI (see chapter D8, Application Reference Number: 6.4.8). Where unavoidable works are required within the buffer zone (including any fencing and vegetation removal and for installation of drainage outfalls), they would be subject to an additional risk assessment and appropriate controls to protect the SSSI as per the provisions of the Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). The buffer zones would be implemented in accordance with the Landscape and Habitat Management Strategy (Application Reference Number 8.16).

9.5.30 The SSSI is also buffered to the west by Dame Sylvia Crowe's Mound, which would be retained throughout construction, although a widened construction haul road for the Site Campus would be located between these two sites.

9.5.31 Appropriate signage would be erected on the fences demarcating the buffer zone to inform site personnel of the sensitivity of the SSSI and that the area is a construction no-go zone. These measures would be reinforced through 'toolbox talks' for all site personnel and through monitoring by an ECoW. These good practice mitigation measures would be delivered through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.5.32 Based on the above, the magnitude of change would be negligible. The effects of habitat loss and fragmentation (excluding air quality and hydrological changes) would be negligible.

Air quality changes

9.5.33 Air quality changes could arise through fugitive dust and emissions from construction plant, machinery and vehicles. The habitats at the Tre'r Gof SSSI are vulnerable to such changes.

9.5.34 Chapter D5 (Application Reference Number: 6.4.5) describes the air quality assessment that has been undertaken to identify any significant effects to the Tre'r Gof SSSI.

9.5.35 Chapter D5 (Application Reference Number: 6.4.5) details that nitrogen and acid deposition rates are predicted to increase by 22% by 2020, dropping to 11% and 12% respectively in 2023. This would result in acid levels exceeding

critical load values whereas baseline nitrogen deposition levels are already in excess of critical loads for alkaline fen habitats (see appendix B5-2 Main Site Construction Phase Air Dispersion EIA - Final Modelling Report (Air Quality), Application Reference Number: 6.4.21) for critical load values). A study by Caporn *et al.* (2016) [RD50] produced linear models to predict changes in habitat quality indicators based on incremental changes in long-term nitrogen deposition above critical loads, and this has been used to predict the change in habitat quality at the Tre'r Gof SSSI. Although alkaline fen as a defined habitat was not represented within the study, the nearest available equivalent was used; in this case bog habitat. It is acknowledged that, ecologically, the two habitats are distinct, but the effects of increased nitrogen deposition are considered similar for both. The study period employed in the work by Caporn *et al* (2016) [RD50] (a period of eight years), is different from the two peak periods of 2020 and 2023 assessed here. However, it is felt that the use of the Caporn *et al*. (2016) study represents a precautionary approach.

9.5.36 A typical response to increases in nitrogen deposition is an increase in nutrient-demanding plants such as grasses and sedges (graminoids), and the consequent loss of less competitive species such as smaller herbs and bryophytes [RD50]; [RD51] which are likely to represent the rarer, more important species present within the SSSI. The predictions for the Tre'r Gof SSSI, derived from the Caporn *et al*. 2016 [RD50] study, show a potential 2.6% decrease in overall species richness, a 7.6% decrease in forb species richness and a 4.4% increase in graminoid cover at 2020 deposition rates. Figures for 2023 deposition rates show a potential 1.3% decrease in overall species richness, a 3.8% decrease in forb species and a 2.2% increase in graminoid cover, although it is recognised that it is unlikely that species diversity would recover in the period between 2020 and 2023.

9.5.37 The increase in acid deposition at the Tre'r Gof SSSI is likely to be buffered by the alkaline nature of the fen, which makes it more resilient to changes in pH levels, although there are areas within the SSSI characteristic of acidic conditions that may be affected by acid deposition in the form of a decrease in species diversity.

9.5.38 Critical levels for atmospheric concentrations of NO_x would be exceeded at the Tre'r Gof SSSI by 49% for the annual mean concentration and 113% for the 24-hour mean concentration. Plant responses to increased concentrations are typically growth stimulus of aerial shoots and, at high concentrations, physiological damage. Gross effects on habitats are similar to nitrogen deposition as a whole with the loss of plant diversity and damage to bryophyte communities.

9.5.39 There is little published literature on the effects of increased atmospheric NO_x concentrations on semi-natural habitats and what does exist looks at brief periods of exposure (three weeks in the case of Morgan, Lee and Ashenden, 1992 [RD52]). It is therefore considered that the medium-term exposure to the predicted concentrations during construction would reflect and potentially exacerbate the changes in species diversity within the SSSI resulting from nitrogen and acid deposition.

9.5.40 Chapter D5 (Application Reference Number: 6.4.5) also describes the predicted effects of dust deposition. The Tre'r Gof SSSI is downwind of the prevailing wind direction to the nearby Mound A and the more distant areas where earthworks and construction activities would be undertaken, such as the Power Station Site and the laydown and landscape mounding area near Tregele.

9.5.41 However, Mound A does not encroach within approximately 100m of the south or east of the Tre'r Gof SSSI, meaning that the majority of dust emitted from the mound creation and landscaping activities would be deposited before reaching the SSSI [RD47]. The Site Campus at Wylfa Head would be approximately 50m north of the Tre'r Gof SSSI at its closest point, and therefore the prevailing wind direction from the south-southwest and southwest would generally transport any emitted dust from the Site Campus to the north-northeast and northeast away from the Tre'r Gof SSSI (chapter D5, Application Reference Number: 6.4.5).

9.5.42 Good practice mitigation measures comprise buffer zones; locating material stockpiles as far away from the Tre'r Gof SSSI as is practicable; grass seeding storage stockpiles as soon as practicable; and the regular use of dust suppression equipment, including water sprays, on the stockpiles. These mitigation measures are included within the Air Quality Management Strategy set out in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

9.5.43 Taken together, the changes in air quality emissions are predicted to lead to measurable changes in the attributes and quality of the Tre'r Gof SSSI, which would represent a small magnitude of change and a moderate adverse effect in the medium term, which is anticipated to reduce as changes reduce towards baseline conditions. Additional mitigation measures to reduce this effect are proposed in section 9.6, below.

Hydrological changes

9.5.44 There are several potential hydrological changes to the Tre'r Gof SSSI due to Main Construction and construction, operation and decommissioning of the Site Campus, as detailed in chapter D8 (Application Reference Number: 6.4.8). Based on the conclusions of chapter D8 (Application Reference Number: 6.4.8), the activities or changes that would potentially result in a minor magnitude of change or greater are discussed in this section.

9.5.45 Hydrological changes could arise via works within the Tre'r Gof Catchment. This includes topsoil stripping, construction of landscape mounds, dewatering of deep excavations, and construction, operation and decommissioning of the Site Campus. These activities could change surface water and groundwater conditions that may affect water quality and quantity within the SSSI.

9.5.46 The Tre'r Gof SSSI Site Management Statement [RD53] identifies the wetland as highly sensitive to changes in water level, stating that "*any actions that would reduce the amount of water entering Tre'r Gof would be damaging to the site*".

9.5.47 The Site Management Statement also states that:

"Good water quality is essential for maintenance of the characteristic assemblage of wetland plants and animals at Tre'r Gof. Nutrients such as nitrogen and phosphorous encourage the spread of strong growing plants…which can out-compete the less common (and more desirable) species at Tre'r Gof. This in turn would have a negative effect upon the animals that depend on these plants." [RD53]

9.5.48 The Site Management Statement also provides a list of potentially damaging operations that could result in hydrological change, many of which would arise during Main Construction and construction, operation and decommissioning of the Site Campus.

9.5.49 In order to understand how the notable features of the SSSI are maintained by the hydrological regime of the Tre'r Gof Catchment, a hydrological/hydrogeological CSM has been produced based on water quality, flow and level data collected since February 2015 (see chapter D8, Application Reference Number: 6.4.8). The CSM shows that the Tre'r Gof SSSI can be considered a seasonal, groundwater-dependent terrestrial ecosystem, dependent on winter recharge by shallow groundwater flows. The inflow of shallow groundwater in the soils brings mineral enriched water into the SSSI, with calcium concentrations being particularly important, supporting conditions for the plant communities within the SSSI (see table 4.1 in appendix D8-7 Surface water and groundwater modelling results, Application Reference Number 6.4.32). Full information on the relationship between hydrology and the ecology of the SSSI is provided in appendix D8-5 Tre'r Gof Hydroecological Assessment (Application Reference Number: 6.4.30).

9.5.50 The embedded and good practice mitigation measures that would be implemented to protect the SSSI are described in chapter D8 (Application Reference Number: 6.4.8) and section 9.4 of this chapter, but comprise:

- construction buffer zones;
- sediment settlement lagoons, ditches/swales, oil interceptors, attenuation tanks and other water treatment facilities to protect surface waters from contaminated or sediment-laden discharges;
- stone-filled, permeable, metal baskets set below ground for natural dispersion into the Tre'r Gof SSSI to trap silt and promote vegetation growth;
- a permeable drainage blanket made up of inert rock material beneath Mound A to the south and east of the Tre'r Gof SSSI to maintain the quality and quantity of surface water flows via the mound;
- use of overflow pipes and control weirs to maintain surface water overland flow; and
- adherence to the Environment Alliance's PPGs.

9.5.51 Although extensive mitigation is proposed, the landscape mounding and drainage would alter the area of the Tre'r Gof Catchment, resulting in changes to surface water flows within the catchment. These changes could particularly affect the south and west compartments of the Tre'r Gof SSSI, which are

reliant on multiple sources of inflows (see appendix D8-5, Application Reference Number: 6.4.30).

9.5.52 A reduction in water availability from diffuse seeps within the Tre'r Gof SSSI could arise due to the implementation of a managed drainage system, construction of the landscape mounds and Site Campus, and the associated drainage for these; this could have subsequent effects on the water quality of the SSSI. The inflow of shallow groundwater in the soils, superficial deposits and potentially the top of the bedrock into the SSSI and underlying peat deposits brings mineral enriched water into the SSSI via a series of small springs, seeps and flushes. A reduction in diffuse inflows could therefore reduce calcium concentrations within the SSSI, particularly in the east compartment (see appendix D8-7 for modelling information (Application Reference Number 6.4.32).

9.5.53 Rainfall onto the exposed bare earth surfaces (e.g. from site clearance, demolition of structures, haul roads, car parks, construction, operation and decommissioning of the Site Campus, soil storage and landscape mound creation) could all result in a high sediment loading in runoff. This could affect water quality within the Tre'r Gof drains. There is a particular risk of high suspended sediment concentrations in runoff from Mound A and Mound B before vegetation is fully established (see chapter D8, Application Reference Number 6.4.8).

9.5.54 Furthermore, topsoil stripping and movement and replacement of topsoil could result in the mobilisation of nutrients that are currently not exposed to leaching. Leaching tests have indicated that elevated concentrations of nutrients could be released from topsoil and these could therefore change water quality. However, any effect would be limited to the time periods when topsoil was being disturbed and the majority of increase in nutrients may pass through the Tre'r Gof SSSI in the drainage ditches rather than entering the peat fen. Additionally, any leaching which did occur would reduce rapidly with time.

9.5.55 Based on the above, chapter D8 (Application Reference Number: 6.4.8) concludes that the overall magnitude of change (based on the Hydrology Magnitude criteria in table B8-12 (Application Reference Number: 6.4.8)) on the whole SSSI due to a reduction in water availability is assessed as small. The magnitude of change on water quality is predicted to be small. These assessments take into account the good practice mitigation described in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16), and the Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), including the use of settlement ponds and treatment (also see appendix D8-8 for further details (Application Reference Number: 6.4.33)).

9.5.56 Given the complexity of the hydrological regime, there is uncertainty relating to how effective the proposed mitigation would be. To address the uncertainty of the mitigation and how any hydrological changes may affect the SSSI, active management of the drainage system would be undertaken. This would include monitoring at every discharge point to determine if there is a significant departure from baseline conditions. If a change is detected, additional mitigation may be required (as outlined in chapter D8. Application Reference

Number: 6.4.8) and section 9.6, below). However, it is recognised that there is a high level of uncertainty over the efficacy of the proposed mitigation, and as such the assessment conclusion is based on a worst case scenario.

9.5.57 Given that the botanical communities within the SSSI are highly sensitive to water quality and quantity (see table 4.1 in appendix D8-7, Application Reference Number: 6.4.32), any changes in these are predicted to result in deterioration in the site's quality and species composition, and such changes to notable vegetation communities could compromise the SSSI's conservation status. As such, it is considered the changes in the site's hydrology could lead to severe damage to key characteristics of the site, potentially leading to the loss of such characteristics and the site's de-notification. Effects are likely to occur in the medium to long-term as the vegetation communities change slowly over time. Such a large magnitude of change would lead to a major adverse effect to the Tre'r Gof SSSI.

Introduction of INNS

9.5.58 There is the potential for the introduction of INNS into the Tre'r Gof SSSI through plant propagules entering the site. This could result in habitat loss/modification should fast-growing INNS start to colonise any of the terrestrial or aquatic habitats for which the site is designated.

9.5.59 The implementation of good practice measures included in the Biosecurity Method Statement (contained within the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)) would mitigate this risk. Good practice mitigation in the form of buffer zones would also contribute to the protection afforded to the SSSI by maximising the distance between the SSSI and potential sources of contamination.

9.5.60 The magnitude of change would be negligible. The effect due to INNS would therefore be negligible.

Combined effects

9.5.61 With the application of embedded and good practice mitigation it is predicted that major adverse effects could occur as a result of changes to hydrological conditions, and minor adverse effects through changes in air quality. There is the potential that these two effects could combine to affect the Tre'r Gof SSSI, but it is not considered that they would result in an effect greater than that already predicted, and that the overall effect would be major adverse.

Cae Gwyn SSSI

9.5.62 The potential for significant effects on the Cae Gwyn SSSI have been identified via the following pathways:

- habitat loss, fragmentation or modification;
- air quality changes;
- hydrological changes; and
- introduction and spread of INNS.

Habitat loss, fragmentation and modification

9.5.63 The SSSI is located adjacent to the Wylfa Newydd Development Area. There would be no direct habitat loss within the SSSI as a result of the Wylfa Newydd Project, although activities associated with construction of Mound C would be approximately 15m to the east of the SSSI boundary. In the absence of mitigation, construction works may result in degradation of the habitats on the boundary of the SSSI, e.g. due to littering, fugitive dust and changes to runoff regimes (the latter two are discussed separately, below).

9.5.64 Fragmentation effects as a result of Main Construction are not considered likely. This is due to the designated habitats within the SSSI already being isolated (by topography and associated hydrological conditions) from other areas with the potential to support a similar botanical assemblage. Therefore, there would be no risk of severing links with similar habitats nearby.

9.5.65 Good practice mitigation would include a 15m-wide buffer zone along the section of the SSSI boundary adjacent to the Wylfa Newydd Development Area within which construction activities would not encroach. Good practice mitigation implemented via the General Site Management Strategy (contained in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)) would also ensure that littering is avoided and that a tidy construction site is maintained, thus mitigating the risk of habitat degradation.

9.5.66 Based on the above, a negligible magnitude of change is predicted as a result of habitat loss, fragmentation and modification, resulting in negligible effects.

Air quality changes

9.5.67 The sphagnum moss present within the Cae Gwyn SSSI is highly sensitive to air quality changes. The habitats and species within the site would also be potentially sensitive to dust deposition.

9.5.68 Chapter D5 (Application Reference Number: 6.4.5) scopes out any effects from changes to both annual mean and 24-hour mean NO_x concentrations on the Cae Gwyn SSSI, Nitrogen and acid deposition at the site is currently below critical load values. The predicted increase in nitrogen deposition would lead to a 5% increase in 2020, taking it over the critical load level. Acid deposition is predicted to increase by 6% in 2020, although this would not lead to an exceedance of critical load.

9.5.69 In 2023, concentrations for nitrogen and acid are lower than in 2020 but still predict a 3% and 2% increase respectively, nitrogen deposition still being above the critical load value.

9.5.70 Predictions for the change in species composition as a result of air quality effects at the Cae Gwyn SSSI, derived from the Caporn *et al.* 2016 [RD50] study, show a potential 0.5% decrease in total species richness, a 2.1% decrease in forb species richness and a 0.8% increase in graminoid cover at 2020 deposition rates. At 2023 deposition rates, these predictions show a potential 0.2% decrease in overall species richness, a 1.0% decrease in forb species and a 0.4% increase in graminoid cover. The changes recorded in the study occurred over a period of eight years so the predicted changes to

species composition above represent a precautionary approach given that deposition rates are assessed at the two peak periods of 2020 and 2023.

9.5.71 With respect to dust deposition, the Cae Gwyn SSSI is located within 50m of sources of fugitive dust, notably Mound C. The area of the SSSI that falls within the 50m study area for dust is limited to approximately 1.4ha (approximately 13% of the 10.1ha area designated as SSSI), along the eastern boundary of the Cae Gwyn SSSI. However, the air quality assessment in chapter D5 (Application Reference Number: 6.4.5) considers that the prevailing wind direction from the south-southwest and southwest would generally transport any emitted dust from the landscape mounding area away from the Cae Gwyn SSSI. Chapter D5 (Application Reference Number: 6.4.5) considers that winds blowing from the north-northeast to the west, (representing the direction from where works would be closest to the SSSI) would occur for only approximately 14% of the year during dry conditions.

9.5.72 Activities with the potential to generate dust within 50m of the Cae Gwyn SSSI would be temporary and limited to the initial soil stripping and subsequent mound creation. During this period, the proposed embedded and good practice mitigation, including dust suppression and control measures, monitoring and surveys/inspections, would be focused on preventing dust emissions causing a significant effect at the Cae Gwyn SSSI.

9.5.73 Taken together, the changes in air quality are predicted to lead to very small measurable changes in the interest features and quality of the Cae Gwyn SSSI, which would represent a small magnitude of change and a minor adverse effect in the medium term, which is anticipated to reduce as changes reduced towards baseline conditions. Additional mitigation measures to reduce this effect are proposed in section 9.6, below.

Hydrological changes

9.5.74 No works would take place within the boundary of the Cae Gwyn SSSI although activities occurring within the surface water catchment of the SSSI comprise site clearance works and the creation of Mound C. The proposed landscape mound would be located approximately 15m to the east of the SSSI boundary.

9.5.75 An assessment of the possible hydrological effects to the Cae Gwyn SSSI is provided in chapter D8 (Application Reference Number: 6.4.8). Based on the conclusions of chapter D8 (Application Reference Number: 6.4.8), the activities or changes that would potentially result in a minor magnitude of change or greater are discussed in this section.

9.5.76 The SSSI is at the upstream end of Nant Caerdegog Isaf and direct rainfall and surface water runoff from the immediately surrounding area provide the main inflow into the Cae Gwyn SSSI. A study of the hydrological regime of the Cae Gwyn SSSI has been undertaken to create a conceptual model that can be used to inform an assessment of how any hydrological changes might alter the ecology of the site (see appendix D8-6 Cae Gwyn Hydroecological Assessment, Application Reference Number 6.4.31). The assessment showed the site as consisting of four distinct hydrological areas: the Northern

Basin, the Western Basin, the Southern Basin and the Primary Outfall Basin (POB).

9.5.77 It considered that neither the Northern nor Western Basins are supported by groundwater as winter groundwater levels in the bedrock remain below the basin floor at both locations. The Southern Basin is also not considered to be supported by groundwater, although there is the possibility that bedrock groundwater levels recorded in the SSSI intersect the base of the peat in the Southern Basin during winter. The POB is predominantly surface-water fed with inflows more or less equal to outflows (over the monitoring period), albeit with significant seasonal variations; during winter, bedrock groundwater levels are within the peat, potentially providing an inflow of groundwater into the basin although this is not thought to be significant in terms of volume. However, its chemical contribution may influence the rich-fen vegetation found there.

9.5.78 Although there could be some changes to the catchment area due to the construction of Mound C, the changes would be outside of the SSSI boundary and only affect a small part of the POB.

9.5.79 Dewatering of deep excavations has the potential effect of drawing down groundwater levels at the Cae Gwyn SSSI and either reducing any groundwater input to the SSSI, or increasing leakage to groundwater from the SSSI. In addition, the construction of Mound C may result in a reduction of direct groundwater recharge and hence a change in groundwater levels near the SSSI.

9.5.80 Based on the above, Chapter D8 (Application Reference Number: 6.4.8) concludes that the potential magnitude of change to water flows to the SSSI is likely to be small, and that this would affect the POB only. The magnitude of change for recharge to deep groundwater would also be small.

9.5.81 The POB principally comprises a quaking bog which supports a range of grass and rush species typical of moderately base-rich conditions; willow carr is also present. This catchment is water logged during winter and can dry out in summer, indicating its reliance on precipitation and surface water flows (see appendix D8-6) (Application Reference Number: 6.4.31).

9.5.82 The Site Management Statement for the SSSI states that a high-water table is essential for the survival of wetland plants and animals, and that no work should be carried out which would lower water levels on the site [RD53].

9.5.83 Although the POB naturally dries in summer and the species present are relatively tolerant of periodic drying, the existing water supply is currently sufficient to re-wet the peat substrate during the winter. This annual re-wetting controls the growth of grass species, such as purple moor-grass (*Molinia caerulea*), that might otherwise outcompete the more sensitive species for which the SSSI is designated.

9.5.84 The POB receives water from other basins that make up the SSSI, principally over-topping from the southern basin, and does not itself input into the wider site. Any changes to the POB would be localised and would not adversely affect the three other basins that make up the rest of the SSSI.

9.5.85 The small magnitude of change predicted in chapter D8 (Application Reference Number: 6.4.8) is considered to have the potential to lead to a minor alteration in the species composition of the SSSI as more competitive species dominate the rarer species that contribute to the importance of the SSSI. It is considered that this would result in a minor adverse effect on the Cae Gwyn SSSI. Additional mitigation is discussed in section 9.6.

Introduction and spread of INNS

9.5.86 There is the potential for the introduction and spread of INNS into the Cae Gwyn SSSI through run-off contaminated with plant propagules. This could result in habitat loss/modification should fast-growing INNS start to colonise any of the terrestrial or aquatic habitats for which the site is designated.

9.5.87 The implementation of good practice measures such as buffer zones and a Biosecurity Method Statement (contained within the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)), means the magnitude of change would be negligible. The effects due to INNS would therefore be negligible.

Combined effects

9.5.88 With the application of embedded and good practice mitigation it is predicted that minor adverse effects would occur as a result of changes to hydrological conditions, and minor adverse effects through changes in air quality. There is the potential that these two effects could combine to affect the Cae Gwyn SSSI, but it is not considered that they would result in a greater magnitude of change than that already predicted, and therefore the overall effect would be minor adverse.

Cemlyn Bay SSSI and Bae Cemlyn/Cemlyn Bay SAC

9.5.89 For the purpose of the assessment of terrestrial and freshwater ecology receptors, vegetated shingle is the only designated feature of interest considered. The other designating features are included within chapter D13 (marine environment) (Application Reference Number: 6.4.13).

9.5.90 Pathways for potential significant effects on the Cemlyn Bay SSSI are therefore considered to be restricted to:

- air quality changes; and
- changes to coastal processes.

Air quality changes

9.5.91 The Cemlyn Bay SSSI/SAC is approximately 110m from the Wylfa Newydd Development Area at its closest point, and so the vegetated shingle habitats are vulnerable to air quality change arising through emissions from plant and machinery.

9.5.92 Chapter D5 (Application Reference Number: 6.4.5) scopes out any effects from changes to annual mean and 24-hour NO_x concentrations and from changes in nitrogen deposition on the Cemlyn Bay SSSI/SAC. Current acid deposition rates are below the critical load value and are not predicted to

exceed them, but rates would increase by 12% by 2020, and in 2023, acid deposition rates would be 4% above baseline.

9.5.93 The SSSI/SAC is outside the 50m area likely to be affected by dust deposition, with Mound E being located approximately 110m away [RD47]. Furthermore, a meteorological data analysis indicates that the wind that could transport any emitted dust from the landscape mound area towards the SSSI/SAC during dry conditions (i.e. wind blowing from the east-southeast through to the south) would occur for only approximately 8% of the time (chapter D5, Application Reference Number: 6.4.5). As such, the effects of dust are considered to be negligible.

9.5.94 Taken together, the changes in air quality emissions are predicted to lead to a negligible change in the interest features and quality of the Cemlyn Bay SSSI/SAC which would represent a negligible effect.

Changes to coastal processes

9.5.95 The construction of permanent and temporary infrastructure within the marine environment has the potential to affect coastal processes and geomorphology and is discussed in chapter D12 (Application Reference Number: 6.4.12).

9.5.96 Changes to coastal processes could adversely affect the shingle ridge habitats for which the SSSI is designated through increased sediment deposition or by increasing erosion from wave action, thus reducing the area of available habitat for perennial vegetation to grow and/or directly affecting perennial vegetation growth. Such habitat modifications could also increase the susceptibility of the notable habitats to non-Project effects, such as trampling.

9.5.97 Chapter D12 (Application Reference Number: 6.4.12) predicts that changes associated with coastal processes and sediment deposition would result in a negligible magnitude of change.

9.5.98 As such, it is considered that there would be a negligible effect on the shingle ridge and its associated vegetation at Cemlyn Bay SSSI/SAC. This conclusion is consistent with the findings of the Shadow HRA.

Llyn Llygeirian SSSI

9.5.99 Pathways for potential significant effects on the Llyn Llygeirian SSSI are considered to be restricted to air quality changes.

9.5.100 However, chapter D5 (Application Reference Number: 6.4.5) scopes out significant effects on the wildlife site resulting from dust deposition, increased rates of nitrogen and acid deposition and elevated levels of NOx. The effects of changes in air quality on Llyn Llygeirian SSSI are therefore not considered further in this assessment.

Trwyn Pencarreg Wildlife Site

9.5.101 Pathways for potential significant effects on the Trwyn Pencarreg Wildlife Site are considered to be restricted to air quality changes. However, chapter D5 (Application Reference Number: 6.4.5) scopes out significant effects on the wildlife site resulting from dust deposition, increased rates of nitrogen and acid deposition and elevated levels of NOx. The effects of changes in air quality

on Trwyn Pencarreg Wildlife Site are therefore not considered further in this assessment.

Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site

9.5.102 The Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site is designated for coastal grassland, a colony of gulls, chough and harbour porpoise (see section 9.3). Effects on chough are assessed separately in this chapter, and effects on the colony of gulls and harbour porpoise are assessed in chapter D13 (Application Reference Number: 6.4.13).

9.5.103 The potential pathways to significant effects are therefore considered to be habitat loss, fragmentation and modification; and air quality changes, both of which could affect coastal grassland.

Habitat loss, modification and fragmentation

9.5.104 There would be 1.1ha of habitat lost from within the boundary of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site (5% of the total site area), as a result of the construction of the outfall infrastructure. The habitats lost comprise coastal grassland with some scrub, and would be temporary: the outfall structure runs underground, so would be recovered and dressed with topsoil once complete; the Site Campus would be in operation during the construction period, then removed with habitat established in line with the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). This would represent a small magnitude of change, as it is considered that this would be a minor loss of a key characteristic, feature or element of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.

9.5.105 Degradation (modification) of habitats is also possible due to increased footfall on the headland caused by workers residing in the Site Campus using the area for recreation. This could lead to trampling of grassland habitats and widening of existing pathways to form areas of bare earth. This would represent a medium magnitude of change, as it is considered possible that there would be some damage and loss of resource, but that this would not affect the integrity of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.

9.5.106 Taken together, it is assessed that the combined effects of habitat loss and degradation would result in a moderate adverse effect and additional mitigation is proposed, as described in section 9.6.

Air quality changes

9.5.107 As the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site is directly affected by construction work within its boundary, sources of fugitive dust would be present within the site itself and within 50m of much of its boundary. Activities with the potential to generate dust would be temporary, associated with construction of the Site Campus, cooling water outfall and Mound A. During this work, the proposed embedded and good practice mitigation, including dust suppression and control measures, monitoring and surveys/inspections, would be focused on preventing dust emissions causing

a significant effect at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.

9.5.108 Chapter D5 (Application Reference Number: 6.4.5) details the air quality assessment undertaken for the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site. The modelling results which support the air quality assessment are provided in appendix B5-2 (Application Reference Number: 6.4.21) and are based on information from reference points on the southern boundary of the Wylfa Head headland, and along the coastal grassland between Porth y Ogof, Porth y Wylfa and Trwyn y Penrhyn.

9.5.109 Chapter D5 (Application Reference Number: 6.4.5) scopes out any effects from changes to annual mean and 24-hour mean NOx concentrations on the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, as well as changes in acid deposition. Changes in nitrogen deposition are scoped in for further assessment.

9.5.110 The two reference points which show the greatest levels of air quality change are located within the areas affected by the outfall and by the Site Campus, where the habitats potentially affected by these air quality changes would be lost as a result of construction. Given these modelled data would not be representative of the overall air quality changes across the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, the highest modelled changes in nitrogen deposition within retained habitats has been used as the level against which potential effects have been assessed. This predicts nitrogen deposition of 4.3kgN/ha/year in 2020, an increase of 33% on the current baseline. Deposition levels in 2023 have been scoped out in chapter D5 (Application Reference Number: 6.4.5) as not requiring further assessment.

9.5.111 Predictions for the change in species composition as a result of air quality effects at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, derived from results of the Caporn et al. 2016 [RD50] study for acid grassland, show a potential 5.1% decrease in total species richness. The model did not allow for a calculation of likely change in total for species richness, nor increase in graminoid cover, although it is considered that the decrease in overall species diversity would lead to a greater reduction in the more sensitive, rarer species present, as the more resilient graminoid species outcompeted them.

9.5.112 Taken together, the changes in air quality are predicted to lead to measurable changes in the attributes and quality of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, which would represent a small magnitude of change and a moderate adverse effect during the period of peak bulk earthworks (modelled as occurring in 2020). This is anticipated to reduce as changes reduce towards baseline conditions, with effects of air quality change scoped out for the period of peak Power Station construction (modelled as occurring in 2023). Additional mitigation measures to reduce this effect are proposed in section 9.6, below.

Combined effects

9.5.113 With the application of embedded and good practice mitigation it is predicted that moderate adverse effects would occur as a result of habitat loss and degradation, and moderate adverse effects through changes in air quality.

There is the potential that these adverse effects could combine to affect the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, but it is not considered that they would result in a greater magnitude of change than that already predicted, and therefore the overall effect would be moderate adverse. The assessment of chough, an interest feature of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, is undertaken separately (see below), but its conclusion of moderate adverse effects has been taken into account in this combined effects assessment

Ancient woodland

9.5.114 The ancient woodland habitat at Simdda-Wen (ID 26059) and The Firs Hotel (ID 26075) would be lost via tree felling and vegetation and topsoil clearance to facilitate construction of the Power Station. Construction activities would also be located within close proximity to the retained woodland at Manor Garden (ID 26060). Potential pathways to significant effects are considered to be:

- habitat loss, fragmentation and modification; and
- air quality changes.

Habitat loss, modification and fragmentation

9.5.115 The removal of woodland habitat at Simdda-Wen and The Firs Hotel would result in the loss of 0.8ha of ancient woodland. These two blocks of ancient woodland are located within the footprint of the Power Station Site and their removal is considered to be a large magnitude of change.

9.5.116 Retained ancient woodland at Manor Garden could potentially be degraded due to construction activity within the immediate vicinity e.g. due to littering or damage to trees or roots due to tracking of machinery or excavation.

9.5.117 Good practice mitigation implemented via the General Site Management Strategy of the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) would seek to ensure that littering is avoided and that a tidy construction site is maintained. The Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would also seek to protect retained trees through the implementation of appropriate buffer and root protection zones, as per the provisions of BS5837:2012 *Trees in relation to design, demolition and construction – Recommendations* [RD54].

9.5.118 The three small areas of ancient woodland within the Wylfa Newydd Development Area are not linked by connecting habitats and do not form part of a larger complex of woodland habitat. As such, the retained woodland at Manor Garden would not be isolated from any associated or supporting habitats due to construction activities.

9.5.119 Given the high value of this receptor, and the large magnitude of change predicted due to the losses at Simdda-Wen and The Firs Hotel, a major adverse effect is anticipated. Additional mitigation is proposed, as described in section 9.6.

Air quality changes

9.5.120 For the retained ancient woodland at Manor Garden (ID 26060), Chapter D5 (Application Reference Number: 6.4.5) identifies annual mean NO_x concentrations as requiring further ecological assessment, together with nitrogen deposition rates. Acid and dust deposition on ancient woodland, and 24-hour mean NO_x concentrations are below the thresholds which require further assessment.

9.5.121 In 2020, critical levels for atmospheric concentrations of NO_x are predicted to be exceeded by 38% for annual mean levels. In 2023, these levels are predicted to have dropped sufficiently to allow them to be omitted from further assessment. Existing nitrogen deposition rates are already in exceedance of critical load, but are predicted to increase by 32% in 2020.

9.5.122 The predicted medium-term changes in air quality are unlikely to result in any measurable changes in the tree species within the woodland [RD55]. Effects on the diversity and condition of the ground flora and epiphytic lichen assemblage may be more pronounced, although the botanical interest within the woodland is limited (see appendix D9-18 Application Reference Number: 6.4.51).

9.5.123 As such it is predicted that the changes in air quality would lead to a very minor loss of, or detrimental alteration to the ancient woodland characteristics, representing a negligible magnitude of change and a negligible adverse effect.

Terrestrial habitats

9.5.124 Potential pathways to significant effects are considered to be habitat loss, fragmentation and modification.

9.5.125 The effects of air quality change, water quality change and the introduction of INNS are not considered likely to result in significant adverse effects to retained habitats due to the low value of the receptor and the implementation of embedded and good practice mitigation (see section 9.4). These effects are therefore not considered further.

Habitat loss, fragmentation and modification

9.5.126 Habitat loss, fragmentation and modification would arise through the clearance of vegetation and topsoil from the majority of the Wylfa Newydd Development Area.

9.5.127 Table D9-7 shows the area of each non-linear Phase 1 habitat type within the Wylfa Newydd Development Area where losses or modification would occur. Areas such as buildings and hardstanding, as well as habitats protected by buffer zones (see section 9.4), have been omitted from this table.

Table D9-7 Habitat changes within the Wylfa Newydd Development Area

Phase 1 habitat type	Potential area affected (ha) (approx.)
Improved grassland	142.3
Poor semi-improved grassland	64.5
Semi-improved neutral grassland	22.4
Arable (no longer cultivated)	20.2
Amenity grassland	7.3
Marsh/marshy grassland	3.6
Bare ground	1.4
Coastal/Maritime Grassland	0.8
Natural rock exposure	0.6
Tall ruderal herbs	0.3
Ephemeral/short perennial land	0.2
Inland mine	0.2
Running water	0.2
Standing water	0.1
Scrub – scattered	3.6
Scrub – dense/continuous	3.5
Coniferous plantation woodland	2.0
Broadleaved plantation	1.8
Mixed plantation woodland	1.0
Broadleaved parkland	0.2
TOTAL	276.2ha

9.5.128 A permanent loss of habitats would occur as a result of permanent infrastructure i.e. the Power Station, Training and Simulator Building, car parks and associated access roads. The remaining areas would be reinstated through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.5.129 The following habitats that are listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016 would be lost due to construction of the Power Station: scrub, plantation woodland, ponds, coastal grassland and marshy grassland. Combined, this accounts for an area of approximately 15ha, or 5% of the total. There would also be the loss of approximately 29km of field boundaries.

9.5.130 The geographical location of the Wylfa Newydd Development Area means that, once cleared, there would be separation of similar areas of habitat and so fragmentation effects would arise. This would affect Wylfa Head and a coastal grassland strip which would be separated from habitats to the south. These effects would last for the duration of Main Construction, Marine Works and the Site Campus.

9.5.131 The loss and fragmentation of habitats would be compensated for via habitat re-creation as detailed in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). The establishment of habitats would be programmed to come into effect as soon as practically possible, starting during the construction period, thereby reducing periods of habitat loss. The habitats created would be of equal or greater value to nature conservation than those lost.

9.5.132 Habitats proposed for creation comprise (approximate values):

- 40ha of improved agricultural grassland (to be sympathetically managed);
- 20ha of close-sward species-rich grassland;
- 100ha of coarse-sward species-rich grassland;
- 10ha of marshy wet grassland;
- 20ha of woodland;
- 10ha of coastal heath/grass mosaic; and
- 10km of hedgerow and cloddiau.

9.5.133 On completion of construction, it is also proposed to convert suitable sedimentation ponds, channels and swales installed during construction to permanent or seasonally wet waterbodies or areas of damp ground.

9.5.134 The newly created, restored and enhanced habitats account for an area of approximately 210ha. Although approximately 276ha of habitat would be removed to enable construction of the Power Station (a deficit of approximately 66ha), the habitats created through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would be of greater biodiversity value and would provide a net biodiversity gain in the long-term. For example, approximately 20ha of woodland would be created compared to the approximate 5ha lost (300% increase); approximately 10ha of marshy wet grassland would be created compared to the approximate 3.6ha lost (178% increase); and approximately 10ha of coastal heath/grass mosaic would be created compared to the approximate 0.8ha lost (1,150% increase). However, there would be a 65% reduction in field boundaries from approximately 29km to 10km, although not all of the field boundaries lost are hedgerows (some are stone walls or fences); the proposed new hedgerows would also be more species diverse than the typically species-poor hedgerows currently within the Wylfa Newydd Development Area.

9.5.135 The majority of the habitat that would be lost is agricultural grassland comprising an area of approximately 229ha, or 83% of the total. The grassland habitat itself is of relatively low value (predominantly improved and

poor semi-improved types). Approximately 180ha of grassland would be reinstated, approximately 120ha being species-rich.

9.5.136 Due to the size of the area affected, the magnitude of change would be medium in the medium-term. As the habitat permanently lost under the footprint of permanent infrastructure mainly comprises low quality grassland, and the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would mitigate habitat losses in the long-term through the creation of habitats of higher biodiversity value, the medium magnitude of change is not expected to affect the integrity of terrestrial habitats. As such, a minor adverse effect due to habitat loss, fragmentation or modification is predicted. Additional mitigation is described in section 9.6.

Fungi

9.5.137 Fungi are potentially susceptible to effects via the following pathways:

- habitat loss and degradation; and
- air quality changes.

Habitat loss, fragmentation and modification

9.5.138 As described in section 9.3 and shown in figure D9-11 (Application Reference Number: 6.4.101), there are three survey sites within the Wylfa Newydd Development Area that support assemblages of fungi of national importance and three survey sites that support assemblages of regional importance. A pathway for a potentially significant effect on fungi is considered to be habitat loss during Main Construction and modification by degradation caused by trampling due to worker pressure.

9.5.139 The extent of the construction works in relation to important areas of grassland fungi is shown in figure D9-11 (Application Reference Number: 6.4.101). The size and value of each grassland survey area is shown in table D9-8.

Table D9-8 Value and size of fungi sites

Area	Value	Total size (ha)
1	High	1.2
2	High	3.5
3	High	13.7
4	Medium	0.9
5	Medium	2.5
6	Medium	1.5
Total	-	23.3

9.5.140 Table D9-8 shows that the total area of medium and high value grassland due to the presence of fungi within the Wylfa Newydd Development Area is 23.3ha. Main Construction would not directly affect the high value survey sites, but all medium value survey sites (totalling 4.9ha) would be lost as a result of earthworks.

9.5.141 The loss of the three medium value sites (4, 5 and 6) is considered to be a medium magnitude of change. This is based on the effect resulting in the partial loss of the receptor that will not adversely affect its integrity. Data presented in appendix D9-1 (Application Reference Number: 6.4.34) show that, despite the loss of 4.9ha of habitat of medium value, there would only be a loss of one species of fungi from the members of the genera *Hygrocybe* (Waxcaps) and *Entoloma* (Pinkgills) and the families Clavariaceae (Fairy Clubs) and Geoglossaceae (Earth Tongues) within the Wylfa Newydd Development Area; one from the 32 species recorded in total in 2013 and 2017. This species is hairy earth tongue (*Trichoglossum hirsutum*), which is a lowest level indicator species ([RD56] and [RD57]), with a national status that is common and widespread.

9.5.142 In addition to the loss of habitats, there is the potential for habitat modification caused by increased footfall on the headland caused by workers residing in the Site Campus using the area for recreation. This could result in trampling of grassland habitats and widening of existing pathways. This is unlikely to affect fungi in terms of their subterranean structures (grassland fungi exist in the soil as mycelia) unless damage to surface habitats is very severe, but the short-lived fruiting bodies could be damaged and reproduction could therefore be affected.

9.5.143 Based on the assessment above, the effect of habitat loss and degradation (modification) on fungi is considered to represent a small magnitude of change as a result of the loss of a key feature of the receptor, which would be a moderate adverse effect. Additional mitigation is proposed as described in section 9.6.

Air quality changes

9.5.144 There is an absence of published literature on the effects of changes in air quality on grassland fungi, the majority of the literature relating to fungi in woodland habitats. However, as with the predicted effects of air quality changes on designated sites, as nitrogen and acid deposition and NOx concentrations increase, species diversity decreases and, on a precautionary basis, it is assumed this would occur for fungi within the retained grassland habitats in the Wylfa Newydd Development Area.

9.5.145 Given the high value fungi areas (sites 1, 2 and 3: Appendix D9-1, Application Reference Number: 6.4.34) lie within retained areas of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, the assessment of air quality effects on this designated site has been used to determine the potential effects of air quality changes on fungi. Chapter D5 (Application Reference Number: 6.4.5) scopes out any effects from changes to annual mean and 24-hour mean NOx concentrations on the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, as well as changes in acid deposition loads. Changes in nitrogen deposition during peak bulk earthworks are scoped in for further assessment, with chapter D5 (Application Reference Number: 6.4.5) predicting nitrogen deposition of 4.3kgN/ha/year, an increase of 33% on the current baseline.

9.5.146 Sources of fugitive dust would be present within 50m of sites 2 and 3 of the high value fungi sites (Appendix D9-1, Application Reference Number: 6.4.32). Site 1 is located approximately 300m away from any construction activity.

Activities with the potential to generate dust would be temporary, associated with construction of the Site Campus, cooling outfall and Mound A. During this work, the proposed embedded and good practice mitigation, including dust suppression and control measures, monitoring and surveys/inspections, would be focused on preventing dust emissions causing a significant effect on these high value sites.

9.5.147 The assessment for the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site predicted measurable changes in the attributes and quality of the wildlife site, which would represent a small magnitude of change and a moderate adverse effect during the period of peak bulk earthworks (modelled as occurring in 2020). This was anticipated to reduce as changes reduce towards baseline conditions, with effects of air quality change scoped out during the period of peak Power Station construction (modelled as occurring in 2023). Based on this assessment, and taking the effect of habitat loss and degradation into account, it is considered that a small magnitude of change would be felt by fungi as a receptor, and a moderate adverse effect is predicted.

Lichen

9.5.148 Lichen are potentially susceptible to effects via the following pathways:

- habitat loss; and
- air quality changes.

Habitat loss

9.5.149 The removal of vegetation, drystone walls and rock outcrops would potentially affect communities of lichen, although the most notable lichen communities within the field survey study area were outside the Wylfa Newydd Development Area. These included the marine and supralittoral communities of the rocky shore, sea-cliff and coastal heathland around Trwyn Pencarreg Wildlife Site, and a rock outcrop to the north of the Wylfa Newydd Development Area.

9.5.150 Important lichen communities are also located within close proximity to the Site Campus (survey locations 5 and 6 (see appendix D9-2, Application Reference Number: 6.4.35)), but these would be protected and retained through the embedded mitigation design and so would not be affected by habitat loss.

9.5.151 Limited habitat loss is predicted as the sycamore (*Acer pseudoplatanus)* trees which *Ramalina fraxinea* was recorded growing on would be felled as part of the Power Station construction works. Additional mitigation is described in section 9.6 with respect to this impact.

9.5.152 Based on the small magnitude changes to lichen communities that would arise due to habitat loss, a negligible effect is predicted.

Air quality

9.5.153 Lichen is vulnerable to air quality change arising through emissions of dust and emissions from construction plant, machinery and vehicles. Chapter D5 (Application Reference Number: 6.4.5) describes the air quality assessment

that has been undertaken, the results of which have been used to identify any significant effects to lichen.

9.5.154 The marine, supralittoral and rocky zones around Trwyn Pencarreg represent the most valuable area for lichens within the Wylfa Newydd Development Area. Chapter D5 (Application Reference Number: 6.4.5) predicts increases in annual mean and 24-hour NO_x concentrations in this area.

9.5.155 Little is known about the effects of air pollution on seashore lichens. Rocky shores near to industrial centres have been shown to possess simplified seashore lichen communities compared with shores away from sources of air pollution, but the effect of wind and wave action on rocky coastal habitats may act to mitigate the detrimental effects of air pollution on lichens [RD58].

9.5.156 The predicted changes would be restricted to the construction period only, and would be reversible on completion of works. However, given the high predicted concentration of NO_x in the Trwyn Pencarreg area it is considered that a small magnitude change may occur. A minor adverse effect on lichen communities is therefore predicted as a result of air quality changes.

Terrestrial invertebrates

9.5.157 The main effects on terrestrial invertebrates would occur during vegetation and topsoil clearance, although effects could also arise due to lighting during the construction period. Potential pathways to significant effects are therefore considered to be:

- mortality and injury;
- habitat loss; and
- disturbance.

Mortality and injury

9.5.158 Vegetation and topsoil clearance would result in injury and mortality to invertebrates. These effects would be less severe for flying insects which are highly mobile, if activities take place during their flying season. However, subterranean species, non-flying species and the larvae, pupae and eggs of many species recorded would be affected.

9.5.159 Many night flying species of insect are attracted to light, especially those lamps that emit an ultra-violet component and particularly if it is a single light source in a dark area [RD59]. Insects can die or become injured when they collide with a hot lamp or they can become disorientated and exhausted making them more susceptible to predation [RD59]. The effects of artificial lighting would be temporary in the medium-term (i.e. up until the end of the construction period).

9.5.160 Based on the above, a small magnitude of change is predicted resulting in a minor adverse effect, although additional mitigation is proposed (see section 9.6).

Habitat loss

9.5.161 Extensive areas of habitat would be removed during the vegetation clearance and topsoil stripping phase of construction, although some of the more valuable habitats for invertebrates (e.g. wetland areas around the Tre'r Gof SSSI and coastal heathland grassland) would be retained.

9.5.162 The removal of many habitats would be temporary in the short and medium-term (up until the end of the construction period) as embedded mitigation implemented via the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) includes the reinstatement, creation and enhancement of habitats of value for invertebrates. For example, new habitats would include approximately 20ha of close-sward species-rich grassland; approximately 100ha of coarse-sward species-rich grassland; approximately 10ha of marshy wet grassland; approximately 20ha of woodland; and approximately 10ha of coastal heath/grass mosaic. In addition, field boundaries would be recreated using traditional materials, new ponds would be created, and approximately 10km of species-rich hedgerow would be planted.

9.5.163 For notable species like the grayling and wall brown butterflies, permanent effects are therefore unlikely, and recovery would take an estimated two to three seasons. Much of the habitat suitable for cinnabar moth is located outside the area affected by site clearance works (e.g. Wylfa Head), although the species is also likely to return to the reinstated and replaced habitats as these would be managed more sympathetically than at present and with a greater focus on nature conservation. Small heath butterfly would be less affected by habitat loss as it can be found in many different habitats, especially those that are open, such as grassland and heathland; such habitats can be found in abundance immediately adjacent to the Wylfa Newydd Development Area.

9.5.164 Taking into account good practice mitigation (buffer zones) and the restoration, creation, and enhancement of habitats via the Landscape and Habitat Management Strategy (Application Reference Number: 8.16), habitat loss is predicted to result in a small magnitude of change and so negligible effects are predicted.

Disturbance

9.5.165 Increased lighting requirements during the construction period could disturb the behaviour of nocturnal flying insects by disturbing their flight, navigation, vision, migration, dispersal, egg-laying, mating, feeding and camouflage [RD59].

9.5.166 The effects of artificial lighting would be temporary in the medium-term. A small magnitude of change and minor adverse effect is predicted due to disturbance, although additional mitigation is proposed (see section 9.6).

Combined effects

9.5.167 With the application of embedded and good practice mitigation it is predicted that minor adverse effects would occur as a result of mortality/injury, and minor adverse effects through disturbance. There is the potential that these two

effects could combine to affect terrestrial invertebrates, but it is not considered that they would result in a greater magnitude of change than that already predicted, and therefore the overall effect would be minor adverse.

Great crested newt

9.5.168 Potential pathways to significant effects are considered to be:

- mortality and injury; and
- habitat loss.

Mortality and injury

9.5.169 GCN have been identified as present in low numbers in the area surrounding and within the Cae Gwyn SSSI. Construction works within 500m of the Cae Gwyn SSSI GCN population and breeding ponds has the potential to kill or injure these animals. This could affect the favourable conservation status of GCN in the local area.

9.5.170 Good practice mitigation carried out under an EPSML would be required, as described in the GCN draft EPSML Method Statement (see appendix D9-21, Application Reference Number: 6.4.54) and summarised below:

- trapping and translocation of GCN from all suitable habitats in the Wylfa Newydd Development Area within 250m of the Cae Gwyn SSSI GCN population; and
- sensitive destructive searching under supervision of an ECoW, of suitable habitats in the Wylfa Newydd Development Area within 500m of the Cae Gwyn SSSI GCN population.

9.5.171 GCN translocated from the construction area would be released in suitable terrestrial habitat close to the Cae Gwyn SSSI, as detailed in the EPSML application.

9.5.172 The good practice mitigation would ensure that the proposed works are not detrimental to the maintenance of the GCN population at a favourable conservation status, as required by Regulation 55(9)(b) of the Conservation of Habitats and Species Regulations 2017.

9.5.173 Given the above, a negligible magnitude of change would arise and negligible effects to GCN are predicted due to mortality or injury.

Habitat loss and fragmentation

9.5.174 Good practice guidance advises that suitable habitats within 250m of a breeding pond are likely to be used most frequently by GCN if there is an absence of dispersal barriers. Small-scale losses of terrestrial habitat, especially over 250m from the breeding pond, are also considered unlikely to have significant effects on GCN [RD1]. As such, it is considered that the effects of habitat loss and fragmentation would only be experienced within 250m of the GCN ponds, a conclusion that was supported by NRW (pers. comm.).

9.5.175 Based on a buffer zone of 250m around the ponds where GCN were present in their terrestrial phase, approximately 0.3ha of habitat for the species would be affected by site clearance for Main Construction, as shown in figure D9-4 (Application Reference Number: 6.4.101). The affected habitats within the 250m buffer are dominated by short-grazed improved pasture and are generally considered to be sub-optimal for sheltering or foraging GCN. Due to the quality of the habitat and the medium-term duration of the habitat loss (up until the end of Main Construction), the effects of habitat loss and fragmentation are expected to be limited.

9.5.176 In addition to the specific mitigation undertaken for the EPSML, the implementation of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would lead to the creation of suitable habitats for GCN that would result in a long-term positive effect. This would include the creation of permanent or seasonally wet water bodies, areas of damp ground, boundary features, woodland, and species-rich grassland across the Wylfa Newydd Development Area. The provision of terrestrial habitats suitable for GCN within 500m of the Cae Gwyn SSSI meta-population breeding ponds has been a key factor in the design of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). Coarse sward species-rich grassland would be planted, providing approximately 0.3ha of this habitat within 250m of the of the Cae Gwyn SSSI meta-population breeding ponds, and 6.6ha of this habitat between 250m and 500m of the meta-population breeding ponds. This is considered to be an improvement in the habitat quality which currently existing within these areas.

9.5.177 There would be no permanent loss of terrestrial habitat within 250m of GCN ponds. The Wylfa Newydd Development Area does not intersect with any core GCN habitat (i.e. habitat within 50m of GCN ponds). There would be no loss of GCN ponds because of Main Construction.

9.5.178 With the implementation of the mitigation outlined in the EPSML and the habitat enhancements described in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16), the magnitude of change due to habitat loss or fragmentation would be negligible and so a negligible effect is predicted.

Common toad

9.5.179 Effects on common toads within the Wylfa Newydd Development Area have been identified via the following pathways:

- mortality and injury; and
- habitat loss and fragmentation.

Mortality and injury

9.5.180 There is the potential for mortality and injury effects to occur during pond destruction, topsoil stripping, vegetation removal and the removal of dry stone walls. Toads could also be killed or injured by machinery movements or through entrapment in excavations.

9.5.181 Good practice mitigation would comprise the trapping and translocation of toads from suitable habitats. Vegetation removal would be undertaken in a directional manner to encourage toad movement towards suitable retained habitats. An ECoW would also supervise the removal of suitable habitat, with any captured toads being translocated to a receptor site.

9.5.182 With the application of these good practice methods, the magnitude of change is expected to be negligible and so mortality and injury effects are predicted to be negligible.

Habitat loss and fragmentation

9.5.183 Four ponds supporting breeding common toad within the Wylfa Newydd Development Area would be lost. All terrestrial habitats within the Wylfa Newydd Development Area suitable to support common toad would also be lost following vegetation and topsoil clearance.

9.5.184 Fragmentation effects would arise as there are areas that support common toad (such as habitat in the Tre'r Gof SSSI) which would be isolated from the wider landscape as a result of construction activities. Fragmentation would make the population more susceptible to localised extinction resulting from chance events (e.g. flooding or pollution).

9.5.185 The removal of many habitats would be temporary in the short- and medium-term. In the long-term, the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would deliver the reinstatement, creation and enhancement of habitats of value for common toad, including: approximately 20ha of woodland; approximately 10ha of marshy wet grassland; and approximately 10km of hedgerow. The creation of field boundaries using traditional materials, the creation of new ponds, and the provision of species-rich grassland would also benefit common toad by providing habitats for breeding, foraging, sheltering, and hibernating.

9.5.186 Given the proposed embedded mitigation, the magnitude of change is predicted to be small, meaning that the effects of habitat loss and fragmentation would be negligible. Additional mitigation is described in section 9.6.

Adder and common lizard

9.5.187 Potentially significant effects on adder and common lizard within the Wylfa Newydd Development Area have been identified via the following pathways:

- mortality and injury;
- habitat loss and fragmentation; and
- disturbance.

Mortality and injury

9.5.188 All activities that involve the clearance of areas containing suitable reptile habitat could result in mortality and injury of adder and common lizard, with the risk increasing in areas of known reptile presence, i.e. sites 2, 7 and 22 (see appendix D9-10, Application Reference Number: 6.4.43), and high

potential reptile habitat (e.g. cloddiau, marshy grassland, disturbed land, scrub, coastal grassland, tall ruderal).

9.5.189 Good practice mitigation for adder and common lizard would be in place prior to site clearance activities commencing, as outlined in section 9.4. This would include a combination of trapping and translocation of individuals, phased and directional habitat manipulation to encourage reptiles to move away from the works area, sensitive removal of suitable refuge features, and supervision of works by an ECoW. This mitigation would be undertaken during the reptile active season (between March and October inclusive, dependent on local weather conditions) in accordance with good practice guidelines [RD60]. Full information is provided in the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

9.5.190 Translocated reptiles would be released at a receptor site. The site comprises a 5ha area of grassland and scrub located adjacent to the Wylfa Newydd Development Area that is being enhanced for reptiles. This area has been secured by Horizon for 15 years, which would cover the full construction period, and would provide a source population for re-establishment of reptiles following the establishment of habitats proposed within the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). The receptor site, in optimum condition, is considered to be sufficient to support the low population of reptiles identified across the Wylfa Newydd Development Area. However, should more animals be found than anticipated, the notable wildlife receptor site (at 15ha) would be used as a supplementary site (see figure D9-9 (Application Reference Number: 6.4.101) for location and section 9.6 for an explanation of this site).

9.5.191 The location of the proposed 5ha receptor site, the habitats that it supports, and the proposed habitat enhancements are illustrated by figure D9-8 (Application Reference Number: 6.4.101).

9.5.192 Based on the implementation of good practice mitigation, a negligible magnitude of change is anticipated and so effects as a result of mortality and injury would be negligible.

Habitat loss and fragmentation

9.5.193 Approximately 12ha of suitable reptile habitat (e.g. marshy grassland, disturbed land, scrub, coastal grassland, fen, tall ruderal) and approximately 12km of suitable field boundaries (i.e. cloddiau and species-poor hedges) would be removed. In context of the total habitat losses of approximately 276ha, potential reptile habitats are localised and small within the Wylfa Newydd Development Area.

9.5.194 Habitat fragmentation would also be likely due to the isolation of habitats between the northern boundary of the Wylfa Newydd Development Area and the coast. This may increase the vulnerability of populations in these areas to localised extinction from chance events, e.g. fire or flood.

9.5.195 The removal of many habitats would be temporary in the short and medium-term as the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) include the reinstatement, creation and

enhancement of habitats that would be suitable for reptiles, including: approximately 10ha of coastal heath/grass mosaic; 10ha of marshy wet grassland; 10km of hedgerow; and field boundaries using traditional materials. Approximately 20ha of new woodland would also be planted and whilst this habitat itself is unlikely to be of value for reptiles, the extensive areas of edge habitat would be utilised by reptiles, especially where these intersect with areas of sympathetically managed grassland.

9.5.196 In addition to the above, habitat loss would also be mitigated through the provision and management of the dedicated receptor site.

9.5.197 The magnitude of change is therefore predicted to be small and so a negligible effect of habitat loss and fragmentation is expected during construction. Additional mitigation is described in section 9.6.

Disturbance

9.5.198 During the construction period, there would be disturbance caused by groundworks excavations and vehicle movements.

9.5.199 There are limited scientific publications that evaluate the impact of human disturbance on reptiles, and there is no strong evidence that reptiles are sensitive to disturbance, although there is potential that disturbing activities could cause stress to individual animals and compromise survival and reproduction rates.

9.5.200 By the time highly disturbing activities commence (e.g. topsoil stripping, deep excavation, blasting), most of the reptiles within the Wylfa Newydd Development Area would have dispersed or been removed as part of the mitigation strategy outlined above. However, the effects of disturbance could be experienced by reptiles within retained habitats in the immediate vicinity (e.g. reptile sites 15 and 16, as shown in appendix D9-10, Application Reference Number: 6.4.43).

9.5.201 Baseline surveys identified low populations of reptiles within the targeted areas subject to surveys. Reptiles are mobile animals, and as refuges such as drystone walls would be retained within habitats adjacent to the Wylfa Newydd Development Area, it is expected that any reptiles within the areas affected would be able to seek shelter, should this be necessary.

9.5.202 Good practice mitigation measures to reduce noise generated by construction activity would also be implemented, as described in chapter D6 (Application Reference Number: 6.4.6).

9.5.203 Based on the above, the magnitude of change is predicted to be minor and so impacts of disturbance to reptiles are expected to be negligible.

Chough

9.5.204 Potentially significant effects on chough have been identified via the following pathways:

- habitat loss and modification; and
- disturbance.

9.5.205 There is also potential for significant effects to SPAs for which chough is a qualifying feature and where significant functional linkages may exist between these sites and chough within the Wylfa Newydd Development Area. However, based on the assessment of functional linkages provided in appendix D9-14 (Application Reference Number: 6.4.47), there are considered to be no significant functional linkages between SPA populations of chough and individuals using the Wylfa Newydd Development Area. This conclusion is consistent with the findings of the Shadow HRA Report (Application Reference Number: 5.2). As such, impact pathways on SPAs with chough as a qualifying feature are not considered further in this assessment.

Habitat loss and modification

9.5.206 The ecology, and in particular the diet, of chough is well understood e.g. Whitehead *et al.* (2005) [RD61], with suitable nesting sites and the provision of short grassland for foraging being critical factors for the success of a population. Effects to nest sites and foraging habitat (during the breeding and non-breeding periods) are therefore key considerations.

Effects to nesting chough

9.5.207 There would be no loss of any of the four historic chough nesting sites within the Wylfa Newydd Development Area as a direct result of Main Construction, Marine Works or construction, operation and decommissioning of the Site Campus, as these are all located outside the footprint of the proposed works areas (see appendix D9-14, Application Reference Number: 6.4.47).

9.5.208 No other suitable chough nesting habitats would be directly affected by construction activities.

Effects to foraging chough during the breeding season

9.5.209 Chough are susceptible to the loss of habitat used for foraging. Kerbiriou *et al.* (2006) [RD62] found that foraging activity usually took place close to nests and was mainly within 300m. The quality of habitat within 300m has been shown to directly influence breeding success, with fecundity directly related to the ratio of foraging habitat with sward heights less than 5cm within this distance [RD62]; [RD63].

9.5.210 Whilst Kerbiriou *et al*. (2006) [RD62] demonstrates the importance of the core foraging area (which is mainly within 300m of the nest site), the baseline surveys also show specific areas of well-used foraging habitat up to 1.5km from the nest sites, although these habitats are often extremely localised and comprise micro-habitats within much larger fields e.g. rock outcrops, clifftops. The baseline surveys indicate that the areas used most by foraging chough during the breeding season are the coastal grasslands around Wylfa Head. Grassland at Trwyn Penrhyn Wildlife Site (and nearby rocky outcrops) and Trwyn Pencarreg Wildlife Site are also utilised, although to a lesser degree than the habitats closer to Wylfa Head (appendix D9-14, Application Reference Number: 6.4.47).

9.5.211 The core foraging area 1.5km from nest sites covers approximately 54ha, and approximately half of this would be lost as a result of Main Construction,

Marine Works and construction of the Site Campus, including well-used habitats to the immediate south-east of Wylfa Head that would be affected by construction of the Site Campus. However, well-used foraging areas of grassland at Trwyn Penrhyn Wildlife Site, Trwyn Pencarreg Wildlife Site and Wylfa Head would be retained (appendix D9-14, Application Reference Number: 6.4.47).

9.5.212 Good practice mitigation would ensure the retention and protection of these habitats through the provision of temporary construction fencing.

9.5.213 Embedded mitigation at Mound A is also proposed, with the parts of this feature that are closest to the Wylfa Head nest site being managed for the benefit of chough with the grassland regularly mown or grazed to maintain a short sward. At its closest point, the mound is approximately 700m from the Wylfa Head nest site and approximately 650m from the nest site at the Existing Power Station. Mound A is within the distance between the nest sites and foraging habitat at Trwyn Pencarreg (1.6km) which baseline surveys have identified as being part of the well-used foraging area. It is therefore considered likely that the Wylfa Head breeding chough would utilise suitable habitat on Mound A.

9.5.214 The removal of most habitats would be temporary in the short- and medium-term as the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) include the reinstatement, creation and enhancement of habitats that would be suitable for chough. Most notably, on completion of the construction period, the Site Campus would be decommissioned and the site reinstated with close-sward species-rich coastal grassland.

9.5.215 The provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would create habitats of higher value for foraging chough than the habitats currently present within the Wylfa Newydd Development Area. For example, approximately 20ha of close-sward species-rich grassland, 100ha of coarse-sward species-rich grassland and 10ha of coastal heath/grass mosaic would be created and appropriately managed; this habitat would also likely see an increase in invertebrate biomass and thus benefit foraging chough. Agricultural grassland would also be sympathetically managed for foraging chough, where appropriate. Additional mitigation would also enhance habitats at Wylfa Head (see section 9.6).

9.5.216 Despite the above, the loss and modification of core habitat has the potential to adversely affect breeding success during the construction period. In a worst case scenario, the reduction in the quality of core habitat could lead to the loss of a breeding population of chough from the Wylfa Newydd Development Area, especially when combined with other pressures (e.g. sub-optimal habitat quality at Wylfa Head due to a recent reduction in grazing).

9.5.217 The loss of core habitat is therefore considered to result in a medium magnitude of change and so a moderate adverse effect is predicted. Additional mitigation is proposed and is described in section 9.6.

Effects to foraging chough during the non-breeding season

9.5.218 Outside the breeding season, chough are known to congregate at traditional roost sites and forage up to 6km from these locations through the winter months (appendix D9-14, Application Reference Number: 6.4.47). Baseline data from surveys in winter 2017 show from colour band sightings that the pair of chough which breed at Wylfa Head are also present in the area during the non-breeding season. These birds are therefore likely to be resident in the Wylfa Head area throughout the year. However, due to the tendency for chough to range more widely outside the breeding season, the relative importance for the Wylfa Head breeding population of non-breeding season foraging habitat near to the nest sites is likely to be reduced.

9.5.219 However, the baseline non-breeding surveys in other years have also shown the distribution of non-breeding chough as similar to that during the breeding season. It is therefore assumed that the Wylfa Head breeding population of chough rely on the same habitats during the non-breeding season as in the breeding season and, as such, the main pathway to effects during the non-breeding season would be the loss of foraging habitats.

9.5.220 The nearest non-breeding season chough roost site to the Wylfa Newydd Development Area is at Church Bay, approximately 6km to the southwest. The baseline data from the non-breeding season recorded a maximum of six chough within the study area. Surveys during the non-breeding period generally recorded approximately four birds within the field survey study area, which are likely to be from the Wylfa Head breeding population. The low numbers of non-breeding chough recorded within the Wylfa Newydd Development Area, the distance from the Church Bay roost, and the availability of alternative suitable habitats elsewhere along the coast suggest that the habitats within the Wylfa Newydd Development Area are not of significant value for non-breeding birds from other populations.

9.5.221 Although the majority of habitats within the Wylfa Newydd Development Area would be lost, the majority of the foraging habitats used by chough would be retained and the resulting landscape would still offer opportunities for foraging chough (breeding and non-breeding). For example, habitats at Trwyn Pencarreg Wildlife Site, Trwyn Penrhyn Wildlife Site, and the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site would be retained, and the landscape mounds capped with topsoil and reseeded through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). Habitat affected by the Site Campus and temporary construction work areas would also be reinstated as close-sward species-rich grassland or coastal heath/grass mosaic.

9.5.222 Furthermore, the topsoil stripped areas elsewhere within the Wylfa Newydd Development Area may provide temporary opportunities for foraging chough as these birds have been recorded to make use of similar conditions (e.g. recently ploughed fields and areas stripped for archaeological investigation (Horizon Environmental Coordinator Observation pers. comm.), albeit rarely [RD64]; [RD63]. In the medium- to long-term, the implementation of the Landscape and Habitat Management Strategy (Application Reference

Number: 8.16) would see these areas restored to close-sward species-rich grassland habitat suitable for foraging chough.

9.5.223 As is the case for the breeding season, the loss of core habitat is considered to result in a medium magnitude of change and so a moderate adverse effect is predicted. Additional mitigation is proposed and is described in section 9.6.

Disturbance

9.5.224 The pathways by which disturbance effects could occur include noise, vibration and visual disturbance. Chough that breed in retained habitats immediately adjacent to the Wylfa Newydd Development Area are considered to be particularly susceptible. The key areas for foraging chough are short grassland habitats within their core foraging range in both breeding and non-breeding seasons, in particular the coastal grasslands around Wylfa Head and Trwyn Pencarreg Wildlife Site. Chough in these areas are also considered to be most susceptible to disturbance.

9.5.225 Main Construction, Marine Works (i.e. Cooling Water System, Cooling Water System intake and outfall, Marine Off-Loading Facility (MOLF) and breakwater structures) and activities associated with construction, operation and decommissioning of the Site Campus would result in changes to noise and visual stimuli through activities such as the operation and movement of machinery, demolition of buildings and structures, excavation, blasting and the change in the number, distribution and activities of people. Activities undertaken during the breeding season between mid-March and August are considered likely to result in potentially significant disturbance effects at the nest and during foraging. Activities during the non-breeding season could result in potentially significant disturbance to foraging.

9.5.226 Chough can be vulnerable to disturbance from human activities, especially in the vicinity of nest sites and core feeding areas [RD62]. Noise has been demonstrated to cause behavioural effects upon birds, varying depending upon the time of year. The potential effects of noise disturbance to birds are described by various studies and have been summarised by Latimer *et al.* (2003) [RD65], although no specific information relating to threshold levels of noise disturbance upon chough is available. However, tolerance of chough to noise disturbance is predicted to be high given that nest site A is within a building which is part of the Existing Power Station and is subject to noise associated with its operation (including fire alarm tests and stack venting). Chough are considered to be generally resilient to disturbance as long as the disturbing factors are regular and present prior to breeding attempts, or occur later in the breeding period after the initial set up of breeding territories (Adrienne Stratford (Welsh Chough Project) / RSPB pers. comm. in March and June 2017). A ‘new’ disturbance event during the early stages of the breeding season can cause birds to desert the nest site for the season, whereas a similar level of disturbance taking place further in to the breeding season is much less likely to have an adverse effect.

9.5.227 Several studies have been undertaken to measure the effects of visual disturbance to birds (e.g. see [RD49]; [RD66]; [RD67]), although the subjects of these studies do not specifically relate to chough. The distance at which individual birds display behaviours associated with disturbance varies

considerably by species and by type of disturbance. The significance of visual disturbance may also be greater when combined with noise disturbance, although this has not been studied with respect to chough [RD65]. Visual disturbance caused by anglers standing on cliffs close to nest site C was considered to have caused the abandonment of the nest site (pers. comm. Adrienne Stratford). However, the timing of this disturbance is considered to have been critical (April), with birds in the process of establishing the nest at the time. Baseline surveys have recorded only one event where foraging chough were disturbed by anthropogenic causes, when chough flying towards a foraging area veered away when a group of eight people with dogs were adjacent to the area being approached. However, chough were also recorded foraging within fields occupied by people, and sometimes within 50m of people. Chough have also been recorded during baseline surveys foraging on banks adjacent to existing car parks and buildings within the Existing Power Station area.

9.5.228 The Wylfa Newydd Development Area is subject to a number of disturbance events above that considered normal in an agricultural environment. There are vehicle movements in association with site security, regular fly-bys of low flying RAF jets (regularly generating noise above 85dB (see appendix D13-13 Noise at Marine Ecological Receptors, Application Reference Number: 6.4.95), and in recent years there have been a number of activities to facilitate ground investigation and archaeological trial trenching. The Wales Coastal Path on Wylfa Head also brings people into close contact with nest sites and core foraging habitat. Chough within the Wylfa Newydd Development Area are therefore currently exposed to many, and sometimes very noisy, short-term disturbance events.

9.5.229 The timing of potentially disturbing effects on chough is particularly important. Chough are considered to be generally resilient to disturbance as long as the disturbing factors are regular and present prior to breeding attempts, or occur later in the breeding season. However, a ‘new’ disturbance event during the very early stages of the breeding season can cause birds to desert the nest site for the season i.e. the anglers example, above (RSPB/Adrienne Stratford pers. comm.).

9.5.230 The results of noise modelling suggest that construction of the Site Campus and Cooling Water System would generate the greatest potential for disturbance within the vicinity of chough nest sites and core foraging habitat. Construction of the Site Campus would take approximately two years and it would be operational until Year 10 before being decommissioned. The operation of the Site Campus would also likely result in noise and visual disturbance due to up to 4,000 workers living there. The Cooling Water System would take approximately three years to construct. The effects of disturbance are therefore temporary in the medium-term.

9.5.231 Noise modelling (see chapter D6, Application Reference Number: 6.4.6) predicts the worst case construction noise levels to be approximately 65dB $L_{Aeq,1\text{-}hour}$ at the historic nest sites within the Existing Power Station (nest site A); approximately 85dB $L_{Aeq,1\text{-}hour}$ at nest site B; approximately 61dB $L_{Aeq,1\text{-}hour}$ at the nest sites on Wylfa Head (nest sites C and D); and up to approximately 85dB $L_{Aeq,1\text{-}hour}$ within core foraging habitats.

9.5.232 At each of the key areas for chough, there would be an increase in noise above baseline levels during construction activities and so the effects of disturbance are possible.

9.5.233 The evidence described above suggests chough are tolerant of high noise levels (at certain times). The predicted noise levels at nest site A are expected to be within acceptable limits given the high levels of noise disturbance already experienced at this location and the attenuation that the building would provide from noise generated outside of it. Chough have made only one unsuccessful nesting attempt at nest site B in 2009 and so the predicted noise levels at this location are not anticipated to adversely affect nesting behaviour as chough are unlikely to be present. The predicted noise levels at Wylfa Head (nest sites C and D) are expected to be within acceptable limits given the existing background noise experienced at these locations (e.g. waves crashing on cliffs; RAF jets exceeding 85dB). As such, noise disturbance is not expected to adversely affect chough at their nesting sites.

9.5.234 Noise levels above baseline conditions may disturb foraging chough that are intolerant of such levels. It is anticipated that these birds would be displaced to retained habitat beyond the area of disturbance during its duration.

9.5.235 Visual disturbance would occur in areas of retained habitats within and adjacent to the Wylfa Newydd Development Area. The effects of visual disturbance from mobile construction teams would vary spatially and temporally, depending on the activity being undertaken. Temporary construction lighting may also disturb chough in retained habitats. Foraging chough that are not tolerant of visual disturbance are expected to be displaced to adjacent retained habitat that would be protected during the construction period. Newly created foraging habitat at Mound A would also provide an alternative resource, as discussed above.

9.5.236 Disturbance of habitats is also possible due to increased footfall on the headland caused by workers residing in the Site Campus using the area for recreation. This could result in the avoidance of foraging habitat by chough.

9.5.237 Embedded mitigation in the form of the landscape mounds would reduce the effects of noise disturbance, although noise levels above baseline conditions would be experienced throughout the entire construction period. The landscape mounds would also provide visual screens between foraging areas at Trwyn Pencarreg Wildlife Site and construction areas to the east.

9.5.238 Good practice guidelines with respect to noise control would be adhered to during construction, as outlined in chapter D6 (Application Reference Number: 6.4.6). Good practice mitigation, enforced by the ECoW, would also seek to ensure that construction noises would not be started at the critical nest establishment stage and would be at levels that chough have habituated to from other sources.

9.5.239 Additional mitigation is also proposed to address the spatial and temporal variations in disturbance so that chough have sufficient alternative foraging sites. Additional mitigation to reduce possible disturbance caused by lighting and the use of Wylfa Head for recreation by workers residing in the Site Campus is also proposed (see section 9.6).

9.5.240 Based on the above, the magnitude of change would be medium, the effect of disturbance to chough would be moderate adverse. Additional mitigation is proposed, as described in section 9.6.

Combined effects

9.5.241 With the application of embedded and good practice mitigation it is predicted that moderate adverse effects would occur as a result of both foraging habitat loss and disturbance. There is the potential that these two effects could combine to affect chough, but it is not considered that they would result in a greater magnitude of change than that already predicted, and therefore the overall effect would be moderate adverse.

Breeding birds

9.5.242 Potentially significant effects on breeding birds have been identified via the following pathways:

- mortality and injury of species;
- habitat loss and modification;
- hydrological changes; and
- disturbance.

Mortality and injury

9.5.243 The mortality and injury of species could occur during all vegetation clearance and removal of other above-ground features (e.g. dismantling of stone walls) and potentially during topsoil stripping. Mortality and injury could occur to adults and dependent young and via destruction of eggs. The effects to nests and eggs could occur to both tree/scrub and ground-nesting species, e.g. meadow pipit (*Anthus pratensis*) and skylark *(Alauda arvensis)* that have been frequently recorded in the field survey study area. Effects could also extend to marine and coastal species such as oystercatcher (*Haematopus ostralegus*) or ringed plover *(Charadrius hiaticula)* that may be attracted to newly-created bare ground habitat within the Wylfa Newydd Development Area.

9.5.244 Good practice mitigation would be implemented by timing vegetation clearance works to avoid the main breeding season, as per the provisions of the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). An ECoW would also supervise unavoidable works affecting suitable nesting habitats during the breeding season, including pre-demolition inspection of the non-breeding barn owl roost locations at Tyddyn-Gele and The Firs.

9.5.245 This mitigation would see that there is a negligible magnitude of change and so the potential effects of mortality and injury on breeding birds would be negligible.

Habitat loss and modification

9.5.246 Vegetation and topsoil clearance works would remove the majority of habitat suitable for breeding birds from within the Wylfa Newydd Development Area.

9.5.247 There are no known barn owl breeding sites that would be destroyed as a result of the Wylfa Newydd Project. Baseline surveys show that the nearest breeding sites are at Mynydd Ithel, Caerdegog Isaf, and the wildlife tower at Cafnan Farm, all of which would be retained. Occasional barn owl roosts would be lost at Tyddyn-Gele and The Firs; these would be checked for barn owl by an ECoW prior to their demolition. If active nests were encountered prior to demolition, all activity likely to affect the nest site would be delayed until the nest fell into disuse; in this instance, appropriate replacement roosts would also be provided in the form of pole mounted barn owl boxes, or similar.

9.5.248 The effects of habitat loss are limited as the types of habitat that would be lost are widely available to breeding birds within the wider landscape. The removal of many habitats would be temporary in the short- and medium-term as the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) include the reinstatement, creation and enhancement of habitats that would be suitable for breeding birds, including approximately 20ha of woodland and 10km of species-rich hedgerow. Most notably, the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would deliver the creation of habitats of higher value for foraging birds than the habitats currently present within the Wylfa Newydd Development Area. For example, approximately 20ha of close-sward species-rich grassland, 100ha of coarse-sward species-rich grassland and 10ha of marshy wet grassland, in addition to the new woodland and enhanced hedgerow habitats, would likely see an increase in invertebrate biomass and thus benefit breeding birds. Similarly, the creation of species-rich grassland would also benefit seed-eating species.

9.5.249 The direct loss of foraging, nesting and roosting habitat would be a small magnitude of change for the species using the Wylfa Newydd Development Area and so a negligible effect is predicted. Additional mitigation is proposed, described in section 9.6 below.

Hydrological changes

9.5.250 Hydrological effects in the form of accidental pollution during the construction period would potentially result in degradation of retained habitats. Pollution events in water bodies could affect a number of species of bird including notable species such as mallard *(Anas platyrhynchos)*, teal *(Anas crecca)* and wigeon *(Anas penelope)*, although birds would be able to relocate to suitable habitats nearby.

9.5.251 Good practice mitigation (delivered through the Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)) includes buffer zones around Nant Cemlyn, Afon Cafnan, Nant Caerdegog Isaf, Nant Cemaes, and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI. The Surface Water and Groundwater Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) would also seek to ensure that good practice mitigation in the form of pollution control measures is implemented.

9.5.252 As such, a negligible magnitude of change would arise and so hydrological changes are predicted to have a negligible effect.

Disturbance

9.5.253 The pathways by which disturbance effects could occur include noise, vibration and visual disturbance. Species that breed in retained habitats immediately adjacent to the Wylfa Newydd Development Area are considered to be particularly susceptible.

9.5.254 Disturbance of breeding birds could adversely affect the survival, range and abundance of certain species, although susceptibility to disturbance does vary between species, from total avoidance through to rapid habituation (e.g. see [RD65]; [RD49]).

9.5.255 Following vegetation clearance and removal of other above-ground features, it is highly likely that only breeding birds in habitats around the boundary of the Wylfa Newydd Development Area would be affected, unless species nest on bare ground habitats or temporary construction infrastructure.

9.5.256 Noise is considered to be a major cause of disturbance and, as shown in chapter D6 (Application Reference Number: 6.4.6), noise contour mapping indicates that there are several areas outwith the Wylfa Newydd Development Area where the worst case noise levels would exceed 55dB $L_{Aeq,1\text{-}hour}$. In these areas, habitats would not have been removed and so effects would be experienced by extant bird populations.

9.5.257 The effects of noise would be localised and temporary (medium-term) and so are not likely to alter the long-term population status of any of the species or assemblages in the local area.

9.5.258 There are barn owl breeding sites at Cafnan Farm, Caerdegog Isaf Farm and at Mynydd Ithel Farm. The results of the noise monitoring detailed in appendix B6-1 Baseline noise monitoring (Application Reference Number: 6.2.20), indicate that the baseline noise levels for these sites are between 40-48 dB $L_{Aeq,T}$ during the day and 30-40 dB $L_{Aeq,T}$ during the night (see chapter D6, Application Reference Number: 6.4.6).

9.5.259 Noise modelling predicts that the worst case construction noise levels during the periods modelled (see chapter D6) (Application Reference Number: 6.4.6) at Cafnan Farm would be approximately 79dB $L_{Aeq,1\text{-}hour}$ between October and December 2020 (day time), and approximately 79dB $L_{Aeq,1\text{-}hour}$ between April and June 2027 (night time).

9.5.260 At Caerdegog Isaf Farm and Mynydd Ithel Farms, the predicted worst case levels during the construction period would be approximately 65dB $L_{Aeq,1\text{-}hour}$ and 63dB $L_{Aeq,1\text{-}hour}$ respectively, between July and September 2020 (day time) and April and June 2027 (night time).

9.5.261 At each of the three breeding sites, there would be an increase in noise above baseline levels during construction activities and so the effects of disturbance are possible.

9.5.262 Barn owl can be tolerant of human activity, although disturbance at the nest can lead to nest failure or desertion. Desertion due to disturbance may also occur more commonly in those years when the birds are already stressed by food shortage [RD68]. A literature review by Scottish Natural Heritage suggested that barn owl can be sensitive to disturbance within 50 to 100m of

the source, although some contact with humans due to barn owl selection of active farm buildings suggests both a high degree of tolerance by at least some pairs and that conditioning to certain types or levels of disturbance can occur [RD68]. There is limited information available relating to barn owl thresholds of tolerance to noise disturbance.

9.5.263 Cafnan Farm, Caerdegog Isaf Farm and Mynydd Ithel Farm are working farms that would be subject to regular noise and visual disturbance and so it is assumed that the birds here are reasonably tolerant of disturbance; this assumption is supported by the successful breeding of barn owl at Caerdegog Isaf in 2017 despite (third party) works involving the replacement of a building's roof at the site (pers. comm. with Horizon Environmental Coordinators).

9.5.264 Embedded mitigation in the form of the landscape mounds would reduce the effects of noise disturbance, although noise levels above baseline conditions would be experienced throughout the entire construction period. However, the landscape mounds would also provide visual screens between the roost sites and construction areas.

9.5.265 Despite Mound D1 acting as an acoustic barrier, there is still potential for abandonment of roosts at Cafnan Farm, Mynydd Ithel Farm or Caerdegog Isaf Farm, and so additional mitigation is proposed.

9.5.266 Regular and occasional barn owl roosts at Plas Cemlyn, Pen Carreg, and Neuadd would all be retained and could act as alternative breeding sites during periods of disturbance at Caerdegog Isaf Farm, Mynydd Ithel Farm and Cafnan Farm (see appendix D9-12 for locations, Application Reference Number: 6.4.45). As such, the local area is expected to retain its capacity to support the current population of two breeding pairs of barn owl. However, additional mitigation is proposed to address the spatial and temporal variations in disturbance so that barn owls have sufficient alternative roosting sites (see section 9.6).

9.5.267 Visual disturbance to birds would occur in areas of retained habitats within and adjacent to the Wylfa Newydd Development Area. The effects of visual disturbance from mobile construction teams would vary spatially and temporally, depending on the activity being undertaken. Temporary construction lighting may also disturb breeding birds in retained habitats. However, the effects would be mitigated by the landscape mounds and so would be temporary up until the point of their construction, or until the species habituates to the disturbance.

9.5.268 Disturbance is predicted to result in a medium magnitude of change and a minor adverse effect, although additional mitigation is proposed (see section 9.6).

Over-wintering and passage birds

9.5.269 Potentially significant effects on over-wintering and passage birds during construction have been identified via the following pathways:

- mortality and injury;
- habitat loss and modification;

- hydrological changes; and
- disturbance.

Mortality and injury

9.5.270 The mortality and injury of species could occur during all vegetation clearance and removal of other above-ground features (e.g. dismantling of stone walls) and potentially during topsoil stripping.

9.5.271 The potential for mortality and injury of species during the winter period is likely to be low because birds would not be confined to nest sites and are likely to move away from sources of disturbance. However, some species do not take flight until the last second when startled or disturbed. For example, snipe typically takes-off only once a potential predator is within 10m–15m; or woodcock, that remains in cover during the day [RD69]. In all likelihood, even these species would still escape safely as potentially harming activities would typically be slow moving and would be preceded by noise and visual disturbance that would flush birds away.

9.5.272 A negligible magnitude of change is predicted and so effects would be negligible.

Habitat loss and modification

9.5.273 The baseline shows that nearly all habitats within the Wylfa Newydd Development Area are used for foraging and roosting by over-wintering and passage birds.

9.5.274 Virtually all habitats within the Wylfa Newydd Development Area (excluding retained habitats and buffer areas) would be removed. The effects of this would vary between species e.g. some ground foraging species may persist (especially once areas of grassland on the landscape mounds establish), whilst hedgerow species are likely to be displaced.

9.5.275 Overall, effects are predicted to be lessened due to the generally low quality of the habitat within the Wylfa Newydd Development Area, being dominated by improved agricultural grassland. Although this habitat can be important for some birds, such as over-wintering foraging geese, it has limited conservation value for the majority of over-wintering bird species recorded during the surveys.

9.5.276 Baseline surveys show that most notable wintering bird species were recorded in the following areas: south of Cemlyn Bay; on semi-improved coastal grassland and heathland south of Cerrig Brith; on semi-improved neutral grassland at Mynydd Ithel, south of the Wylfa Newydd Development Area; and, on marshy grassland around Tregele (see appendix D9-13, Application Reference Number: 6.4.46). None of these areas would be directly affected by habitat loss or modification.

9.5.277 The loss of foraging and roosting habitat would only be permanent for the area under the footprint of the Power Station and associated infrastructure, which mainly comprises semi-improved grassland. The remaining habitat would be replaced in the medium- to long-term by the implementation of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16),

with short-term effects generally mitigated by the availability of similar habitat in the wider landscape with the potential to support over-wintering and passage birds. The reinstatement, creation and enhancement of habitats that would be suitable for over-wintering and passage birds, includes: approximately 20ha of woodland; approximately 40ha of improved agricultural grassland; approximately 20ha of close-sward species-rich grassland; approximately 100ha of coarse-sward species-rich grassland; approximately 10ha of marshy wet grassland; and approximately 10km of hedgerow.

9.5.278 Given the above, a small magnitude of change is expected and so a negligible effect would occur as a result of habitat loss and modification. Additional mitigation is described in section 9.6.

Hydrological changes

9.5.279 The potential for, and effects of, hydrological changes are as per the assessment for breeding birds above.

9.5.280 It is expected that embedded and good practice mitigation would be adequate to control the risk of hydrological changes affecting retained wetland habitats of importance for over-wintering and passage birds.

9.5.281 A negligible magnitude of change is predicted and so hydrological changes are considered to have a negligible effect.

Disturbance

9.5.282 Disturbance can adversely affect the survival, range and abundance of birds. The pathways for disturbance effects on over-wintering and passage birds are similar to those potentially affecting breeding birds, and would include temporary lighting, noise and vibration, and increased human activity within the Wylfa Newydd Development Area and adjacent areas.

9.5.283 Birds react to disturbance in different ways. Species that are susceptible to disturbance could be displaced, and prevented from foraging effectively, whilst other species could become habituated to constant levels of relatively predictable background disturbance.

9.5.284 The results of the noise monitoring detailed in appendix B6-1 (Application Reference Number: 6.2.20) indicate that the baseline noise levels for the sites of greatest value for over-wintering and passage birds are between 40-48 dB $L_{Aeq,T}$ during the day and 30-40 dB $L_{Aeq,T}$ during the night (see chapter D6, Application Reference Number: 6.4.6).

9.5.285 Noise modelling predicts the worst case construction noise levels during the winter periods modelled (see chapter D6, Application Reference Number: 6.4.6) within the areas used most by notable species. Greatest value noise levels at Cerrig Brith and around Tregele would be between approximately 70 and 75 dB $L_{Aeq,1\text{-}hour}$ between October and December 2019. During the same period, noise levels at Mynydd Ithel and south of Cemlyn Bay would be approximately 60 to 65 dB $L_{Aeq,1\text{-}hour}$, and approximately 55 to 60 dB dB $L_{Aeq,1\text{-}hour}$, respectively.

9.5.286 Noise disturbance would be reduced once the landscape mounds had been constructed. During the noisiest winter construction periods after 2019 (which

would be the period between January and March in 2023), the worst case noise levels would be as follows: approximately 55 – 60 dB $L_{Aeq,1\text{-}hour}$ at Cerrig Brith; approximately 65 to 70 dB $L_{Aeq,1\text{-}hour}$ around Tregele; approximately 55 to 60 dB $L_{Aeq,1\text{-}hour}$ at Mynydd Ithel; and approximately 45 to 50 dB $L_{Aeq,1\text{-}hour}$ to the south of Cemlyn Bay.

9.5.287 At each site, there would be an increase in noise above baseline levels during construction activities and so the effects of disturbance are possible, although birds would likely make use of similar habitats in less disturbed locations in the wider landscape.

9.5.288 Visual disturbance to birds would occur in areas of retained habitats within and adjacent to the Wylfa Newydd Development Area, although the effects would be reduced by embedded mitigation following construction of the proposed landscape mounds.

9.5.289 There is a paucity of habitats likely to support aggregations of birds within the Wylfa Newydd Development Area following the initial clearance of vegetation and topsoil stripping. The adjacent habitats which would be affected are also common and widespread within the wider landscape, and so adequate resource is available for any displaced individuals.

9.5.290 The magnitude of change is expected to be medium and so potential effects of disturbance to over-wintering or passage birds are predicted to be minor adverse. Additional mitigation is proposed in section 9.6.

Bats

9.5.291 Potentially significant effects on bats have been identified via the following pathways:

- mortality and injury;
- habitat loss and fragmentation; and
- disturbance (noise, vibration and lighting).

Mortality and injury

9.5.292 Bats could be killed or injured as a result of building demolition and tree felling, if roosts are present.

9.5.293 Figure D9.5 (Application Reference Number: 6.4.101) shows the location of roosts which would be lost through demolition (a total of 16 buildings). Measures to protect bats would be put in place in accordance with an EPSML for bats that would ensure there would be no detriment to the maintenance of the population of the species concerned at a favourable conservation status, as per Regulation 55(9)(b) of the Conservation of Habitats and Species Regulations 2017. A draft EPSML is provided in appendix D9-20 (Application Reference Number: 6.4.53).

9.5.294 To prevent the mortality and injury of bats, soft-stripping and hand-demolition works at known roosts would be undertaken between March and June, as per good practice guidelines [RD32]; this would reduce the likelihood of bats that are particularly susceptible to disturbance being present e.g. hibernating individuals or pups. Works would also be supervised by a licensed bat worker,

who would be present to capture any bats found and remove them to one of the bat barns or pole mounted bat boxes provided as part of the EPSML.

9.5.295 A number of trees that would be removed during the construction phase have features with the potential to support roosting bats. To confirm the presence or likely-absence of roosts, pre-felling surveys would be undertaken in accordance with good practice guidelines [RD5]. Should evidence of roosting bats be recorded, good practice mitigation would be required (e.g. appropriate timing of works, soft-felling) and, as with building demolition, works would be carried out under an EPSML with respect to bats.

9.5.296 The implementation of good practice mitigation would see that there is a negligible magnitude of change and so the effects of mortality and injury would be negligible.

Habitat loss and fragmentation

9.5.297 There are 16 buildings that support roosting bats that would be demolished as part of Main Construction (see section 9.3). The measures described within the draft EPSML would ensure there would be no detriment to the maintenance of the population of the species concerned at a favourable conservation status, as per the requirements of Regulation 55(9)(b) of the Conservation of Habitats and Species Regulations 2017. These include the construction of two new bespoke bat barns (see figure D9.5, Application Reference Number: 6.4.101), for which planning consent exists and construction is underway with a predicted completion date of summer 2018.

9.5.298 The two new bat barns would be buffered by 10m of native planting and connected to the wider landscape by planting and habitat enhancements, as outlined in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). In association with each barn, two telegraph poles would be installed with four bat boxes of differing designs mounted on each to enhance the roosting opportunities available within 50m of the bat barns.

9.5.299 Good practice mitigation would also be required if trees supporting bat roost potential would be lost. This would comprise the provision of bat boxes to mitigate the loss of roosting features. All works affecting tree roosts would be subject to an EPSML, as outlined in appendix D9-20 (Application Reference Number: 6.4.53).

9.5.300 Topsoil stripping and vegetation clearance would remove potential foraging habitat, including approximately 229ha of agricultural grassland, 3.6ha of marshy grassland, and approximately 5ha of woodland.

9.5.301 Habitat fragmentation would also occur following the removal of features that bats follow for foraging and commuting, especially linear features that link retained habitats within the Wylfa Newydd Development Area (such as the Tyn-y-Maes bat barn and foraging habitat at the Tre'r Gof SSSI, Dame Sylvia Crowe's Mound, and coastal grassland) with habitats in the wider landscape. This may cause a reduction in use of the Wylfa Newydd Development Area by bats in the short and medium-term, with affected bats being displaced into the wider landscape. Retention of boundary features on the outer edges of the Wylfa Newydd Development Area and the habitats created through the provisions of the Landscape and Habitat Management Strategy (Application

Reference Number: 8.16) (e.g. linear woodland planting, hedgerows, drystone walls) are likely to reduce adverse effects of habitat fragmentation in the medium- and long-term.

9.5.302 The removal of many habitats would be temporary in the short and medium-term (up until the end of Main Construction and decommissioning of the Site Campus) as embedded mitigation implemented through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) includes the reinstatement, creation and enhancement of habitats of value for bats. For example, new habitats would include approximately 20ha of woodland that would provide a near-continuous belt around the south of the proposed Power Station and would connect to existing habitats in the wider landscape as well as retained habitats within the Wylfa Newydd Development Area. This would benefit roosting, foraging and commuting bats in the long-term. In addition, field boundaries would be recreated using traditional materials and approximately 13km of species-rich hedgerow would be planted, benefiting foraging and commuting bats in the medium- to long-term.

9.5.303 Furthermore, habitats created through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) are expected to increase invertebrate biomass and so benefit foraging bats. The creation of new ponds, approximately 20ha of close-sward species-rich grassland, approximately 100ha of coarse-sward species-rich grassland, approximately 10ha of marshy wet grassland, and approximately 10ha of coastal heath/grass mosaic would all be of value for invertebrates and thus foraging bats.

9.5.304 It is predicted that roost loss would result in a negligible magnitude of change and so the effect on roosting bats would be negligible. The effects of foraging/commuting habitat loss and fragmentation would be a small magnitude of change and would have a negligible effect. Additional mitigation is described in section 6.9.

Disturbance

9.5.305 Retained and newly created roosts would not be directly affected by construction activity although their proximity to the works area means that they may be affected by disturbance caused by noise, light or vibration. Bats commuting or foraging in retained habitats within or adjacent to the Wylfa Newydd Development Area may also be affected by noise or light disturbance.

9.5.306 Noise and vibration during Main Construction, Marine Works, and construction and decommissioning of the Site Campus have the potential to disturb bats whilst they roost during the day, if roosts are located immediately adjacent to the proposed construction works area. Such disturbance may cause bats to depart from their roosts prematurely during daylight hours, increasing their exposure to predation. Hibernating bats may also be prematurely woken; this increases energy expenditure that cannot easily be replaced and so reduces their chances of surviving the winter [RD32]. Roosts may also become temporarily unsuitable for use during the period over which disturbance occurs, resulting in a temporary loss of roost sites. Noise disturbance affecting foraging bats has not been well studied although excessive noise can affect foraging efficacy in those species that hunt through ‘passive listening’ for prey

(i.e. gleaning bats) with noise also potentially impairing how bats receive echolocation responses (e.g. see [RD70]; [RD71]).

9.5.307 The results of the noise monitoring detailed in appendix B6-1 (Application Reference Number: 6.2.20) indicate that the baseline noise levels for sites supporting retained roosts are between 40-48 dB $L_{Aeq,T}$ during the day and 30-40 dB $L_{Aeq,T}$ during the night (see chapter D6, Application Reference Number: 6.4.6).

9.5.308 The Tyn-y-Maes bat barn is within an area where noise modelling predicts that the worst case noise levels during Main Construction could reach 75dB $L_{Aeq,1\text{-}hour}$ during the active season (greatest value levels predicted between April and June 2027) and 70dB $L_{Aeq,1\text{-}hour}$ during the hibernation season (greatest value levels predicted between January and March 2023). There would be an increase in noise above baseline levels during construction activities, and so the disturbance to retained roosts is possible in areas affected by these changes.

9.5.309 There is little published information relating to bat tolerance to noise disturbance. However, it is considered likely that the physical structure of a roost would provide buffering for roosting bats from noise generated by construction activities outside. The greatest potential for noise disturbance to roosting bats is likely to arise during activities directly affecting roost structures, or those within 20m of retained roosts (based on the recommended buffer zones for forestry work [RD72]). Noise generating activities would vary spatially and temporally and so roost structures would not be subject to constant above-baseline levels of noise for the entire period of Main Construction. There is published research indicating studies have not found any correlation of effects between limiting noise outputs and the activity of bats at roosts or in important habitats [RD73]. It has therefore not been attempted to assign threshold levels above which disturbance is predicted.

9.5.310 Main Construction works would largely be restricted to daytime activities, which would avoid the sensitive emergence and re-entry times for bats using retained roosts. Daytime works would also avoid disturbance during foraging periods when increased noise levels may affect foraging efficiency. However, night time construction activities are proposed, with some of the worst case predicted noise levels arising at night (e.g. 75dB $L_{Aeq,1\text{-}hour}$ at Tyn-y-Maes bat barn between April and June 2027).

9.5.311 Blasting events would be designed to meet the blasting vibration limits set out in appendix B6-2 (Application Reference Number: 6.2.21), and which would be included in the Wylfa Newydd CoCP and Main Power Station Site sub-CoCP (Application Reference Numbers 8.6 and 8.7 respectively). These state vibration levels shall not exceed 6mm/s peak particle velocity (PPV) for 95% of blasting events in any six-month period, and that vibration levels from any single event shall not exceed 100mm/s PPV.

9.5.312 Blasting has the potential to lead to vibration effects at the Tyn-y-Maes bat barn. There is limited published information on the potential disturbance effects of vibration on bats. A study by URS [RD74] on bats hibernating in a quarry site quotes reports which found that vibration levels up to 13.97mm/s did not have an effect on cave-dwelling hibernating bats, and other studies

have found that PPV of less than 6mm/s have no effect on bats hibernating in caves. It is therefore considered that 95% of blasting events would not affect bats roosting at the Tyn-y-Maes bat barn, and when 6mm/s is exceeded, effects would be short-term, temporary and negligible.

9.5.313 Good practice mitigation would be applied to mitigate effects of noise disturbance during Main Construction works. Primarily this would include the provision of appropriate work exclusion zones around existing roosts, thereby restricting noise and vibration effects. The exclusion zones, determined through discussion with the ECoW, would be in place at the commencement of construction, and would be designed to provide the maximum protection possible.

9.5.314 Good practice guidelines with respect to noise control would also be adhered to during construction, as outlined in chapter D6 (Application Reference Number: 6.4.6).

9.5.315 Lighting can have both positive and negative effects upon bats, depending on species. Delays to bat emergence from roosts are likely if roost exits are lit, reducing the period available for foraging [RD75]. Artificial lighting can reduce invertebrate assemblages on a site, thus affecting foraging success [RD75]. Conversely, increased lighting can be beneficial for some species of bat (e.g. noctule and pipistrelle) as they forage prey that are attracted to light [RD75]. Lighting also has a high potential for causing many species of bats (particularly broad winged, slow flying species such as long-eared and *Myotis* bats) to avoid the lit area, potentially resulting in losses of foraging and/or roosting habitats.

9.5.316 Main Construction would require temporary lighting, although much of this would not be installed until after the removal of surface vegetation (e.g. hedgerows, trees) and walls; these are the features that are primarily used by foraging bats within the Wylfa Newydd Development Area. As such, most foraging and commuting bats are expected to have been displaced from the works area by the time that most construction related lighting is introduced.

9.5.317 Within the field survey study area, bat activity hotspots were identified around the Tre'r Gof SSSI and plantation; the existing Visitor Centre; Cemlyn Road; Cestyll Gardens; Cafnan Farm; Tyddyn Gele; the two Community woodlands within Cemaes; and Foel Fawr Farm. These hot-spots were associated with the presence of trees and linear features. Dark corridors would be maintained that allow bats roosting at the retained Tyn-y-Maes bat barn to access foraging habitat at Dame Sylvia Crowe's Mound and the Tre'r Gof SSSI; this will be achieved through the retention of a 10m wide buffer strip within which no works would be permissible without additional risk assessment and method statements, and measures to reduce light spill, as per the provisions of the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7). These buffer strips would be fenced appropriately to demarcate areas during construction.

9.5.318 Based on the above, the magnitude of change is expected to be small and so a minor adverse effect is predicted as a result of disturbance, although this would be reduced through the provision of additional mitigation (see section 9.6).

Otter

9.5.319 The baseline shows that otter use both freshwater and marine systems in the field survey and desk study areas. In both environments, only evidence of foraging and commuting has been recorded. The potential effects on otter, therefore, exclude mortality and injury as there would not be any excavation of a known holt or laying-up site, and subsequent risk to individual adults or their young (see appendix D9-6, Application Reference Number 6.4.39). Pre-construction surveys would be undertaken to identify any changes to the baseline situation.

9.5.320 Potentially significant effects on otter during the construction phase have been identified via the following pathways:

- habitat loss, fragmentation or modification;
- hydrological changes; and
- disturbance (noise and lighting).

Habitat loss, fragmentation or modification

9.5.321 Riparian habitat loss for foraging and commuting otter would be limited to the approximately 400m long section of Nant Caerdegog Isaf (watercourse 13) that would be realigned and 200m of the Nant Porth-y-pistyll (watercourse 6) that would be lost to the footprint of a sediment pond. Realignment of the section of Nant Caerdegog Isaf would be prior to the loss of the existing watercourse channel, so there would be no net loss or fragmentation of habitat.

9.5.322 No otter field signs were identified on the Nant Porth-y-pistyll, which is a short watercourse that does not link up with other watercourses and thus the loss of this habitat is considered to be negligible.

9.5.323 Construction would also affect intertidal habitats, especially those at Porth-y-pistyll. Construction of the Cooling Water System, breakwaters, and Marine Off-loading Facility (MOLF) would all result in the loss of rocky intertidal habitats likely to be used by foraging and commuting otter.

9.5.324 Otter make use of terrestrial habitats, although there is no baseline evidence to suggest that this commonly occurs within the field survey study area. However, the removal of linear terrestrial features, such as hedgerows and drystone walls, could further the effects of fragmentation.

9.5.325 Although Main Construction would affect habitats utilised by foraging and commuting otters, these animals would still be able to access ‘core’ habitats within the local landscape, specifically Cemlyn Lagoon and the Afon Cafnan (Watercourse 10 and 12). Although most of the habitats within the Wylfa Newydd Development Area would be heavily modified during the construction period, they would be permeable to otter movements, especially along the riparian buffer zones described above.

9.5.326 The proposed temporary bridge crossing of the Afon Cafnan (Watercourse 10) would be a clear span bridge design, thereby ensuring no fragmentation of otter habitat in this location during its installation and operation. Security fencing would not cross watercourses and so would be porous to otter

movement. No culverts of watercourses with otter records are proposed. All permanent culverts to be installed would also allow for the safe passage of otter by being an appropriate diameter and through the provision of mammal ledges designed in line with good practice guidelines (e.g. the *Design Manual for Roads and Bridges* [RD76]). No habitat loss or fragmentation of otter habitat via the installation of culverts is anticipated.

9.5.327 Otter are highly mobile species and would be expected to navigate their way around localised barriers, especially given these do not also present a high risk of mortality (such would be the case with a new road, for example). Good practice mitigation in the form of buffer zones around the Nant Cemlyn, Nant Cemaes, Afon Cafnan, Nant Caerdegog Isaf and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI would also reduce the effects of fragmentation.

9.5.328 Good practice mitigation through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would also seek to avoid long-term loss of terrestrial and freshwater habitat, although intertidal habitat loss would be permanent.

9.5.329 Given the above, the magnitude of change is predicted to be small and so a negligible adverse effect is predicted.

Hydrological change

9.5.330 Habitat degradation is a potential effect in areas where waterbodies used by otter are in close proximity to, or have hydrological connectivity with, construction work areas. These include Cemlyn Bay lagoon, the Nant Caerdegog Isaf (Watercourse 13), the Nant Cemaes (Watercourse 3) and the Afon Cafnan (Watercourse 12) (see appendix D9-6, Application Reference Number 6.4.39). Degradation effects would potentially include smothering of riparian habitats by sediment-laden runoff, and a reduction in water quality (e.g. arising from pollution events or changes in turbidity).

9.5.331 However, good practice mitigation is proposed to adequately protect retained waterbodies (see chapter D8, Application Reference Number: 6.4.8). This would include the implementation of 15m buffer zones to protect the Nant Cemlyn, Afon Cafnan, Nant Caerdegog Isaf, Nant Cemaes, and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI, and adherence to good practice measures with respect to pollution prevention.

9.5.332 Additionally, embedded mitigation in the form of a Surface Water and Groundwater Management Strategy and the Environmental Emergency Management Strategy, both contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) would adequately protect the water quality of foraging habitats at Cemlyn Bay, the Tre'r Gof SSSI and the marine environment so that these areas remain suitable for foraging otter (see chapter D8, Application Reference Number: 6.4.8).

9.5.333 Based on the implementation of embedded and good practice mitigation, the magnitude of change is predicted to be negligible and so the effects of hydrological change would be negligible.

Disturbance

9.5.334 Disturbance effects could be caused by noise, an increased human presence near to watercourses used by the species, and lighting. As no holts or lay-up sites have been identified within the Wylfa Newydd Development it is considered that the risk of disturbance to otter is minimal.

9.5.335 With good practice mitigation in the form of buffer zones around the Nant Cemlyn, Nant Cemaes, Afon Cafnan, Nant Caerdegog Isaf and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI (detailed in chapter D8, Application Reference Number: 6.4.8), the magnitude of change is predicted to be negligible and so negligible effects would arise.

Water vole

9.5.336 Potentially significant effects on water vole have been identified via the following pathways:

- mortality and injury;
- habitat loss, fragmentation or modification;
- hydrological change; and
- disturbance.

Mortality and injury

9.5.337 Mortality and injury to water vole could occur during the backfilling of Nant Caerdegog Isaf (Watercourse 13). Good practice mitigation in the form of a trapping and translocation exercise would therefore be required, completed under a conservation licence (appendix D9-19, Application Reference Number: 6.4.52).

9.5.338 The proposed temporary bridge crossing of the Afon Cafnan (Watercourse 10) would be a clear span bridge design thereby ensuring no direct effects to the banks. Micro-siting of the bridge would seek to avoid any areas of the Afon Cafnan with active water vole burrows. The same approach would be adopted for the positioning of drainage outfalls. If pre-construction surveys indicate that good practice mitigation in the form of trapping and translocation and/or habitat manipulation were required at other locations, a conservation licence would be sought from NRW with the mitigation strategy designed in accordance with good practice guidelines [RD33].

9.5.339 The above good practice and embedded mitigation would see a negligible magnitude of change and so effects of mortality and injury would be negligible.

Habitat loss, fragmentation or modification

9.5.340 Habitat loss and fragmentation could occur as a result of the backfilling of a section of the Nant Caerdegog Isaf (Watercourse 13) (see figure D9-6. Application Reference Number: 6.4.101). By programming the realignment works approximately 12 months in advance of the backfilling of this watercourse, vegetation would be established within the realigned section prior to its connection. As such, water vole would be translocated into the new section directly from the section to be backfilled and so habitat loss and

fragmentation effects would not occur as a result of the realignment. The habitat would be modified but, as described in chapter D8 (Application Reference Number: 6.4.8), the new section of watercourse would be enhanced with improved sinuosity and enhanced bankside vegetation, resulting in a negligible effect.

9.5.341 No other activities directly affecting watercourses currently supporting water vole (i.e. Afon Cafnan (Watercourses 10 and 19), Nant Caerdegog Isaf (Watercourse 13), and Watercourse 15, see appendix D9-6, Application Reference Number 6.4.39) are proposed.

9.5.342 A 200m section of the Nant Porth-y-pistyll (Watercourse 6) would be lost to the footprint of a sediment pond. No water vole signs were identified on this watercourse and the loss of this habitat is considered unlikely to affect water vole.

9.5.343 Habitat loss and fragmentation could occur during installation of temporary or permanent infrastructure. Security fencing would not cross watercourses and so there would be no loss of riparian habitat or fragmentation effects from this activity. It is not proposed to install culverts into watercourses with water vole records and so no habitat loss or fragmentation of water vole habitat as a result of this activity would arise. Temporary bridges and culverts would be installed over the Nant Cemlyn but these would be micro-sited to avoid burrows and suitable water vole habitat.

9.5.344 In the medium and long-term, habitat creation associated with the Landscape and Habitat Management Strategy (Application Reference Number: 8.16), and the 15m wide buffer strips along the Nant Cemlyn, Afon Cafnan, Nant Caerdegog Isaf, Nant Cemaes, and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI, would benefit water vole by promoting the growth of riparian vegetation and reducing the effects of grazing and poaching by livestock.

9.5.345 A negligible magnitude of change is predicted and so effects of habitat loss, fragmentation or modification would be negligible.

Hydrological change

9.5.346 Habitat degradation of watercourses currently supporting water vole could arise e.g. from pollution events, smothering of riparian habitat.

9.5.347 Good practice mitigation is proposed to adequately protect retained waterbodies (see chapter D8, Application Reference Number: 6.4.8); this would include the implementation of 15m buffer zones to protect the Nant Cemlyn, Afon Cafnan, Nant Caerdegog Isaf, Nant Cemaes, and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI, and adherence to good practice measures with respect to pollution prevention i.e. adherence to PPGs.

9.5.348 A negligible magnitude of change is predicted and so effects of hydrological change would be negligible.

Disturbance

9.5.349 Realignment of Nant Caerdegog Isaf (Watercourse 13) could lead to disturbance effects on water vole, as the existing section would be filled in and the new section would be tied into the retained watercourse.

9.5.350 Good practice mitigation in the form of water vole translocation would remove animals from affected areas. This mitigation would be completed under a conservation licence from NRW, as outlined in appendix D9-19 (Application Reference Number: 6.4.52).

9.5.351 Good practice mitigation in the form of 15m buffer zones would be applied from watercourses where water vole have been previously recorded i.e. the Nant Cemlyn, Nant Cemaes, and drains into the Cae Gwyn SSSI.

9.5.352 A negligible magnitude of change is predicted and so effects of disturbance would be negligible.

Red squirrel

9.5.353 Potentially significant effects on red squirrel have been identified via the following pathways:

- mortality and injury;
- habitat loss and fragmentation; and
- disturbance (noise and vibration and visual).

Mortality and injury

9.5.354 Red squirrels are most likely to be affected by mortality and injury if they are in dreys when trees are felled during works, but due to the small numbers of animals estimated to be present, the likelihood of this occurring is considered to be low.

9.5.355 However, to adequately protect red squirrels from mortality and injury, good practice mitigation in the form of pre-construction surveys, supervision of works by an ECoW and timing of works to avoid the period when dependant young may be present (February to September), would be undertaken as outlined in section 9.4, and in the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

9.5.356 Taken together, these would result in a negligible magnitude of change and so negligible effects would arise.

Habitat loss and fragmentation

9.5.357 The clearance of plantation woodland would result in the loss of approximately 3ha of habitat suitable for red squirrel, although 10.5ha of plantation woodland on Dame Sylvia Crowe's Mound (including where an active drey was recorded) would be retained. The connectivity between the retained plantation woodland and habitats outside the Wylfa Newydd Development Area would be reduced as vegetation clearance would isolate the woodland.

9.5.358 Compensation for the loss of woodland habitats would be provided in the long-term by creating new areas of planted woodland (approximately 22ha) and the enhancement of retained habitats through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). Areas of woodland would be planted as early as possible following bulk earthworks and would provide a near-continuous belt around the south of the

proposed Power Station and would connect to habitats in the wider landscape. Field boundaries and hedgerows would also be reinstated or established to provide connectivity between the retained woodland on Dame Sylvia Crowe's Mound, new woodland planting, and the wider landscape.

9.5.359 The magnitude of change is considered to be small as there would be partial loss of the habitat resource. A negligible adverse effect is predicted although this would not prevent red squirrel from occupying the Wylfa Newydd Development Area in the long-term. Additional mitigation is proposed in section 9.6.

Disturbance

9.5.360 Red squirrels are vulnerable to disturbance during their breeding season.

9.5.361 The area of retained plantation woodland on Dame Sylvia Crowe's Mound would be surrounded by Main Construction works. There is therefore the potential for disturbance effects in the form of noise and vibration, and from people and vehicular movements. The degree to which the colonising red squirrel population would become habituated to disturbance is difficult to predict, as there is no historical context available against which to measure change.

9.5.362 Disturbance to red squirrel would be mitigated through adherence to good practice guidelines with respect to noise minimisation (see chapter D6, Application Reference Number: 6.4.6). Pre-construction surveys would also identify the requirement for additional mitigation based on the distribution of red squirrel at the time of construction.

9.5.363 A small magnitude of change is predicted and so the effects of disturbance are assessed as being minor adverse, although this would be reduced through additional mitigation (see section 9.6).

Notable mammals (brown hare, hedgehog and polecat)

9.5.364 Potentially significant effects on brown hare, hedgehog and polecat have been identified via the following pathways:

- mortality and injury of species;
- habitat loss and fragmentation; and
- disturbance (noise and lighting).

Mortality and injury

9.5.365 Mortality and injury of species within the Wylfa Newydd Development Area could occur where features with the potential to support nests, burrows or covers are removed, e.g. cloddiau, around existing and demolished buildings and long-grass habitats.

9.5.366 Good practice mitigation in the form of the provision of an ECoW and timing of works to avoid periods where there is the potential for dependent young to be present would therefore be applied (see section 9.4).

9.5.367 Fencing around the Wylfa Newydd Development Area would allow animals to escape via gaps left for Public Rights of Way and vehicular access.

9.5.368 With these measures in place, a negligible magnitude of change is predicted and so negligible effects would arise due to mortality and injury.

Habitat loss and fragmentation

9.5.369 The removal of all habitats within the Wylfa Newydd Development Area (excluding buffer zones) is considered likely to have the greatest effect on these notable mammal species. Habitat loss would result in the populations being displaced into adjacent areas of suitable habitat. Whilst suitable habitat is abundant in the wider area, it is considered that there could be some pressure on resource availability in the short-term. This could cause a small magnitude of change for brown hare and polecat owing to the mobility of these species.

9.5.370 The effects of displacing a population of hedgehogs are considered to constitute a greater effect due to the species' vulnerability to land use change and their loyalty to home ranges [RD77]. A displaced population is also potentially at greater risk of mortality and injury from traffic, as animals establish new home ranges and search for hibernation sites.

9.5.371 Fragmentation effects are possible due to the isolation of Wylfa Head and the plantation woodland habitats on Dame Sylvia Crowe's Mound from the wider environment because of habitat removal. This effect is not predicted for brown hare as there are no records of the species from these areas. For polecat, fragmentation effects would be negligible, as despite connecting habitats being removed, the effects would potentially only impact a very small number of animals.

9.5.372 The total area covered by Dame Sylvia Crowe's Mound and Wylfa Head is 26ha. Should hedgehog be present in this area at average densities of between 0.3 and two per hectare, there could be between eight and 13 hedgehogs present (appendix D9-15, Application Reference Number: 6.4.48). This is below the 120 individuals recommended by Moorehouse (2013) [RD78] as being the minimum value for a viable population in rural environments. Fragmentation effects could therefore cause temporary extinction of hedgehog from Dame Sylvia Crowe's Mound and Wylfa Head. This would be due to reduced access to food resources, as well as reduced recruitment into the area. The lack of recruitment could cause difficulties in finding mates and a reduction in gene flow, both of which have been shown to negatively affect the species [RD79]. Isolation of this habitat would therefore represent a large magnitude of change as the integrity of the habitat resource would be temporarily affected.

9.5.373 Habitat removal would be mitigated for in the medium to long-term by the provision of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16), which would lead to the creation or reinstatement of enhanced new habitat that has connectivity to the wider landscape e.g. 20ha of woodland and 10km of hedgerow. Improved grassland, species-rich grassland and coastal heath/grass mosaic would be of value for foraging hedgehog due to the invertebrate assemblages likely to be supported by these

habitats. Woodland, stone-walls, and hedgerows would also benefit foraging or sheltering notable species.

9.5.374 Taken together, habitat loss, fragmentation and isolation on notable mammals would result in a small magnitude of change and so a negligible adverse effect is predicted.

Disturbance

9.5.375 Disturbance effects on notable mammals would only occur to retained habitats in the Wylfa Newydd Development Area and immediately adjacent areas.

9.5.376 Brown hare and polecat are highly mobile and may avoid habitats on the boundary of the Wylfa Newydd Development Area, but this effect would be lessened based on the abundance of similar habitat in the wider landscape. Hedgehog is less mobile but as a species that is regularly encountered in urban environments in close proximity to human activity, the species is considered to be reasonably tolerant of noise and lighting.

9.5.377 Good practice mitigation in the form of buffer zones would reduce the effects of noise and visual disturbance affecting retained habitats within the Wylfa Newydd Development Area that may be used by notable mammals e.g. Dame Sylvia Crowe's Mound, the Tre'r Gof SSSI, and riparian habitats. Good practice mitigation measures with respect to noise reductions would further reduce the effects of disturbance (see chapter D6, Application Reference Number: 6.4.6).

9.5.378 Temporary lighting may also affect the use of illuminated habitats by notable mammals during the night. This may reduce the effectiveness of retained habitats acting as buffer zones or dispersal routes throughout of the Wylfa Newydd Development Area.

9.5.379 The magnitude of change is predicted to be small and so the effects of disturbance would be minor. Additional mitigation with respect to disturbance from lighting is described in section 9.6.

Freshwater habitats

9.5.380 The main effects on freshwater habitats would occur as a result of bulk earthworks, topsoil clearance and watercourse realignment, installation of drainage, excavation of culverts and installation (and removal) of cofferdams around outfall sites. Potential pathways to significant effects are therefore considered to be:

- habitat loss and fragmentation;
- hydrological changes; and
- introduction and spread of INNS.

Habitat loss and fragmentation

9.5.381 Prior to topsoil clearance, site drainage would be installed including construction of sediment settlement ponds and associated outfalls into watercourses. A sediment settlement pond is proposed within the footprint of

the Nant Porth-y-pistyll (the Power Station Catchment). During creation of the pond, approximately 200m of low-quality riverine habitat would be lost.

9.5.382 During topsoil stripping and other earthworks activities, nine ponds would be permanently lost during Main Construction. The realignment of approximately 400m of Nant Caerdegog Isaf would also occur.

9.5.383 Vegetation clearance would involve the controlled displacement of species along approximately 300m of ephemeral ditch habitat running between Rhwng dau Fynydd and the Afon Cafnan.

9.5.384 There would be several discharge points for the surface water drainage that would discharge into freshwater habitats at the Afon Cafnan, the Nant Cemaes, the Nant Cemlyn, Tre'r Gof drains on the west side of the SSSI, and the Nant Caerdegog Isaf. Localised habitat loss under the footprint of the newly constructed outfalls, and changes to instream habitat, as a result of hydrological changes within the vicinity of the outfalls are predicted.

9.5.385 Good practice mitigation for the loss of habitat is included within the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) which has been developed to include new ponds as well as riparian planting around the proposed watercourse diversion.

9.5.386 Good practice mitigation also includes 15m buffer zones around specific retained watercourses (Nant Cemlyn, Afon Cafnan, Nant Caerdegog Isaf, Nant Cemaes, and drains into the Cae Gwyn SSSI and the Tre'r Gof SSSI). Where 15m is not practicable, a reduced buffer zone may be required or work completed using a site-specific risk assessment and method statement approach (e.g. during the realignment of the Nant Caerdegog Isaf or where drainage infrastructure would be installed into these watercourses).

9.5.387 With mitigation in place, Main Construction activities are predicted to result in a negligible magnitude of change and so effects of habitat loss and fragmentation would be negligible.

Hydrological changes

9.5.388 The main potential effects on freshwater habitats during Main Construction via hydrological changes would result from bulk earthworks, installation of drainage, topsoil clearance, the realignment of Nant Caerdegog Isaf, excavation of culverts, and installation (and removal) of cofferdams around outfall sites.

9.5.389 Modification of channels during the watercourse realignment may change the natural hydrology of the watercourse within the upstream and downstream tie-in points as well as the realigned channel. This has the potential to disrupt natural sedimentation processes, and natural transport and accretion of bed and bank material downstream.

9.5.390 Freshwater habitats may be affected by sediments mobilised during topsoil clearance. Sediment may enter nearby watercourses and be transported as fine sediments downstream, affecting the natural diversity and function of coarse substrates, and reducing habitat suitability for other aquatic receptors. An increase in sedimentation can influence stream processes and thereby instream freshwater habitat. All sediment releases, including those associated

with runoff would be mitigated through embedded mitigation including an appropriate drainage design, incorporating a system of sediment settlement ponds and treatment with polyelectrolytes.

9.5.391 Changes to the volume of water discharged into the watercourses are possible. Changes to fluvial geomorphology and surface water conditions are discussed in chapter D8 (Application Reference Number: 6.4.8). The watercourse diversion would result in a channel with increased sinuosity leading to a greater diversity of flow conditions with subsequent improvement in habitat quality.

9.5.392 The Main Power Station Site sub-CoCP (Application Reference Number: 8.7) includes good practice mitigation in the form of buffer zones (Ecology and Landscape Management Strategy), and adherence to good practice mitigation measures with respect to pollution prevention (Surface Water and Groundwater Management Strategy) and dust suppression (Air Quality Management Strategy). See also section 9.5 and chapters D5 and D8 (Application Reference Numbers 6.4.5 and 6.4.8).

9.5.393 Based on the implementation of good practice mitigation, construction is predicted to result in negligible magnitude of hydrological change and therefore a negligible effect on freshwater habitats.

Introduction and spread of INNS

9.5.394 There is also the potential for the introduction and spread of INNS into freshwater habitats. The potential for the introduction and spread of INNS would be reduced by the good practice mitigation measures included in the Biosecurity Risk Assessment and Method Statement (contained in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)), and effects are assessed to be of negligible magnitude and therefore negligible effect.

Macroinvertebrates

9.5.395 The main potential effects on macroinvertebrates during Main Construction works would result from activities including bulk earthworks, the realignment of the Nant Caerdegog Isaf, installation of drainage, excavation of culverts, and installation (and removal) of cofferdams around outfall sites. Potential pathways for significant effects to macroinvertebrate species are considered to be:

- mortality and injury of species;
- habitat loss or fragmentation; and
- hydrological changes.

Mortality and injury

9.5.396 During the watercourse diversion, sessile macroinvertebrates within the original channel of the watercourse diversion would be lost, though communities are expected to quickly re-colonise the realigned channel through downstream drift following the diversion. No taxa of high conservation value were identified near the watercourse realignment site. The potential for

an effect on general macroinvertebrate populations is low, with a negligible magnitude of change predicted and therefore a negligible effect.

9.5.397 The loss of nine ponds, including two that meet Priority pond status (Tregele Pond and Power Station Pond), would occur during the installation of drainage, topsoil clearance and vegetation removal. Without additional mitigation (see section 9.6), macroinvertebrates of conservation interest (minute moss beetle and mud snail) within these water features would be lost and so there is the potential for a large magnitude of change resulting in a moderate effect through mortality.

Habitat loss or fragmentation

9.5.398 Good practice mitigation for the loss of habitat would be included as part of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) and would involve both pond habitat creation, and habitat enhancement, such as the establishment of buffer zones and riparian planting.

9.5.399 As such, a small magnitude of change and minor adverse effect are predicted.

Hydrological changes

9.5.400 During vegetation and topsoil clearance, there would be the potential for the release of pollutants into watercourses as a result of site runoff and accidental spills. Sedimentation may smother habitats and individuals. Increased sediment loading may also result in reduced primary production rates of algae and macrophyte species due to decreased light penetration.

9.5.401 The potential effects of fine silt on retained water bodies are discussed in chapter D8 (Application Reference Number: 6.4.8). All sediment releases, including those associated with runoff, would be mitigated through embedded and good practice mitigation including buffer zones, adherence to PPGs and a drainage design incorporating a system of sediment settlement ponds and polyelectrolyte treatment (see chapter D8 Application Reference Number: 6.4.8 and section 9.4 of this document). Changes to water quality conditions at the sediment settlement ponds discharge points may result in localised changes to the macroinvertebrate community structures within the vicinity of the outfall.

9.5.402 The inclusion of embedded and good practice mitigation is likely to result in a negligible magnitude of change and therefore effects of hydrological change would be negligible.

Freshwater fish

9.5.403 The effects on freshwater fish during Main Construction would result from bulk earthworks, topsoil clearance, the realignment of Nant Caerdegog Isaf, installation of drainage, excavation of culverts and installation (and removal) of cofferdams around outfall sites. Potentially significant effects on freshwater fish within the Wylfa Newydd Development Area have been identified via the following pathways:

- mortality and injury of species;
- habitat loss or habitat fragmentation;

- hydrological changes; and
- disturbance.

Mortality and injury

9.5.404 Approximately 200m of riverine habitat supporting a small population of European eel would be lost from Nant Porth-y-pistyll, adjacent to the Existing Power Station. The upper reach of the watercourse is culverted with the lower 200m of open channel flowing into Porth-y-pistyll. During the watercourse realignment, fish may be at risk from mortality and injury associated with dewatering.

9.5.405 Good practice mitigation, in the form of fish rescues, reduces the potential for fish mortality within the watercourse to a negligible magnitude of change and therefore a negligible effect.

Habitat loss or fragmentation

9.5.406 Habitat fragmentation would result from hydrological changes (see below) reducing connectivity between habitats or an increase in instream barriers, for example culverts.

9.5.407 Good practice mitigation in the form of buffer zones and the avoidance of works within known migratory periods would ensure that the effects of habitat loss and fragmentation are reduced.

9.5.408 However, the installation of outfalls and changes in flow conditions as a result of site drainage (refer to chapter D8, Application Reference Number: 6.4.8) may result in small magnitude changes and so minor adverse effects are predicted.

Hydrological changes

9.5.409 Accidental release of pollutants through spills or leaks may include but is not limited to, fuel and oil from plant and fine sediment release. The organic constituents of runoff may include vehicle fuel and oil, other hydrocarbons, herbicides and pesticides, all of which cause deleterious effects to fish. Immiscible fuel and oil present a direct threat of mortality to fish by coating gill structures. Suspended solids from an increase in sedimentation could prevent the successful development of fish eggs and larvae, and affect respiration through the clogging of gills and the smothering of food sources.

9.5.410 Hydrological changes could also result in habitat loss or fragmentation affecting sensitive receptors.

9.5.411 Potential changes in water quality would be controlled through embedded and good practice mitigation, such as the development of the drainage design and adherence to PPGs.

9.5.412 The potential magnitude of hydrological change is predicted to be negligible, therefore the predicted effect will be negligible.

Disturbance

9.5.413 Noise (vibration) emissions have the potential to create a deterrent to fish species, preventing or delaying their migration through a watercourse. Topsoil clearance, vehicle movements, open cutting and excavation activities carried out in the vicinity of a watercourse could generate ground-borne vibrations that might propagate into watercourses. Depending on the frequency and levels of noise, this may have the potential to affect sensitive species (including brown trout and European eel) and at various life stages.

9.5.414 Good practice mitigation includes buffer zones along the specific retained watercourses (as detailed in section 9.4 and chapter D8, Application Reference Number: 6.4.8). Where 15m is not practicable, a reduced buffer zone may be required, or works would be completed under a risk assessment and method statement approach (e.g. where drainage infrastructure is connected to retained watercourses or during the realignment of the Nant Caerdegog Isaf). Disturbance to freshwater fish through noise and vibrations would therefore be limited to localised temporary effects during the watercourse realignment and creation of outfall locations.

9.5.415 The potential magnitude of disturbance is considered to be negligible, leading to a negligible effect.

Operation

Pathways to effects

9.5.416 Terrestrial and freshwater ecology receptors across the Wylfa Newydd Development Area may potentially be affected during operational activities via a number of pathways as outlined below. During the operational period, construction of the spent fuel storage buildings would also take place which could potentially lead to effects upon terrestrial ecology receptors via disturbance pathways and air quality changes.

Mortality and injury of species

9.5.417 Operation of the Cooling Water System may result in entrainment and or impingement of fish receptors that move between the freshwater and marine environments as part of their life-cycle. This would include migratory species that may utilise freshwater habitats, including European eel, brown trout and lamprey species. Potential effects are discussed in chapter D13 (Application Reference Number: 6.4.13).

Habitat loss/gain, fragmentation or modification/degradation

9.5.418 During operation, it is not considered likely that there would be any habitat loss, fragmentation or degradation that could affect terrestrial habitats other than those described below in the hydrological changes section.

Species disturbance (including noise, vibration, visual and light disturbance)

9.5.419 The potential disturbance effects from operation would affect a similar range of receptors as those detailed in the construction effects sections on

disturbance, with effects identified that could principally affect mobile receptors. The provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would become fully established during the operational period, with those species recolonising newly established habitats and becoming habituated to disturbance effects from the operation of the Power Station.

9.5.420 During the construction of the spent fuel storage buildings, there is the potential for qualifying features of designated sites and/or mobile species to be affected by noise, vibration, lighting or visual disturbance in the areas around the construction works to the south-west of the Power Station.

Air quality changes

9.5.421 Changes to air quality during operational activities would be principally associated with the on-site use of combustion plant and machinery and could potentially have an effect on designated sites, terrestrial habitats, freshwater habitats, fungi and lichen. A summary of the possible effects is detailed in chapter D5 (Application Reference Number: 6.4.5).

Hydrological changes (including water quality and quantity)

9.5.422 Hydrological changes are detailed in chapter D8 (Application Reference Number: 6.4.8) and include changes to both water quality and quantity within watercourses and wetland areas.

9.5.423 There is the potential for changes in water quality from accidental spills on site and an increase in road runoff leading to elevated contaminant loads entering watercourses. Contaminants discharged into watercourses can have adverse effects on aquatic and riparian organisms through toxicity and bioaccumulation.

9.5.424 Modification of hydrological regimes could result in changes to wetland habitats, notably within the Tre'r Gof SSSI and the Cae Gwyn SSSI.

9.5.425 Changes to the quantity of flow could potentially alter in-stream habitat within a channel making it less suitable for certain receptors.

Receptor-based assessment

9.5.426 During the operation of the Power Station there are a number of terrestrial receptors for which no potentially significant effects are anticipated. These receptors are not sensitive to the predicted levels of changes in air quality (see chapter D5, Application Reference Number: 6.4.5) or hydrological changes (see chapter D8, Application Reference Number: 6.4.8) that may occur during operation and are unlikely to suffer disturbance during either the ongoing operation of the Power Station or as a result of construction of the spent fuel storage buildings. No pathways to significant effects are predicted for the following receptors:

- ancient woodland (retained woodland at Manor Gardens);
- terrestrial habitats (excluding specified designated sites);
- lichen;

- terrestrial invertebrates;
- GCN;
- common toad;
- adder and common lizard;
- red squirrel;
- notable mammals (brown hare, hedgehog and polecat); and
- macroinvertebrates.

9.5.427 Those receptors where pathways to significant effects during operation have been identified are discussed individually below.

Tre'r Gof SSSI

9.5.428 Potentially significant effects on the Tre'r Gof SSSI as a result of operation of the Power Station have been identified via the following pathways:

- air quality changes; and
- hydrological changes.

Air quality changes

9.5.429 Chapter D5 (Application Reference Number: 6.4.5) predicted long-term nitrogen deposition rates at the Tre'r Gof SSSI to increase by 0.8%, the site already experiencing deposition rates above the critical load for this habitat. Using Caporn *et al.* 2016 study [RD50], it is considered that the predicted increase in nitrogen deposition at Tre'r Gof SSSI would potentially result in a less than 1% decrease in total species richness within the site, with a similarly small increase in the coverage of competitive grass and sedge species, and an associated reduction in the less competitive forb species present. Such small predicted changes in species compositon are considered to present a negligible effect on the site.

9.5.430 The potential effects from commissioning testing of the plant associated with the Power Station identified 24-hour mean NO_x levels potentially exceeding critical levels of 75µg/m^3 at the Tre'r Gof SSSI, although the probability of this occurring was 15% (Chapter D5, Application Reference Number: 6.4.5). The frequency of these events occurring is two 24-hour periods within the 60-year lifespan of the Power Station.

9.5.431 The study of Morgan *et al*. [RD52] exposed bryophytes to constant 24-hour concentrations of 65µg/m^3 of NO_x over three weeks, which resulted in the damaging effects they described. It was also observed that the physiological damage which had occurred over this period of constant exposure was reversed following exposure to a similar period of pollution-free (i.e. 0µg/m^3) conditions. However, it is acknowledged that the study did not investigate the effects of exposure to higher concentrations of NO_x, in particular those at the levels predicted at the Tre'r Gof SSSI, and these sites already experience background concentrations of NO_x, albeit relatively low concentrations which are well below the critical level. However, the study does show that physiological change as a result of NO_x exposure can reverse once levels decline, demonstrating that any effects that were felt as a result of the 24-hour

concentration levels are unlikely to be permanent, especially when the short-term nature of the exposure is considered.

9.5.432 Given the infrequency of commissioning testing, the brief (24-hour) period during which the highest levels of NO_x could be experienced, and the relatively low probability of exceedance at the Tre'r Gof SSSI, it is considered unlikely that bryophyte assemblages at this site would experience long-term negative effects as a result of NO_x emissions during commissioning testing. As background concentrations at the Tre'r Gof SSSI are well below the critical level, if there were negative effects then bryophytes would be expected to recover between commissioning tests.

9.5.433 Chapter D5 (Application Reference Number: 6.4.5) assesses the potential short-term effects for the use of the standby generators in an emergency situation (referred to as loss of off-site power (LOOP) and loss of coolant accident (LOCA) scenarios). This would require all emergency and back-up generators to operate for at least a period of two hours after which some may shut down. The occurrence of a LOOP or LOCA event which would extend to 24 hours is predicted to be a one in 200-year event, and as such it is not considered further in this assessment.

9.5.434 Chapter D5 (Application Reference Number: 6.4.5), also considers the Mobile Emergency Equipment Garage (MEEG) mobile plant testing scenario, which indicates that there would potentially be exceedances of the 24 hour mean critical level for NOx at Tre'r Gof SSSI. However, the MEEG testing scenario has been modelled conservatively and the predicted concentrations would be considerably lower than presented in chapter D5 (Application Reference Number: 6.4.5). The modelling assumes that the largest plant item (14.5MWth) runs continuously, whereas in reality the thermal inputs of the sources being testing vary between 0.5MWth to 14.5MWth. There are also approximately 45 individual plant items associated with the MEEG testing, and it is anticipated that maintenance testing of the plant would take place once a month with each item of plant being tested for approximately five minutes. The MEEG testing and associated emissions of pollutants to air would therefore have a duration of approximately 3.75 hours in any 24-hour period.

9.5.435 The MEEG testing scenario has been modelled with testing occurring continuously throughout the year (i.e. 24 hours per day, 365/366 days per year) using 10 years of meteorological data where the highest concentration of any 24-hour period was selected. As the MEEG testing would only occur for 3.75 hours in any day, the maximum 24-hour mean concentrations predicted would be considerably less (i.e. approximately 84% lower) than those presented in chapter D5 (Application Reference Number: 6.4.5). Given the conservative modelling approach, exceedances of the 24-hour mean critical level for NOx are not likely to occur, and it is therefore not considered further in this assessment.

9.5.436 Based on the above assessments, it is predicted that the long-term changes in air quality would lead to a very minor loss of, or detrimental alteration to the site's interest features, representing a negligible magnitude of change and a negligible adverse effect.

Hydrological changes

9.5.437 The hydrological assessment in chapter D8 (Application Reference Number: 6.4.8) has assessed the effects of changes to water quantity and quality to the Tre'r Gof SSSI during the operational period. Based on the conclusions of chapter D8 (Application Reference Number: 6.4.8), the activities or changes that would potentially result in a minor magnitude of change or greater are discussed in this section.

9.5.438 The assessment has identified that a medium magnitude of change would arise due to a reduction in water availability caused by a reduction in the catchment area owing to the presence of landscape mounding and drainage. This in turn could affect water quality within the SSSI. The effects of changes to water quantity and quality during operation would be consistent with those for construction, as described in section 9.5, and a similar level of uncertainty around the mitigation design would still exist.

9.5.439 As such, taking a precautionary approach, it is not possible to confidently predict a magnitude of change less than large over the long-term, which would result in a major adverse effect.

Cae Gwyn SSSI

9.5.440 Potentially significant effects on the Cae Gwyn SSSI as a result of operation of the Power Station have been identified via the following pathways:

- air quality changes; and
- hydrological changes.

Air quality changes

9.5.441 The air quality assessment in chapter D5 (Application Reference Number: 6.4.5) shows that the Cae Gwyn SSSI would not be subject to an exceedance in critical loads or critical levels above the threshold at which significant effects could arise.

9.5.442 The potential effects from commissioning testing of the plant associated with the Power Station identified 24-hour mean NO_x levels potentially exceeding critical levels of 75µg/m^3 at the Cae Gwyn SSSI although the probability of this occurring was 1% (Chapter D5, Application Reference Number: 6.4.5). The frequency of these events occurring is two 24-hour periods within the 60-year lifespan of the Power Station.

9.5.443 Given the infrequency of commissioning testing, the brief (24-hour) period during which the highest levels of NO_x could be experienced, and the relatively low probability of exceedance the Cae Gwyn SSSI, it is considered unlikely that bryophyte assemblages at this site would experience long-term negative effects as a result of NO_x emissions during commissioning testing. As background concentrations at Cae Gwyn SSSI are well below the critical level, if there were negative effects then bryophytes would be expected to recover between commissioning tests.

9.5.444 Based on the above, a negligible magnitude of change leading to negligible effects is predicted.

Hydrological changes

9.5.445 The hydrological assessment in chapter D8 (Application Reference Number: 6.4.8) has assessed the effects of changes to water quantity and quality to the Cae Gwyn SSSI during the operational period. Taking into account the embedded and good practice mitigation measures that would be implemented to protect the SSSI, the assessment in chapter D8 (Application Reference Number: 6.4.8) considers that the magnitude of change would be negligible. As such, effects to the SSSI would also be negligible.

Cemlyn Bay SSSI and Bae Cemlyn/Cemlyn Bay SAC

9.5.446 Potentially significant effects on the Cemlyn Bay SSSI/SAC as a result of operation of the Power Station have been identified via the following pathways:

- air quality changes; and
- changes to coastal processes.

Air quality changes

9.5.447 The air quality assessment in chapter D5 (Application Reference Number: 6.4.5) shows that the Cemlyn Bay SSSI/SAC would not be subject to an exceedance in critical loads or critical levels above the threshold at which significant effects could arise. As such, this site is not considered further.

Changes to coastal processes

9.5.448 The coastal processes and geomorphology assessment in chapter D12 (Application Reference Number: 6.4.12) considers the operational effects to the shingle ridge at the Cemlyn Bay SSSI/SAC.

9.5.449 Chapter D12 (Application Reference Number: 6.4.12) considers that small magnitude changes to the shingle ridge may arise but only in the context of increased wave height during a worst case scenario winter storm. The assessment in chapter D12 (Application Reference Number: 6.4.12) also considers that any changes to wave height would be within the range of natural changes predicted due to climate change, and that these changes would be experienced with or without the Power Station.

9.5.450 A small magnitude of change would typically result in minor adverse effects. However, in this instance the likelihood of the predicted change occurring due to operation of the Power Station is sufficiently remote that a conclusion of negligible effects is considered to be appropriate. This conclusion is consistent with the findings of the Shadow HRA Report (Application Reference Number: 5.2).

9.5.451 However, to reflect the uncertainty, geomorphological monitoring is proposed during operation to identify any changes to baseline conditions that could be attributed to the Power Station (see chapter D12. Application Reference Number: 6.4.12).

Statutory and non-statutory designated sites potentially affected by changes to air quality

9.5.452 Several designated sites are located within the air quality study area (15km) associated with operation of the Power Station (see chapter D5, Application Reference Number: 6.4.5). However, the air quality assessment in chapter D5 (Application Reference Number: 6.4.5) shows that no other designated sites would be subject to an exceedance in critical loads or critical levels above the threshold at which significant effects could arise during the operational scenario modelled.

9.5.453 The potential effects from commissioning testing of the plant associated with the Power Station identified 24-hour mean NO_x levels potentially exceeding critical levels of 75µg/m^3 at the Trywn Pencarreg Wildlife Site, although the probability of this occurring was less than 1% (Chapter D5, Application Reference Number: 6.4.5). The frequency of these events occurring is two 24-hour periods within the 60-year lifespan of the Power Station. Given the very low probability, it is not considered that there would be adverse effects to Trwyn Pencarreg Wildlife Site as a result of commissioning testing.

Fungi

9.5.454 As the air quality assessment in chapter D5 (Application Reference Number: 6.4.5) shows, the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site would not be subject to an exceedance in critical loads or critical levels above the threshold at which significant effects could arise. As such, it is concluded that there would be no significant effects to fungi from operational air quality changes.

Chough

9.5.455 Potentially significant effects on chough have been identified via the following pathway:

- disturbance.

9.5.456 In respect of the operation of the Power Station, tolerance of chough to noise and visual disturbance is predicted to be high, based on chough nesting in a building within the Existing Power Station and having adapted to noise associated with its operation.

9.5.457 The results of noise modelling show that noise levels under normal operational conditions would be consistent with the baseline conditions. Noise levels of less than 35dB $L_{Aeq,T}$ are predicted at the historic chough nesting sites and within areas of core foraging habitat (see appendix D9-14, Application Reference Number: 6.4.47) during normal operational conditions. During very rare worst case scenarios when all emergency equipment would be in operation, noise levels at Wylfa Head and within core foraging habitat are temporarily predicted to be between 35dB $L_{Aeq,T}$ and 45dB $L_{Aeq,T}$. Foraging areas on coastal grassland at Trwyn Pencarreg Wildlife Site are predicted to experience temporary worst case noise levels of 50dB $L_{Aeq,T}$ during very rare events. These noise levels would represent a negligible magnitude of change and would result in negligible effects on chough.

9.5.458 Construction of the spent fuel storage buildings is scheduled to commence in year 15 and would take two years to complete. This facility would be located in the south-west corner of the Power Station Site. The closest current chough breeding site is 1.2km away in the Existing Power Station. The current Wylfa Head breeding site is 1.7km away. Given these distances, disturbance to chough at their nest sites or within core foraging habitat would therefore not arise as a result of construction activity.

9.5.459 The spent fuel storage buildings would be screened from possible foraging habitats outwith the Wylfa Newydd Development Area by landscape mounds C, D and E, and so visual and noise disturbance is unlikely to affect non-breeding foraging chough. Good practice mitigation with respect to noise reduction measures would also be implemented during construction.

9.5.460 The magnitude of change to chough due to construction noise is predicted to be negligible. The effects of disturbance are predicted to be negligible.

Breeding birds

9.5.461 Potentially significant effects on breeding birds have been identified via the following pathways:

- disturbance.

9.5.462 An assessment of the noise levels generated during operational conditions is provided in chapter D6 (Application Reference Number: 6.4.6). The results of the noise modelling assessment show that the magnitude of change as a result of normal operational disturbance would be negligible, with the majority of restored or newly created habitats within the Wylfa Newydd Development Area not subject to noise disturbance significantly above baseline levels. Only localised areas immediately adjacent to new Power Station buildings would experience noise levels above 55dB.

9.5.463 Breeding barn owl roosts at Cafnan Farm and Caerdegog Isaf would experience normal operational noise levels of less than 35dB $L_{Aeq,1\text{-}hour}$. During very rare worst case scenarios when all emergency equipment would be in operation, noise levels at these roosts are temporarily predicted to be between 40dB $L_{Aeq,T}$ and 45dB $L_{Aeq,T}$.

9.5.464 These predicted noise levels under normal and worst case conditions would represent a negligible magnitude of change and would result in negligible effects on breeding birds.

9.5.465 Temporary noise disturbance during the construction of the spent fuel storage buildings could adversely affect the survival, range and abundance of certain bird species. Given the availability of suitable habitats beyond the Wylfa Newydd Development Area, disturbance is unlikely to affect birds using habitats close to the location of the spent fuel storage buildings for foraging alone and significant effects are only likely for those species which are breeding in close proximity to the location of the proposed construction works.

9.5.466 Disturbance could also affect barn owls which breed at Cafnan Farm and Caerdegog Isaf. However, both are located further than 100m from the location of the spent fuel storage buildings and would be screened by Mounds D and C, respectively. Breeding barn owls have also demonstrated tolerance

to noise disturbance with owls successfully breeding at Caerdegog Isaf in 2017 despite (third party) works involving the replacement of a building's roof at the site (pers. comm. with Horizon Environmental Coordinators). Any noise disturbance as a result of construction of the spent fuel storage buildings is unlikely to affect the breeding success of this species.

9.5.467 Given the temporary and limited nature of the construction works in respect of the spent fuel storage buildings and the availability of alternative bird breeding and foraging habitats in the wider area, the magnitude of change is predicted to be negligible. The effects on breeding birds are therefore considered to be negligible.

Over-wintering and passage birds

9.5.468 As discussed above, changes associated with operational noise disturbance are expected to be negligible with effects to over-wintering and passage birds also expected to be negligible.

9.5.469 It is assessed that disturbance effects during construction of the spent fuel storage buildings would also be negligible, based on embedded mitigation (landscape mounds) and good practice mitigation (noise reduction measures during construction). The localised and temporary nature of the works would further reduce the magnitude of change.

9.5.470 The effects on over-wintering and passage birds are therefore considered likely to be negligible.

Bats

9.5.471 Potentially significant effects on bats have been identified via the following pathway:

- disturbance.

9.5.472 The results of noise modelling show that the magnitude of change under normal operational conditions would be negligible (chapter D6, Application Reference Number: 6.4.6). The majority of restored or newly created habitats within the Wylfa Newydd Development Area would not be subject to noise disturbance significantly above baseline levels. Under normal conditions, operational noise levels at Tyn-y-Maes bat barn and the new bat barns to the east of the A5025 and the west of Cemaes would be less than 35dB $L_{Aeq,T}$. During very rare worst case scenarios when all emergency equipment would be in operation, noise levels at Tyn-y-Maes bat barn are temporarily predicted to be between 35dB $L_{Aeq,T}$ and 45dB $L_{Aeq,T}$; noise levels during these periods may increase to 55dB $L_{Aeq,T}$ in some localised foraging areas at Dame Sylvia Crowe's Mound. These predicted noise levels under normal and worst case operational conditions would represent a negligible magnitude of change and would result in negligible effects on roosting and foraging bats.

9.5.473 There is potential for operational lighting to disturb roosting, commuting or foraging bats. Embedded mitigation in the form of lighting designed in accordance with the Wylfa Newydd CoOP (Application Reference Number: 8.13) would seek to avoid the illumination of retained or newly

created linear habitats (e.g. hedgerows, walls, woodland edges, treelines) and other high quality foraging areas.

9.5.474 The Tyn-y-Maes bat barn and newly created roosts created as part of the EPSML obtained for construction of the Power Station would remain unlit. Furthermore, due to the heavily wooded area directly between the bat barn and both the Existing Power Station and the Wylfa Newydd Power Station, there would be no lighting visible (see appendix D10-10 Environmental Lighting Impact Assessment, Application Reference Number: 6.4.67).

9.5.475 The Tyn-y-Maes bat barn and the location of the new bat barn that would be delivered as part of the EPSML are located in excess of 1km from the proposed location of the spent fuel storage buildings. Given the distances involved, noise or visual disturbance from construction are not predicted.

9.5.476 The magnitude of change to bats due to operational disturbance is predicted to be negligible. The effects of disturbance are predicted to be negligible.

Otter

9.5.477 Potentially significant effects on otter have been identified via the following pathway:

- hydrological changes during operation and construction of the spent fuel storage buildings.

9.5.478 Otter could be affected, either directly or indirectly, by hydrological changes (as detailed in chapter D8, Application Reference Number: 6.4.8) affecting water quality and quantity within nearby watercourses and wetland areas.

9.5.479 Drainage mitigation during operation would be embedded in the detailed design. An Environmental Emergency Preparedness and Response Procedure would be implemented as part of the Wylfa Newydd CoOP (Application Reference Number: 8.13) which would detail the arrangements and procedures for managing any environmental incidents.

9.5.480 Good practice mitigation would be followed during construction of the spent fuel storage buildings. These measures are anticipated to be consistent with those implemented during Main Construction and so would be adequate to protect watercourses and other habitats of value for otter.

9.5.481 It is considered that this embedded and good practice mitigation would reduce the magnitude of change to negligible and so negligible effects on otter are expected during operation.

Water vole

9.5.482 The assessment for water vole during the operational phase is as for otter, detailed above.

9.5.483 Based on the proposed good practice and embedded mitigation, the magnitude of change would be negligible and so negligible effects on water vole are expected during operation.

Freshwater fish

9.5.484 Potentially significant effects on freshwater fish from operation have been identified via the following pathways:

- mortality and injury of species; and
- hydrological changes during operation and construction of the spent fuel storage buildings.

Mortality and injury

9.5.485 Accidental release of pollutants through spills or leaks may include but is not limited to fuel and oil from plant and fine sediment release. The organic constituents of runoff may include vehicle fuel and oil, other hydrocarbons, herbicides and pesticides, all of which cause deleterious effects to fish. Immiscible fuel and oil may present a direct threat of mortality to fish by coating gill structures.

9.5.486 Potential changes in water quality would be largely controlled through embedded mitigation such as the development of the drainage design, incorporating a system of sediment settlement ponds and oil interceptors. The provisions of the Surface Water and Groundwater Management Strategy and the Environmental Emergency Management Strategy, both contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), would provide mitigation for potential effects on the water environment.

9.5.487 A negligible magnitude of change is predicted and so the effects of mortality and injury would be negligible.

Hydrological changes

9.5.488 Hydrological changes from increased surface water run off may modify natural river process and affect habitat availability to fish species. Changes in flow conditions as a result of site drainage (refer to chapter D8, Application Reference Number: 6.4.8) may result in minor adverse effects caused by habitat loss/fragmentation.

9.5.489 With the inclusion of embedded and good practice mitigation, (as detailed in chapter D8, Application Reference Number: 6.4.8), the magnitude of change is considered to be negligible and effects of hydrological change would be negligible.

Decommissioning

9.5.490 The operational lifetime of the Power Station would be 60 years. During this time, habitat created through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would develop and the ecological baseline of the Wylfa Newydd Development Area would evolve in response to a variety of environmental factors. The effects of decommissioning are therefore uncertain given that the baseline at that time would not necessarily reflect what it is today. The methods of decommissioning, including technologies used, are also uncertain at this time. The environmental changes caused during decommissioning are however

likely to be similar to those identified in the Main Construction assessment. The anticipated pathways to effects are discussed below.

Pathways to effects

Mortality and injury of species

9.5.491 Effects as a result of mortality and injury are likely to be limited given decommissioning would not involve large scale loss of habitats. The potential for direct mortality is likely to be limited to breeding birds using the Power Station buildings and structures for nesting. Such effects could be addressed via standard approaches such as timing of works and ecological supervision, as described for Main Construction.

Habitat loss/gain, fragmentation or modification/degradation

9.5.492 Habitat loss and fragmentation would not occur as decommissioning would involve the demolition of Power Station infrastructure. However, degradation of habitats could occur as a result of changes in air quality and hydrology, including water quality and quantity during demolition works. These impacts and the resulting effects would likely be temporary for the duration of the demolition works and many are likely to be mitigated to non-significant levels through the implementation of well-established good practice measures similar to those that would be adopted during Main Construction.

Species disturbance (including noise, vibration, visual and light disturbance)

9.5.493 Disturbance to sensitive receptors could arise during decommissioning. However, the effects would be partially mitigated by the landscape mounds and associated planting. These features would provide some screening from areas outwith the Wylfa Newydd Development Area. Good practice guidelines consistent with those implemented during Main Construction would also be adopted.

Receptor-based assessment

9.5.494 Potentially significant effects on ecological receptors, identified as valuable in the current baseline, are considered possible for those receptors sensitive to habitat loss, changes in air quality, hydrological changes, and disturbance (via noise, vibration and lighting). These would include:

- Cemlyn Bay SSSI/SAC;
- Tre’r Gof SSSI;
- Cae Gwyn SSSI;
- Trwyn Pencarreg Wildlife Site;
- Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site;
- terrestrial habitats;
- fungi;
- lichen;

- adder and common lizard;
- chough;
- breeding birds;
- over-wintering and passage birds;
- bats;
- otter;
- water vole;
- red squirrel;
- freshwater habitats;
- macroinvertebrates; and
- freshwater fish.

9.5.495 The works required to decommission the Power Station would be subject to a separate EIA which would assess in detail the effects against the baseline conditions at that time.

Transboundary

9.5.496 Following consultation, a recommendation was made in the scoping opinion that "…*consideration should be given in the ES to any likely significant effects on the environment of another Member State of the European Economic Area. In particular, the [IPC] recommends consideration should be given to discharges to the air and sea and to potential impacts on migratory species.*" (see chapter B9, Application Reference Number: 6.2.9).

9.5.497 With respect to terrestrial and freshwater ecology, the pathway for transboundary effects would be through effects to the following receptors:

- breeding and over-wintering bird species; and,
- European eel, river lamprey and brown trout.

9.5.498 Effects on seabirds may also lead to transboundary effects. These are addressed within chapter D13 (Application Reference Number: 6.4.13).

9.5.499 Although both the breeding and over-wintering bird assemblages within the study area have been assigned a value of low, within each assemblage are migratory species and species which form qualifying features of European Designated Sites. Both breeding and over-wintering birds would experience some habitat loss and temporary disturbance during construction, although this is considered to be small in magnitude. Extensive suitable alternative habitat exists immediately surrounding the Wylfa Newydd Development Area and the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) would recreate habitats of value to both breeding and over wintering birds. Disturbance effects would be temporary during construction only and, given the value of the receptor, the effects are considered to be minor adverse. No significant effects from the Wylfa Newydd Project on breeding and over-wintering bird species have been identified and thus it is unlikely that significant transboundary effects would occur. This

conclusion is consistent with the findings of the Shadow HRA Report (Application Reference Number: 5.2).

9.5.500 European eel, river lamprey and sea trout are migratory fish species which move between freshwater and the marine environment during their life cycle. European eel has been recorded in all the main catchments within the desk and field study area. River lamprey and sea trout have been recorded during the marine surveys described in chapter D13 (Application Reference Number: 6.4.13), but not within freshwater watercourses within the Wylfa Newydd Development Area. Given that the potential transboundary effects for these species would occur during their marine migration, this is covered further in chapter D13 (Application Reference Number: 6.4.13).

9.6 Additional mitigation

9.6.1 In accordance with chapter B1 (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to terrestrial and freshwater ecology were taken into account when determining the 'pre-mitigation' significance of effects. These are detailed in the design basis and activities section of this chapter.

9.6.2 Additional mitigation measures would be implemented to address potential significant effects identified in the assessment of effects section. These additional mitigation measures are summarised in tables D9-10, D9-11 and D9-12 for construction, operation and decommissioning, respectively. Additional mitigation would be secured as DCO requirements or through the Wylfa Newydd CoCP (Application Reference Number: 8.6), Main Power Station Site sub-CoCP (Application Reference Number: 8.7), Wylfa Newydd CoOP (Application Reference Number: 8.13) or the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.6.3 All identified adverse effects that are minor or above are presented in table D9-9, including whether additional mitigation is practicable to reduce the significance of effects. The details of all additional measures are then provided. An assessment of the residual effects following implementation of additional mitigation is provided in section 9.7.

Table D9-9 Adverse effects summary

Receptor	Effect	Significance	Additional mitigation possible
Tre'r Gof SSSI	Air quality	Moderate adverse	Yes
	Hydrological changes	Major adverse	Yes
Cemlyn Bay SSSI/SAC	Air quality	Minor adverse	Yes
Cae Gwyn SSSI	Air quality	Minor adverse	Yes
	Hydrological changes	Minor adverse	Yes

Receptor	Effect	Significance	Additional mitigation possible
Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site	Air quality	Moderate adverse	Yes
	Habitat loss, fragmentation or modification	Moderate adverse	Yes
Ancient woodland	Habitat loss (ID 26059 and ID 26075)	Major adverse	Yes
Terrestrial habitats	Habitat loss, fragmentation or modification	Minor adverse	Yes
Fungi	Habitat loss, fragmentation or modification	Moderate adverse	Yes
Lichen	Air quality	Minor adverse	Yes
Terrestrial invertebrates	Mortality and injury	Minor adverse	Yes
	Disturbance	Minor adverse	Yes
Chough	Habitat loss, fragmentation or modification	Moderate adverse	Yes
	Disturbance	Moderate adverse	Yes
Breeding birds	Disturbance	Minor adverse	Yes
Over-wintering and passage birds	Disturbance	Minor adverse	No
Bats	Disturbance	Minor adverse	Yes
Red squirrel	Disturbance	Minor adverse	Yes
Notable mammals	Disturbance	Minor adverse	Yes
Macroinvertebrates	Mortality and injury	Minor adverse	Yes
Freshwater fish	Habitat loss, fragmentation or modification	Minor adverse	No

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Construction

Table D9-10 Additional mitigation measures - construction

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Pre-construction monitoring data would be used during detailed design to refine the drainage system to reduce potential effects on watercourse catchments in the Wylfa Newydd Development Area. Monitoring during Main Construction would enable adaptive management of the drainage system to mitigate any movement away from baseline conditions. This mitigation would be delivered through the Surface Water and Groundwater Management Strategy within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	Reduce sediment loading to sensitive surface water features (i.e. the Tre'r Gof SSSI and the Cae Gwyn SSSI) and prevent deterioration of surface waters (chapter D8, Application Reference Number: 6.4.8).	Sampling of discharge water to check concentrations post-treatment do not significantly exceed baseline water quality levels (chapter D8, Application Reference Number: 6.4.8).
A monitoring regime will be developed for the surface water and groundwater environment at and around the Power Station as appropriate, and to be agreed with the regulator. This will include appropriate monitoring of water quality and quantity (groundwater levels and surface water flows) at and around Tre'r Gof SSSI and Cae Gwyn SSSI to identify any changes to baseline conditions, which may require management. To determine changes in flows in watercourses (including that brought about by groundwater dewatering), monthly monitoring at existing and additional flume locations would be undertaken continuously throughout construction to determine if there is a significant departure from baseline conditions. If there is, then additional mitigation may be required. Options	Monitoring would identify adverse effects on the water flows in the Tre'r Gof SSSI and the Cae Gwyn SSSI and subsequent actions would restore the water levels and flows in the watercourses (chapter D8, Application Reference Number: 6.4.8).	Restoration of groundwater levels and surface water flows to baseline conditions (chapter D8, Application Reference Number: 6.4.8).

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
include: (1) artificial groundwater recharge, (2) direct recharge to watercourses, (3) changes to drainage system, (4) sealing of fractures in excavations. (Chapter D8, Application Reference Number: 6.4.8). This mitigation would be delivered through the Surface Water and Groundwater Management Strategy contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).		
Any temporary storage of waste vegetation rising from clearance on site will not be located within 100m of Tre'r Gof SSSI or any other protected sites. Detailed within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	Reduce nutrient run-off into, and enrichment of designated sites.	This would be a requirement of the Main Construction contract. The ECoW would monitor and report on this measure.
A comprehensive air quality monitoring and reporting scheme would be developed by Horizon in discussion with the IACC and NRW, including agreement of thresholds and additional achievement criteria to ensure compliance with the appropriate environmental standards. Since the scheme is in development it will continue to be developed with the regulator and finalised for approval prior to the start of construction. Where necessary, additional modelling assessment would be undertaken to support the development of the scheme as it matures. In order to achieve the appropriate environmental standards, the scheme would include a range of measures to achieve that outcome, for example:	To reduce the predicted increases in annual mean and 24-hour mean NOx concentrations and annual mean nitrogen and acid deposition rates at key ecological receptors (e.g. Tre'r Gof SSSI).	The main achievement criteria would be to prevent an exceedance of the NO_2 AQOs. Continuous monitoring of NO_2 would be used to identify exceedances of the one-hour mean AQO and identify the need to alter the emissions management scheme. Passive NO_2 diffusion tube monitoring would also be used to track the changes in annual mean NO_2 concentrations. Regular reports to the IACC and NRW and on-line web access system to the monitoring system.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
• A fleet mix that will include newer NRMM complying with the EU Stage IV NRMM emissions standards (i.e. plant generally manufactured after 2014), which emit 80% less NOx than Stage IIIB plant. • Active and on-going management of the plant and machinery operating in close proximity to the key exceedance areas where an impact is predicted (e.g. Tre'r Gof SSSI based on modelling of the current construction scenario). • Use of continuous NO_2 monitoring to track compliance against the AQOs and mitigation objectives, including appropriate feedback mechanisms to ensure the emissions management scheme can be adapted to respond to measured exceedances or elevated concentrations. This would include measurements at suitable locations representative of long-term exposure locations identified in the assessment where exceedances of the one-hour mean AQO could occur. The continuous monitoring would be supplemented with passive NO_2 diffusion tube monitoring at a greater number of locations to track the changes in annual mean NO_2 concentrations. This mitigation would be delivered through the Air Quality Management Strategy contained within the Main Power Station Site sub-CoCP (Application		

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Reference Number: 8.7) and the Wylfa Newydd CoCP (Application Reference Number: 8.6).		
A regime of annual cutting of vegetation would be implemented during construction to reduce the increased biomass which is predicted to occur as a result of increased nitrogen deposition. Studies such as Stevens *et al*., 2013 [RD51] have shown this to be an effective technique to reduce nitrogen levels and to control competitive graminoid species. This mitigation would be delivered through Landscape and Habitat Management Strategy (Application Reference Number: 8.16).	To retain the species composition and structure within the SSSI.	Habitat monitoring, as set out in a Landscape and Habitat Management Strategy (Application Reference Number: 8.16) agreed by NRW as the statutory consultee, would be undertaken and used to determine if habitat deterioration resulting from air quality change was arising. Habitat management would be reviewed and adapted if required.
A Tre'r Gof SSSI compensation strategy would create new rich-fen habitat and enhance existing rich-fen and mire habitat across three sites within Anglesey (appendix D9-23 SSSI Compensation Strategy - Volume I, Application Reference Number 6.4.56 and appendix D9-24 SSSI Compensation Strategy - Volume II, Application Reference Number: 6.4.57). This compensation would be delivered through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) and the Phasing Strategy (Application Reference Number: 8.29).	To secure and manage areas of land away from the Wylfa Newydd Development Area and create new wetland habitats which would potentially offset adverse effects. To identify adverse effects on the notable features of the SSSI.	Habitat monitoring, as set out in appendix D9-23 (Application Reference Numbers 6.4.56); and appendix D9-24 (Application Reference Numbers: 6.4.57), agreed by NRW as the statutory consultee, would be undertaken and used to determine if the compensation sites had achieved the wetland habitat objectives required. Habitat management would be reviewed and adapted if required to achieve desired habitat objectives.
As far as practicable, Horizon will manage grassland at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site to support the re-establishment of high quality coastal grassland which will support foraging	To restore the area affected by the construction of the cooling outfall to coastal grassland similar to	The establishment of grassland containing a species composition similar to that found on the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
chough through natural regeneration within the cooling outfall work area. If required, natural regeneration will be supported by the control of undesirable plant species and/or reseeding the area with seed harvested from Wylfa Head. This mitigation would be secured through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).	adjacent habitats within the designated site.	Monitoring would be undertaken to methods prescribed in the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).
A management scheme for Wylfa Head would be developed with the objective of providing optimal foraging habitat for chough within the retained habitat on Wylfa Head. Grass seeding of temporary stockpiles to mitigate loss of grassland habitat. Management of Mound A to maintain short-sward habitat conditions suitable for foraging breeding chough. This would be secured by the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).	Managing the habitats at Wylfa Head to achieve optimal conditions for foraging chough.	Reintroduction of grazing and the restoration of optimal chough foraging habitats on Wylfa Head throughout the duration of the construction period and until core foraging habitat affected by the Site Campus has been reinstated. Annual monitoring and reporting of management activities and chough foraging behaviour during the breeding and non-breeding season. Monitoring is detailed within the ecology monitoring strategy within the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).
The provision of information on the sensitivities and legal protection relevant to the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site and its associated species, and avoiding direct access from the Site Campus onto the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.	The objective would be to manage the use of sensitive habitats outwith the construction fencing by workers residing in the Site Campus, in particular	The Workforce Management Strategy (Application Reference Number: 8.5) would be successful if there are no significant effects on ecological receptors outwith the construction fencing caused by workers from the Site Campus e.g.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	coastal footpaths and within the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site.	disturbance of chough, or degradation of habitats from over-use of existing footpaths or creation of new 'desire-line' paths in areas of coastal grassland. The reporting criteria would be via the habitat monitoring in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) and chough monitoring (delivered through the ecology monitoring strategy within the Landscape and Habitat Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.16), that would both influence any changes to the Workforce Management Strategy that would be required (Application Reference Number: 8.5).
Translocation of topsoil and coppice stools from the two areas of ancient woodland to be lost to a receptor site totalling 1.3ha identified on Horizon-owned land (see figure D9-7 Application Reference Number: 6.4.101). Translocation of timber from felled trees supporting the rare *Ramalina fraxinea* lichen. This mitigation would be delivered through the Ecology and Landscape Management Strategy contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To reduce the effects of loss of areas of ancient woodland and notable species.	Successful translocation of important habitat features. Habitat monitoring of translocated topsoil, coppice and lichen, as set out in the Ecology and Landscape Management Strategy within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), would be undertaken to establish woodland of appropriate value. Habitat management would be reviewed and adapted if required.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
The management and enhancement of retained trees, scrub and hedgerows including area of Dame Sylvia Crowe designed woodland and new areas of landscaping to completed areas of landscape mounding and the control of unwanted plant species including invasive species. This additional mitigation would address both landscape and visual (see chapter D10, Application Reference Number: 6.4.10), and ecological receptors. This mitigation would be delivered through the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), and the Landscape and Habitat Management Strategy (Application Number: 8.16).	Successful establishment, maturation and longevity of existing vegetation to be retained, to reduce long-term effects of habitat loss (chapter D10, Application Reference Number: 6.4.10).	Maintenance of full extent of retained existing habitat and no deterioration in its quality, with implementation to be inspected at regular intervals (chapter D10, Application Reference Number: 6.4.10).
Landscaping to complete areas of landscape mounding as soon as practicably possible, in order to mitigate the extent of working area at any one point in time, and to reduce the duration of adverse effects of habitat loss. Agreed sequence of work to be developed further to progressively complete areas of landscape mounding on the Wylfa Newydd Development Area perimeter. Wherever possible, landscaping to be undertaken in the next available planting season following completion of defined areas of landscape mounding. This mitigation would be delivered through the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To reduce the duration of adverse effects caused by habitat loss (chapter D10, Application Reference Number: 6.4.10).	Successful planting of landscape mounds as soon as practicably possible after their completion, as per the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). See also chapter D10 Application Reference Number: 6.4.10).

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Where soils will be stored for longer than 60 days, stockpiles and temporary landscape mounding will be seeded with an appropriate low-maintenance seed mix. This mitigation would be delivered through the Ecology and Landscape Management Strategy contained within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	Reduce sediment loading to sensitive surface water features (i.e. the Tre'r Gof SSSI and the Cae Gwyn SSSI) and prevent deterioration of surface waters.	Sampling of discharge water to check concentrations post-treatment do not significantly exceed baseline water quality levels (chapter D8, Application Reference Number: 6.4.8).
Grass seeding of temporary stockpiles to mitigate loss of grassland habitat. Management of Mound A to maintain short-sward habitat conditions suitable for foraging breeding chough. This mitigation would be delivered through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To reduce adverse effects of loss of grassland and chough foraging habitat.	Preparation of performance requirements for timing and specification of seeding, including management. Annual reporting of management activities and chough foraging behaviour during the breeding and non-breeding season at Mound A.
To ensure the long-term presence of notable mammals in the local area, and achieve a source population from which the recreated or restored habitats can be repopulated, an off-site enhancement area has been secured by Horizon to the west of the Wylfa Newydd Development Area. It is approximately 15ha in area and would be managed to provide high quality habitats to support a range of species, including common toad and notable mammals. The area (including planting and creation of artificial hibernacula) would be established prior to the commencement of start of Site Preparation and Clearance Works (see Wylfa Newydd CoCP	To minimise the effects of habitat loss and fragmentation to ecological receptors.	Establishment of suitable refuge and foraging habitats, as per the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). Monitoring and modification of habitat management measures, as required.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
(Application Reference Number: 8.6), and the Landscape and Habitat Management Strategy Application Document Number: 8.16). As well as providing suitable refuge and foraging habitat, the area would also provide strong corridors linking the Wylfa Newydd Development Area with the surrounding landscape, facilitating safe passage of animals from the site into suitable adjacent habitats. This would be aided by phased and directional clearance of vegetation across the Wylfa Newydd Development Area (east to west). See figure D9-9 (Application Reference Number: 6.4.101) for the location and design. The off-site compensation area would also mitigate for the loss of habitat for terrestrial invertebrates, adder and common lizard, breeding birds, over-wintering birds and bats.		
The clearance of vegetation, topsoil stripping and removal of dry stone walls would be carried out in a directional manner to encourage movement of notable mammals towards the two receptor sites located to the west of the Wylfa Newydd Development Area, and discourage their movement towards features such as the A5025 road or residential areas of Cemaes. Boundary fencing will be permeable to small mammal movement to facilitate the safe passage of animals away from the Wylfa Newydd Development Area and to reduce the effects of habitat severance. In the period between vegetation clearance and topsoil stripping, vegetation will be managed to ensure that it	This would reduce the potential for toads, reptiles and notable mammals to become trapped in islands of sub-optimal habitat or pushed up against features such as the A5025 road or residential areas of Cemaes, where species would be at greater risk of mortality and injury from traffic. Keeping vegetation short prior to top soil	Clearance in a directional manner and managing the height of vegetation is a requirement of the Main Construction contract. Regular reporting of progress by the principal contractor to Horizon and supervision of works by an ECoW would record how this approach is being adopted.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
is no higher than 50mm above ground level. This mitigation would be delivered through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	clearance will reduce the risk of the site's recolonization by those species moved off-site.	
In line with the Wylfa Newydd CoCP (Application Document Reference: 8.6), the demolition of dry stone walls and cloddiau would take place between March and September, or between November and February with supervision from the ECoW.	To mitigate potential killing and injuring of reptile, amphibian and small mammal species.	Timing of works would be part of the Main Construction Contract.
Destruction of ponds would be timed to avoid amphibian breeding season or, if not possible, works would be supervised by an ECoW. Any amphibians captured would be translocated in accordance with English Nature guidance (2011) [RD1] using artificial refuges to the nearest retained pond. This mitigation would be delivered through the Wylfa Newydd CoCP (Application Reference Number: 8.6).	To mitigate potential mortality of amphibians during clearance works.	Timing of works would be part of the Main Construction Contract. Any translocation would be supervised by the ECoW.
The provision of alternative bat roost structures (both boxes and within built structures). This mitigation would be delivered through the Ecology and Landscape Management Strategy within the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To avoid a net loss of suitable bat roosting habitat within the Wylfa Newydd Development Area.	Installation of all boxes prior to commencement of building demolition and tree felling. Annual monitoring and replacement of damaged or missing boxes throughout the duration of the construction period.
To mitigate possible disturbance to retained bat roosts, retained habitats would be enhanced and managed, and extra bat boxes to reduce the effects of noise disturbance to existing roosts would be erected	To mitigate the potential effects of disturbance to Tyn-y-Maes bat barn by	Installation of all boxes prior to commencement of Main Construction. Annual monitoring and replacement of

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
within an area of retained woodland to the east of the Power Station (see figure D9-5 Application Reference Number: 6.4.101). The boxes would be suitable for the species and roost-type potentially affected and would be installed prior to the commencement of Main Construction. The exact locations of the bat boxes would be determined by the ECoW at the time of their erection but would be positioned to maximise the likelihood of them being used by bats, providing a range of roosting conditions suitable for all species affected by the WNDA Development, and allowing for effective monitoring (detailed within the ecology monitoring strategy). This mitigation and associated monitoring would be delivered through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	providing replacement roost features.	damaged or missing boxes throughout the duration of the construction period.
Occasional barn owl roosts that would be lost at Tyddyn-Gele and The Firs would be replaced through the provision of two barn owl boxes. A further two barn owl boxes would be provided to mitigate possible disturbance to roosts at Caerdegog Isaf and Cafnan Farm. This mitigation would be delivered through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To provide alternative roost features to mitigate the effects of disturbance to retained roosts.	Installation of four barn owl nest boxes prior to the onset of activities affecting known/possible roosts at Tyddyn-Gele, The Firs, Caerdegog Isaf and Cafnan Farm. Monitoring/reporting of each new box to be undertaken annually throughout the construction period.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Additional mitigation for red squirrel would comprise the enhancement of existing habitats on Dame Sylvia Crowe's Mound by erecting artificial dreys (maximum of ten boxes) and providing a supplementary food resource (on a monthly basis during the construction period). These mitigation measures would be secured through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To retain a viable population of red squirrel within Dame Sylvia Crowe's Mound.	Annual monitoring of red squirrel within Dame Sylvia Crowe's Mound would be undertaken during the construction period.
Mud snail would be translocated to an existing wetland area within the receptor site for notable wildlife (see figure D9-9 Application Reference Number: 6.4.101). This mitigation would be delivered through the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).	To offset the loss of Tregele pond through the translocation of mud snails and the creation of new ponds with the potential to develop into suitable habitat.	Monitoring of habitats and species surveys would be undertaken at intervals and to methods prescribed in the Ecology and Landscape Management Strategy in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).
Where practicable, construction lighting would be designed to reduce sky glow, glare and light spill onto sensitive ecological receptors (i.e. bats, breeding and wintering birds, otter, water vole, notable mammals, red squirrel and chough) to below thresholds where significant effects are predicted. This mitigation would be delivered through the General Site Management Strategy contained within the Wylfa Newydd CoCP (Application Reference Number: 8.6).	The lighting design would be developed using the best available technologies to reduce light spill onto sensitive receptors to below thresholds where significant effects would be predicted. Best available technologies would include: the use of a CMS (Central Management System) to reduce or switch off lighting	Preparation of lighting design in accordance with the General Site Management Strategy within the Wylfa Newydd CoCP (Application Reference Number: 8.6), with implementation to be inspected at regular intervals.

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	when not required; use of back shields, bunds, etc. to avoid/reduce light spill and glare onto adjacent areas; luminaires and coatings of lowest level and most appropriate colour temperature to achieve requirements (e.g. Philips ClearField technology, which emits a subtle red-green light), with no lighting above horizontal and best achievable colour rendering, where humans can judge perception at night without interfering with ecological receptors.	

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Operation

Table D9-11 Additional mitigation measures - operation

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Long-term botanical monitoring of Tre'r Gof SSSI which would identify the need for any adaptive management. The management of the Ecological Compensation Sites would contribute to off-setting any potential adverse effects. This mitigation would be secured through the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).	To identify any changes to baseline conditions so that appropriate additional mitigation can be implemented. To create and manage new and existing wetland habitats at the selected sites away from the Wylfa Newydd Development Area.	Habitat monitoring, as set out in a Landscape and Habitat Management Strategy (Application Reference Number: 8.16) agreed by NRW as the statutory consultee, would be undertaken at the selected compensation sites. Habitat management would be reviewed and adapted if required to achieve desired habitats.
As per table D9-10, operational monitoring of water quality and quantity would be undertaken at the Tre'r Gof SSSI and the Cae Gwyn SSSI to identify any changes to baseline conditions. Monitoring would be in line with the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13).	To identify any changes to baseline conditions so that appropriate additional mitigation can be implemented.	Restoration of groundwater levels and surface water flows to baseline conditions, where practicable.
As per table D9-10, operational monitoring of air quality would be undertaken at the Tre'r Gof SSSI to identify any changes to baseline conditions during the commissioning of generators. Monitoring would be in line with the Wylfa Newydd CoOP (Application Reference Number: 8.13).	To identify any changes to baseline conditions so that appropriate additional mitigation can be implemented.	Restoration of air quality to baseline conditions and/or appropriate habitat management, where practicable.

Decommissioning

Table D9-12 Additional mitigation measures - decommissioning

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
None identified at this stage.	N/A	N/A

9.7 Residual effects

9.7.1 This section describes the residual effects for terrestrial and freshwater ecology having taken into account the application of embedded mitigation, good practice mitigation and additional mitigation described above. Table D9-13 provides a summary of significant residual effects identified post application of additional mitigation for the construction and operation phases.

9.7.2 It is not possible to identify significant adverse effects for the decommissioning phase at this stage.

9.7.3 Additionally, all effects of minor significance or greater identified in the assessment of effects section are summarised in appendix I3-01 Master residual effects table (Application Reference Number: 6.9.8).

Tre'r Gof SSSI

9.7.4 A major adverse residual effect to the Tre'r Gof SSSI is predicted as a result of hydrological changes during construction and operation. Embedded, good practice and additional mitigation would all be applied to reduce the effects of hydrological change by working to maintain water quality and quantity at baseline conditions. However, there is uncertainty relating to the potential effectiveness of the embedded drainage design in maintaining the quality and quantity of water sources that feed the SSSI. Monitoring would be undertaken to assess the efficacy of the Surface Water and Groundwater Management Strategy (and Air Quality Management Strategy) (both in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)) and to identify any changes compared to baseline levels or exceedances of permitted levels. Botanical monitoring would also be undertaken as part of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). The combined results of the monitoring studies would inform the requirement for adjustments to the design/implementation of mitigation measures.

9.7.5 In addition to monitoring, a compensation package would be provided and managed by Horizon, which is designed to enhance areas of existing rich fen habitat within Anglesey, and to create new areas of rich fen habitat to offset potential effects to the Tre'r Gof SSSI. This compensation package would be secured through the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.7.6 If monitoring of the Tre'r Gof SSSI suggests that embedded mitigation, Air Quality Management Strategy and Surface Water and Groundwater Management Strategy (both in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7)) have been successful, the compensation site(s) would still be provided and managed by Horizon; this would represent a significant net-gain in wetland habitat, with additional benefits also likely for invertebrates, breeding and wintering birds, small mammals and bats.

Ancient woodland

9.7.7 Loss of ancient woodland during construction would be a major adverse residual effect.

9.7.8 Ancient woodland is considered an irreplaceable resource and an ancient woodland ecosystem cannot be moved [RD80]. Whilst the translocation of ancient woodland soil to a new (larger) site is proposed as a compensation measure for the loss of ancient woodland during construction, it is not possible to replicate the same conditions at another site and thus it will no longer be ancient woodland. However, it is possible that translocation of the soils to a new site, which would then be planted with typical native woodland tree and shrub species, could support the development of an ecosystem which contains some of the plants and fungi of the former ancient woodland and is of potentially greater biodiversity value than the poor quality woodland recorded at the two ancient woodland sites that would be lost.

Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site

9.7.9 A moderate adverse effect to the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site was assessed following the combined effect of the temporary loss of 1.1ha habitat as a result of the cooling water outfall and the potential degradation of habitats caused by pressure from workers occupying the Site Campus during construction. No adverse effects were identified during operation.

9.7.10 The loss of habitat would be addressed through the provision of additional mitigation to restore the affected area to habitats similar to existing. Enhancement of existing, unaffected habitat is also proposed as good practice mitigation within the Landscape and Habitat Management Strategy (Application Reference Number: 8.16). This would include control of bracken and scrub with the intention of maximising areas of habitat for which the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site is designated i.e. coastal grassland.

9.7.11 The potential for workers accommodated in the Site Campus to cause habitat degradation would be controlled through the provisions of the Workforce Management Strategy (Application Reference Number: 8.5). This prevents direct access to the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site from the Site Campus, and provides information on the sensitivities of the habitats and species, notably chough, which are present within the wildlife site.

9.7.12 Taken together it is considered that the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) and Workforce Management Strategy (Application Reference Number: 8.5) would reduce the significance of the effect of habitat loss, fragmentation or modification on the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site from a moderate adverse effect to a minor adverse effect.

Fungi

9.7.13 The combined loss of grassland habitats and potential for degradation due to pressure from workers resident in the Site Campus were assessed as potentially resulting in a moderate adverse effect on fungi.

9.7.14 Measures to enhance coastal grassland at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site, the key high value area for fungi, and to provide a more species diverse grassland sward across sympathetically managed agricultural land, are likely to benefit the species group. These are detailed within the Landscape and Habitat Management Strategy (Application Reference Number: 8.16).

9.7.15 It is also assessed that the effects of increased visitor pressure from workers using areas outwith the construction fencing for recreation would be controlled through the provisions of the Workforce Management Strategy (Application Reference Number: 8.5) which include providing information on the sensitivity of areas such as the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site where the higher value areas for fungi are located.

9.7.16 With the application of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) and Workforce Management Strategy (Application Reference Number: 8.5), it is therefore assessed that the residual effect on fungi would reduce from moderate adverse, to a minor adverse effect.

Chough

9.7.17 Following the application of additional mitigation, minor adverse residual effects are predicted for chough affected by habitat loss/fragmentation and noise and/or visual disturbance. Habitat management and enhancement (see Landscape and Habitat Management Strategy (Application Reference Number: 8.16)) at Wylfa Head is expected to reduce the reliance of foraging chough on habitats affected by construction activity (notably the construction, operation and decommissioning of the Site Campus) by increasing the area of suitable habitat in retained areas that are unaffected by construction activities and closer to the nesting site. This mitigation would be complemented by the supplementary feeding of chough at Wylfa Head and, in the medium-term, the management of Mound A to maintain short-sward habitat conditions suitable for foraging chough. Furthermore, disturbance of habitats on the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site by workers from the Site Campus would be controlled by the measures within the Workforce Management Strategy (Application Reference Number: 8.5), as additional mitigation. The combined effect of this mitigation would be to avoid a net loss of suitable habitat within the core foraging range of breeding and non-breeding chough, especially in areas that would be undisturbed by construction activities. The significance of effects is therefore considered to reduce from moderate to minor adverse following the application of additional mitigation.

9.7.18 It is assessed that the relevant magnitude of change for each receptor would not increase as a result of any combined effect and as such the residual effect for each would remain unchanged from those described above.

9.7.19 Potentially significant residual effects on ecological receptors during decommissioning, identified as valuable in the current baseline, are considered possible for those receptors sensitive to changes in air quality and hydrology and particularly susceptible to disturbance via noise, vibration and lighting. These effects are considered likely to be temporary for the duration of the impacting activities. The works required to decommission the Power Station would be subject to a separate EIA which would assess in detail the effects against the baseline conditions at that time.

9.7.20 The design of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) incorporates the reinstatement, creation and enhancement of significant areas of habitat which would be of benefit to those ecological receptors present within the Wylfa Newydd Development Area. These habitats would replace the existing baseline condition which is a predominantly agricultural landscape of lower biodiversity value. As such it is anticipated the provisions of the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) have the potential to result in net biodiversity gain which would preserve and possibly enhance the conservation status of the ecological receptors present.

SSSI Compensation Proposal

9.7.21 Three sites have been identified which provide opportunity to create and enhance rich-fen and mire habitat to off-set the potential significant adverse effects on Tre'r Gof SSSI. The works proposed to create and enhance this habitat are described in appendix D9-24 (Application Reference Number: 6.4.57), and an assessment of the potential effects from these works is provided in appendix D1-2 Ecological Compensation Sites: Assessment of Environmental Effects (Application Reference Number: 6.4.18).

9.7.22 The assessment concludes that there would be the potential for large-scale improvements in the quality and extent of rich-fen and mire habitat, although it is recognised that there is a degree of uncertainty in relation to the extent and quality of habitat created. As such, a moderate rather than major positive effect has been concluded for this habitat.

9.7.23 The location of two of the Ecological Compensation Sites (Cors Gwawr and Cae Canol-dydd) is designed to link isolated SSSI units: Cors Gwawr located between Caeau Talwrn and Cors Bodeilio, and Cae Canol-dydd located between two separate units of Caeau Talwrn. These SSSI units (with the exception of the southernmost unit of Caeau Talwrn at Cors Gwawr), also form part of the Corsydd Môn/Anglesey Fens SAC. The creation and enhancement of rich-fen at the two compensation sites would strengthen links between these SSSI units, and the resilience of the Corsydd Môn/Anglesey Fens SAC, which has the potential to result in extensive restoration and enhancement of these designated site receptors; a large magnitude of change. However, it is again recognised that there is a degree of uncertainty in relation to the extent and quality of habitat created and, as such, a moderate rather than major positive effect has been concluded for this receptor.

Table D9-13 Summary of residual effects

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Construction								
Tre'r Gof SSSI	High	Air quality changes	Temporary Reversible Adverse	Small	Moderate	Habitat management and monitoring.	Negligible	Minor adverse
		Hydrological changes	Permanent Irreversible Adverse	Large	Major	Monitoring and additional mitigation, as required. Provision of a compensation package of habitat enhancement and creation.	Large	Major adverse
Ancient woodland	High	Habitat loss (ID 26059 and ID 26075)	Permanent Irreversible Adverse	Large	Major adverse	Translocation of valuable ancient woodland features.	Medium	Major adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site	Medium	Habitat loss, fragmentation or modification	Temporary Reversible Adverse	Medium	Moderate adverse	Restoration of the area affected by the cooling outfall construction. Enhanced management of the wildlife site. Absence of direct access from Site Campus onto Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site and the provision of information detailing the sensitivities and legal protect afforded to the site and its key	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
						features (e.g. chough).		
		Air quality changes	Temporary Reversible Adverse	Small	Moderate	Enhanced management of habitat to avoid course graminoid species dominating the grassland sward. Fugitive dust suppression and air quality monitoring in line with those detailed within chapter D5 (Application Reference Number: 6.4.5).	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Fungi	High	Habitat loss, fragmentation or modification	Permanent Irreversible Adverse	Medium	Moderate adverse	Improved management of the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site and the provision of a more species diverse grassland sward across sympatheticall y managed agricultural land. Absence of direct access from Site Campus onto the Arfordir Mynydd y Wylfa - Trwyn Penrhyn wildlife site and the provision of information	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
						detailing the sensitivities and legal protect afforded to the site and its key features (e.g. chough).		
		Air quality changes	Temporary Reversible Adverse	Small	Moderate	Enhanced management of habitat to avoid course graminoid species dominating the grassland sward. Fugitive dust suppression and air quality monitoring in line with those detailed within chapter D5 (Application	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
						Reference Number: 6.4.5).		
Chough	Medium	Habitat loss, fragmentation or modification	Temporary Reversible Adverse	Medium	Moderate adverse	Habitat enhancements at the Arfordir Mynydd y Wylfa - Trwyn Penrhyn Wildlife Site and supplementary feeding of chough. Provision of grassland habitats which provide optimal foraging habitat for chough, including seeding of landscape mounds.	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
		Disturbance	Temporary Reversible Adverse	Medium	Moderate adverse	The Workforce Management Strategy (Application Reference Number: 8.5) would provide workers with information on the sensitivity of Wylfa Head as a nesting site, together with the legal status of the species. There would be no direct access onto Wylfa Head from the Site Campus, discouraging the use of the area for recreation.	Small	Minor adverse

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Operation								
Tre'r Gof SSSI	High	Hydrological changes	Permanent Irreversible Adverse	Large	Major adverse	Hydrological and botanical monitoring would be undertaken in agreement with NRW and if required the drainage system would be modified (if possible). Provision of a compensation package of habitat enhancement and creation.	Large	Major adverse
Decommissioning								
Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage	Not identified at this stage

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
SSSI compensation								
Caeau Talwrn SSSI Cors Bodeilio SSSI Corsydd Môn/Anglesey Fens SAC	High	Habitat enhancement	Permanent Reversible Positive	Large	Moderate	Not identified at this stage	Large	Moderate
Terrestrial habitats (rich fen/mire habitat)	High	Habitat creation and enhancement	Permanent Reversible Positive	Large	Moderate	Not identified at this stage	Large	Moderate

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Table D9-14 Schedule of references

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HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.12 ES Volume D - WNDA Development D12 - Coastal processes and coastal geomorphology

PINS Reference Number: EN010007

Application Reference Number: 6.4.12

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00044

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Contents

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12 Coastal processes and coastal geomorphology

12.1 Introduction

12.1.1 This chapter describes potential changes to coastal and marine processes and effects on coastal geomorphology receptors resulting from the construction, operation and decommissioning of the Power Station, other on-site development as described in chapter A1 (introduction) (Application Reference Number: 6.1.1.), Marine Works and the Site Campus within the Wylfa Newydd Development Area. It also considers potential effects at the registered Holyhead North marine disposal site (IS043), herein referred to as the Disposal Site.

12.1.2 Please refer to chapter B12 (coastal processes and coastal geomorphology) (Application Reference Number: 6.2.12) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the coastal and marine processes and coastal geomorphology assessment; and assessment methodologies and criteria.

12.1.3 The assessment herein supports the application for development consent and also the application for a Marine Licence for marine construction works and marine dredging and disposal, required separately under the Marine and Coastal Access Act 2009. Specifically, the Marine Licence application contains a site characterisation report which has been informed by the studies referred to in this Chapter.

12.2 Study area

12.2.1 This section describes the study area(s) relevant to the coastal and marine processes and assessment of effects on coastal geomorphology receptors for the Wylfa Newydd Development Area and the Disposal Site.

12.2.2 A full description of the methodology used for the identification of the study areas for the assessment of effects upon coastal and marine processes and coastal geomorphology at the Wylfa Newydd Development Area and the Disposal Site is provided in chapter B12 (Application Reference Number: 6.2.12).

12.2.3 Three separate study areas have been defined for coastal and marine processes and geomorphology (figures D12-1 and D12-2, Application Reference Number: 6.4.101). These are:

- Firstly, a study area for coastal geomorphology receptors close to the Power Station Site potentially affected by changes to waves and currents caused by Marine Works (such as the breakwater).
- Secondly, a wider study area covering the potential extents of sediment plumes and sediment deposition on geomorphology receptors and the seabed close to the Wylfa Newydd Development Area. Fine sediments

released from Licensable Marine Activities such as dredging have the potential to be carried large distances.

- Thirdly, a study area to capture the potential extents of sediment plumes and sediment deposition on geomorphology receptors and the seabed close to the Disposal Site. Fine sediments released from Licensable Marine Activities such as disposal have the potential to be carried large distances.

12.2.4 Figures D12-1 and D12-2 (Application Reference Number: 6.4.101) show the extent of the three study areas for investigations at the Wylfa Newydd Development Area and the Disposal Site. These areas have been determined primarily through identification of the likely extent of potential change (in coastal and marine processes) and modelling with particular respect to sensitive geomorphological receptors.

12.2.5 Whilst taking into account the guidance given on coastal cells and sub-cells in Technical Advice Note 14 [RD1], expert knowledge and experience of geomorphological and hydrodynamic processes operating within the wider marine environment was applied to determine the three study areas prior to knowing the results of the modelling. The refinement of these areas using more detailed information as it became available through the wave, current and sediment plume modelling work is explained in more detail in chapter B12 (Application Reference Number: 6.2.12).

12.2.6 The study area extent has been informed by both hydrodynamic and wave modelling investigations which employ a series of nested model grids with the ability to detect changes far into the Irish Sea. The nested model grids function together at increasing resolutions, with the finest detail centred upon the site of proposed activity. These grids are used to predict the likely extent of potential effects of Licensable Marine Activities upon coastal and marine processes.

12.2.7 Data on key geomorphological features (for coastal water receptors) were initially collected by field survey in 2014 (for a distance of approximately 2km east and 3km west from Wylfa Head (also referred to on figure D12-2 (Application Reference Number: 6.4.101) as points A and B). Expert geomorphological assessment informed by available literature was used. The points demarking this study area are major promontories around which significant littoral sediment transport would not be anticipated.

12.2.8 For the purposes of this study, the area of investigation reflects boundaries implemented within the hydrodynamic and wave models used to support this assessment. Broadly, there is a shelf sea boundary (the regional context), an intermediate boundary (the majority length of the northern coastline of Anglesey, and extending approximately 3km offshore) and a detailed inner boundary area (encompassing the development site and coincident with the marine area between Trwyn Cemlyn in the west to Llanlleiana Head in the east, and extending approximately 2km offshore). By capturing the range of spatial scales associated with the various oceanographic processes, the adoption of these spatial scales facilitates a robust assessment of the sediment regime at, and in the vicinity of, the Wylfa Newydd Power Station.

12.2.9 The 'final' study areas were chosen for the Wylfa Newydd Development Area based on the hydrodynamic modelling results (figure D12-2, Application Reference Number: 6.4.101). The model was run with successive tidal excursions allowing the areal extents of potential effects to be determined. The modelling could have been extended as far as needed into the Irish Sea around Anglesey but in practice narrower study areas (based on the modelling grids) were defined.

12.2.10 The wave and current modelling investigations have demonstrated that potential changes in waves, currents and sediment processes (excluding fine sediment) resulting from the proposed scheme, would be highly unlikely to extend beyond the embayment i.e. that it operates as a closed system.

12.2.11 Fine sediments released from Licensable Marine Activities such as dredging have the potential to be carried large distances. Again the hydrodynamic modelling results were used to refine the study area by determining the potential extent of effects on the plume and associated sediment deposition. The modelling showed there would be no discernible effects beyond the outer grid (70m medium resolution). Chapter B12 (Application Reference Number: 6.2.12) explains this definition of study areas in more detail.

12.2.12 This assessment has built upon the findings of several historic and recent investigations. These include the findings of:

- detailed oceanographic and geophysical studies undertaken by Titan Environmental Surveys Ltd. (hereafter referred to as Titan) [RD2];
- computational spectral wave transformation model: SWAN (Simulating Waves Nearshore) for surface waves (see appendix D12-3, Wylfa Newydd Main Site Wave Modelling Report, Application Reference Number: 6.4.82);
- hydrodynamic modelling: Delft3D for tidal currents and coupled currents plus waves at the Wylfa Newydd Development Area (appendix D13-8 Marine Hydrodynamic Modelling Report – Wylfa Newydd Development Area, Application Reference Number: 6.4.90) and the Disposal Site (appendix D13-12 Marine Hydrodynamic Modelling Report – Disposal Site, Application Reference Number: 6.4.94);
- Coastal Geomorphology Baseline for Wylfa Newydd Project – 2014 (see appendix D12-1, Application Reference Number: 6.4.80); and
- sediment regime baseline study (see appendix D12-2, Sediment Regime, Application Reference Number: 6.4.81).

12.2.13 The SWAN wave model study covers the whole of the north Anglesey coastline (see appendix D12-3, Application Reference Number: 6.4.82). The model has four nested grids with increasing resolution of 500m, 200m, 50m and 20m centred on the Wylfa Newydd Development Area.

12.2.14 The Delft3D hydrodynamic model mesh also encompasses the whole of Anglesey, and embedded within it, includes nested grids at both study areas. This means that closer to the area of potential effects more detailed higher resolution modelling has been used and 'nested within' a much wider area

covered by coarser modelling. At the Disposal Site, the outer grid was upgraded by the addition of a 3-dimensional (70m) grid covering 10.6km by 13km with 10 vertical layers. These defined the study area to capture the key changes within the disposal area (figure D12-1, Application Reference Number: 6.4.101). At the Wylfa Newydd Development Area a mid-resolution (70m) grid and a high resolution (23m) inner grid extend approximately 3.5km and 1.5km respectively, to the east and west (figure D12-2, Application Reference Number: 6.4.101).

12.2.15 The extent of potential effects, defined through the hydrodynamic modelling and sediment regime baseline studies provided in appendix D13-8 (Application Reference Number: 6.4.90) and appendix D12-2 (Application Reference Number: 6.4.81), was also cross-checked with the location of sensitive geomorphological receptors identified within section 12.3.

12.2.16 Based on desk study data, the model outputs and field investigations, the defined study area around the Wylfa Newydd Development Area includes the coastal zone between the Hen Borth (A) and the Llanbadrig headland (B) (see figure D12-2, Application Reference Number: 6.4.101). Within this area, there are three main embayments: Cemlyn Bay, Porth-y-pistyll and Cemaes Bay (see appendix D12-1, Application Reference Number: 6.4.80).

12.2.17 Two remote but important designated sites for coastal geomorphology on Anglesey have been considered for inclusion within the assessment; these are Newborough Warren (important for its coastal features) at a distance of 30-60km and Tywyn Aberffraw (a large intact dune system) at a distance of 25-55km from the development. On account of distance from the source of potential effects (both from the Wylfa Newydd Development Area and the Disposal Site) and the prevailing dominant currents from the south-west passing through the Irish Sea [RD3] the literature confirms that the potential for transport is very low. Furthermore, through investigation of transport pathways using the extended nested grids of the SWAN wave and Delft3D hydrodynamic modelled scenarios (see appendices D12-13 (Application Reference Number: 6.4.82), D13-8 (Application Reference Number: 6.4.90) and D13-12 (Application Reference Number: 6.4.94)), both sites are shown to be beyond the limit of detectable change. On that basis, both of these sites have been scoped out from this assessment.

12.2.18 The method to define the extent of the Disposal Site study area is outlined in chapter B12 (Application Reference Number: 6.2.12) and appendix D13-12 (Application Reference Number: 6.4.94). The north-western corner of the Disposal Site is the furthest point from shore at approximately 15km from Holyhead harbour and, at its nearest point, approximately 18km from Porth-y-pistyll. The total area of the site is approximately 28.8km². Studies of the hydrodynamics and benthic ecology have been carried out and are reported in appendix D13-2 (Benthic Ecology Report) (Application Reference Number: 6.4.84) and chapter D13 (the marine environment) (Application Reference Number: 6.4.13). For the purposes of this assessment only, marine processes and geomorphology at the Disposal Site are reported in this chapter (Application Reference Number: 6.4.12).

Other topic receptors

12.2.19 The results of the coastal and marine processes and geomorphology assessment for both the Wylfa Newydd Development Area and at the Disposal Site have also been used to inform other topics. This includes chapter D13 (Application Reference Number: 6.4.13), chapter D7 (soils and geology) (Application Reference Number: 6.4.7) and chapter D11 (cultural heritage) (Application Reference Number: 6.4.11). Specific elements of this study of interest to other topics are noted in table D12-1.

Table D12-1 Relevance to other topics

Topic	Environmental Statement chapter number	Topic receptor / activities potentially affected by changes in coastal and marine processes
Cultural heritage	D11 (Application Reference Number: 6.2.11)	• Archaeological site west of Wylfa Head, site of wreck near cooling water outfall, Porth Wnal.
Soils and geology	D7 (Application Reference Number: 6.2.7)	• Regionally Important Geological Sites (RIGS) along the coast. • Dolerite intrusion at cooling water outfall, Porth Wnal.
The marine environment	D13 (Application Reference Number: 6.2.13)	• Benthic habitat.
Shadow Habitat Regulations Assessment (HRA) Report	n/a (Application Reference Number: 5.2)	• Benthic habitat.
Water Framework Directive (WFD) Compliance Assessment	(Application Reference Number: 8.26)	• Hydromorphology quality elements for The Skerries, Anglesey North and Cemlyn Lagoon water bodies.
Other permits and licences	n/a	• Environmental Permit and Marine Licence.

12.3 Baseline environment

12.3.1 This section provides a summary of the baseline conditions for coastal and marine processes and coastal geomorphology within the study area described in section 12.2.

12.3.2 The baseline conditions of the two key areas are described separately below, firstly for the proposed Wylfa Newydd Development Area, followed by the Disposal Site.

Wylfa Newydd Development Area – coastal and marine processes

12.3.3 Summary baseline information for the present-day physical oceanographic environment provided in this section includes the character and functioning of waves and tidal currents (hydrodynamics); bathymetry; boundary materials (bedrock and superficial geology) and sediments that underpin the coastal and marine processes. Further details on wave, hydrodynamic and the sediment regime baselines can be found within appendix D13-8 (Application Reference Number: 6.4.90) and appendix D12-2 (Application Reference Number: 6.4.81).

Waves, tides and currents

Waves

12.3.4 There are two types of wave affecting the Wylfa Newydd Development Area study area, namely swell waves originating outside the area (from the Irish Sea), and locally generated wind waves. Waves therefore vary in response to a number of factors:

- wind conditions;
- the fetch over which winds can blow and generate waves;
- water levels;
- orientation of the coastline and dominance of headlands and rock outcrops; and
- inshore bathymetry.

Wave climate

12.3.5 Studies close to the Wylfa Newydd Development Area [RD4] examined a variety of sources in relation to the wave climate, which included field data from an oceanographic monitoring campaign. Four fixed monitoring stations, deployed between August 2010 and February 2011 (see figure D12-2 (Application Reference Number: 6.4.101) for three located within the study area), revealed (at mooring station S2) a predominant offshore wave direction from the west [RD4]. The locally complex coastline includes west-, north- and east-facing shorelines. [RD4] reports that the orientation of the coastline and shelter afforded by rocky island groups, such as the Skerries, prevent swell waves approaching from the south-west. Incoming waves are refracted around the coastline along the north coast, approaching predominantly from 270° to 90° [RD4]. Consequently, further inshore the predominance of westerly waves is no longer evident. Both to the west and east of Wylfa Head (at mooring stations S9 and S11 respectively), waves have been shown to have a predominant north-westerly direction (appendix D12-3, Application Reference Number: 6.4.82).

12.3.6 Significant wave heights recorded at the fixed moorings have been observed to be lower in the sheltered bays compared with offshore. The average significant wave height west of Wylfa Head was 0.68m (recorded between

October 2010 and January 2011) compared to the equivalent value at the furthest offshore fixed mooring of 1.24m [RD4].

12.3.7 As waves enter shallower waters, wave energy can penetrate to the seabed; orbital motions associated with wave progression, if sufficiently powerful, can give rise to sediment mobilisation. During storms, waves can be a powerful agent bringing sediments into suspension.

12.3.8 As waves enter shallower water they undergo a transformation known as 'shoaling' due to changes in the ratio of wave height to water depth. For example, as the bathymetry changes toward the coastline, there is a reduction in wave height with distance shorewards associated with a gradual dissipation of wave energy. Of the order of 50% reductions in wave height offshore to the inner embayments are indicated via the SWAN and Delft3D models.

12.3.9 As the water depth further decreases closer inshore, wave height increases prior to breaking. At this stage the water is shallow and wave-induced currents can form, caused by the wave breaking introducing a variation in shear stress over the width of the surf zone. Although complex, generally there are two types of current considered: those perpendicular i.e. at 90 degrees to the shore (shore normal) and those parallel to the shore (shore parallel or longshore).

12.3.10 The 2012 Wylfa Coastal Processes Study [RD4], found that longshore currents with potential to transport sediments along the sheltered coastline (littoral drift) tended to be weak. This is because of the effects of shoaling within the bays and wave diffraction around the headlands. Where weak longshore currents did exist, their energy decreased as they expended energy by transporting sediment along the shoreline. This type of sediment movement brings about a natural adjustment in the orientation of the beach front, realigning it to face the incoming waves [RD4].

12.3.11 Sediment transport induced by wave action in exposed locations may occur in a general easterly direction along the north Wales coast. At some localities, waves capable of moving material along the shoreline via littoral drift effects may change direction depending on the prevailing wind directions.

12.3.12 For the purposes of this assessment, the modelling of wave conditions has been undertaken using the wave transformation model SWAN, (as reported in appendix D12-3, Application Reference Number: 6.4.82). The wave model baseline results describe the locally complicated conditions for modelling. This is explained with reference to the highly variable coastline and differences in wave environment of the near and offshore environments. Effects of waves within the harbour of the Wylfa Newydd Development Area have been modelled using the wave disturbance model ARTEMIS, as seen in appendix D12-3 (Application Reference Number: 6.4.82).

12.3.13 Present-day ('present day (2023)') and evolving ('foreseeable future (2087)') 35.5 year-long wave climate records were generated by the SWAN model for a range of scenarios and these are reported within the Further Wave Model, Phase 2 study in appendix D12-3 (Application Reference Number:

6.4.82). Wave conditions for the present day baseline scenarios (table D12-2) are based upon a location (referred to as offshore point 3) approximately 1.8 km north of Wylfa Head, which is a reference validation point common to both models (SWAN and Delft3D, see figures D12-1 and D12-2) (Application Reference Number: 6.4.101).

Table D12-2 Wave conditions relating to summer and winter climate for present day (2023) baseline scenarios in SWAN model

Season / Sector / Event	Wave height (meters)	Wave period (seconds)	Direction (degrees)
Summer			
	0.60	3.3	254
Winter / North			
50th percentile	0.93	4.1	360
90th percentile	2.49	6.0	343
99th percentile	4.21	7.8	345
Winter / North-east (NE)			
50th percentile	0.89	4.0	57
90th percentile	2.29	5.9	39
99th percentile	3.48	6.9	36
Winter / North-west (NW)			
50th percentile	1.17	4.4	309
90th percentile	2.76	6.5	329
99th percentile	4.03	7.5	303

Note: Three wave directions used for the winter period. The location of the wave generation was offshore Point 3 (Application Reference Number: 6.4.82).

12.3.14 As described in appendix D12-3 (Application Reference Number: 6.4.82), the foreseeable future (2087) baseline scenario outputs reflect precautionary values for climate change conditions of sea level rise and increases in storm events recommended within the most up-to-date UK Climate Predictions 2009 (UKCP09) and Welsh government guidance.

12.3.15 Figure D12-3 (Application Reference Number: 6.4.101) shows a selection of SWAN model outputs showing baseline wave heights distributions in four panels. A typical westerly wave is shown for present day (2023) summer conditions (top left image). The summer baseline scenario represents typical calm conditions. Extreme conditions are represented by winter 99th percentile (or 1% probability) waves arising from the northeast sector (lower right image) and northwest sector (upper right image). A future (2087) scenario is also shown for a winter, 99th percentile northwest sector wave condition (lower right image). All three winter wave scenarios show wave heights greater than 1m over large sections of the Esgair Gemlyn ridge, with

the highest waves shown arising from the northeast sector, depicted as rising up to 2m high in the central part of the shingle ridge (see appendix D12-3, Application Reference Number: 6.4.82).

12.3.16 Irrespective of time frames shown, the scenarios selected for figure D12-3 (Application Reference Number: 6.4.101) show the best representation of the potential range of wave heights and behaviour for calm and extreme storm conditions. Baseline waves entering Cemlyn Bay from the north-east are shown to generate the greatest heights at the rear of the bay, by the Esgair Gemlyn shingle ridge, due to the long fetch and alignment with the orientation of the headlands and embayment. Baseline waves arising from the north-west are shown to be lower at the rear adjacent to Esgair Gemlyn, but higher overall. In particular, north-westerly waves are the highest at Porth-y-pistyll, this pattern is observed for present day as well as under the foreseeable future (2087) baseline scenario, which includes the potential effects of climate change. The full range of scenario results can be found in appendix D12-3 (Application Reference Number: 6.4.82).

12.3.17 Baseline wave conditions (defined within SWAN) have also been incorporated into the Delft3D hydrodynamic model to represent combined scenarios with tidal currents. Within the Delft3D model, the combined scenarios have drawn upon wave boundary conditions taken from the same offshore point (3) (defined within the SWAN model area in appendix D12-3, Application Reference Number: 6.4.82). Four coupled (waves plus currents) scenario conditions have been created as described in table D12-3. These include scenarios for an average or typical wave condition, a higher winter wave condition and a more extreme 'high wave from the north' wave condition. The three wave conditions have been selected to represent varying directions, distances (fetch) and wave heights (for more detail, see appendix D13-8, Application Reference Number: 6.4.90).

Table D12-3 Wave conditions represented within the Delft3D model for the assessment of waves and currents combined

Wave conditions represented within Delft3D model		Description of wave boundary condition	
	Wave height (m)	Wave period (seconds)	Direction (degrees)
No wave	n/a	n/a	n/a
Typical	0.91	6.0	228.1
Winter	2.0	6.2	343.7
High north wave (98th percentile)	2.85	6.9	358.3

Tides and currents

12.3.18 Tidal data for north Anglesey, recorded at Cemaes Bay, indicate that semi-diurnal cycles occur approximately every 12.4 hours. Tidal currents are particularly strong off Anglesey [RD2].

12.3.19 Early studies [RD2] reported characteristic spring tide currents recorded off Wylfa Head with peak (depth averaged) velocities in excess of 2m/s. These currents flow from west to east on the flood tide and strongly east to west on the ebb tide. At the furthest offshore oceanographic monitoring station (S2) the mid-ebb currents have been recorded as being consistently stronger than those of the mid-flood tide. Between August 2010 and February 2011, the maximum recorded mid-ebb current speed at S2 was 2.3m/s. Mooring station S4, just over 1km offshore of Wylfa Head, had maximum current speeds (depth averaged) of 2.01m/s.

12.3.20 The Titan report [RD2] found that "*tidal currents offshore of Wylfa Head are rectilinear in an East-West orientation and current velocities are strongest at maximum tidal streaming HW+2. Current velocities over ebb were greater than those recorded over flood and there was a distinct spring-neap current variation with currents being greater over springs than neaps*"

12.3.21 This aligns with wider studies of currents and sediment transport within the Irish Sea which indicate the dominance of offshore currents flowing west to east, aligned with prevailing currents arising in the Irish Sea and flowing from the south-west [RD3].

12.3.22 The four hydrodynamic model scenarios shown in figure D12-4 (Application Reference Number: 6.4.101) indicate the typical range of currents and energy across the tidal conditions for spring, neap, ebb and flood combinations. The model outputs reveal a pattern of high offshore velocities (in excess of 2m/s for peak spring tides) northward of an arc running across the principal headlands (including Trwyn Cemlyn in the west, Wylfa Head and across to Llanlleiana Head in the east) and far lower velocities within the inshore embayments (of Cemlyn and Cemaes). These results concur with the observed mean velocities of the offshore monitoring stations (S2 and S4) which were found to be approximately double those of the onshore stations (S9 and S11) (see appendix D12-2, Application Reference Number: 6.4.81).

12.3.23 Contrary to the Holmes and Tappin [RD3] description of (west to east) offshore sediment movement, the observed and modelled baseline results (presented in figure D12-4) (Application Reference Number: 6.4.101) agree with one another, indicating the strongest offshore currents to be on the spring ebb tide, flowing from east to west, with weaker currents on the flood tide, flowing west to east. All four scenarios depicted in figure D12-4 (Application Reference Number: 6.4.101) reflect the presence of the strongest tidal currents beyond the headlands of Wylfa Head and Trwyn Cemlyn under all spring/neap and flood/ebb tide conditions in contrast to the sheltered conditions within Cemlyn Bay and Porth-y-pistyll, to the west of the Wylfa Newydd Development Area.

12.3.24 The Wylfa Head promontory causes a stable eddy structure to form in Cemlyn Bay (to the west) and Cemaes Bay (to the east) on both the flood and ebb tides (see figure D12-4) (Application Reference Number: 6.4.101) and this is more pronounced during spring tides. The rotation and strength of eddies varies over the flood-ebb cycle. The maximum current speeds recorded at the fixed moorings (figure D12-2) (Application Reference Number: 6.4.101) were 0.95m/s (at S9, to the west of Wylfa Head in Cemlyn

Bay) and 1.1m/s (at S11, to the east of Wylfa Head in Cemaes Bay). These observed values concur with the modelled velocity magnitude data presented in figure D12-4 (Application Reference Number: 6.4.101). The modelled tidal currents within figure D12-4 (Application Reference Number: 6.4.101) also illustrate how the headland itself influences the direction and energy of the flows.

12.3.25 Figure D12-4 (Application Reference Number: 6.4.101) shows modelled offshore tidal flows of greater than 0.8m/s, during all tidal conditions, with inshore current speeds within Cemlyn and Cemaes Bays shown to be lower, predominantly below 0.4m/s during the mid-ebb scenario runs. The action of the eddies, propagating from the effect of strong currents north of Wylfa Head, assists with interchange and mixing of water within and between the two bays.

12.3.26 The evolving baseline shows a similar pattern of tidally-related currents. However, the potential effects of climate change upon longer term scenarios associated with sea level rise and more frequent events do not make significant differences within the results of the Delft3D model itself, other than increasing the overall water depths. Where these effects are identified as changes in wave height (e.g. via increased storminess), they have been indicated through the SWAN and ARTEMIS wave model results (see appendix D12-3, Application Reference Number: 6.4.82) and as such are reported in the assessment section of this report.

12.3.27 The tidal range (assuming average meteorological conditions) recorded nearby at Cemaes gauge is given in table D12-4 [RD5]. It is important to note, however, that meteorological conditions differing from the average (such as strong or prolonged winds) would cause differences between predicted and actual tide levels.

Table D12-4 Tidal range at Cemaes gauge measured in metres relative to Ordnance Datum (mOD)

Tide level	mOD
HAT (Highest Astronomical Tide)	+3.9
MHWS (Mean High Water Springs)	+3.0
MHWN (Mean High Water Neaps)	+1.5
MSL (Mean Sea Level)	+0.1
MLWN (Mean Low Water Neaps)	-1.3
MLWS (Mean Low Water Springs)	-2.8
LAT (Lowest Astronomical Tide)	-3.6

12.3.28 Tidal height measurements have also been collected every 15 minutes over a 12-month period (March 2010 to February 2011) at the jetty of the Existing Power Station. These data also demonstrate a semi-diurnal tidal signal with a maximum measured range of 7.5m. The maximum and minimum recorded tidal heights were +3.9mOD to -3.6mOD generally in line with the range recorded at Cemaes.

12.3.29 Table D12-5 provides sea levels for a range of extreme water levels for both Cemaes and off Wylfa Head and the probability of occurrence. These levels are taken from a publication by the Department for Environment, Food and Rural Affairs/Environment Agency [RD6] aimed at providing more consistency in managing for extreme events. These levels are based on extrapolation of data limited to less than 100 years of records, they should therefore be treated with caution especially for the higher return period events.

Table D12-5 Extreme sea level events (mOD) [RD6]

Return period (years)	Annual probability of occurrence	Cemaes Bay (mOD)	Off Wylfa Head (mOD)
1	100%	+3.9	+3.7
5	20%	+4.1	+3.9
10	10%	+4.1	+4.0
100	1%	+4.4	+4.2
200	0.5%	+4.4	+4.3
1,000	0.1%	+4.6	+4.4
10,000	0.01%	+4.7	+4.6

Bathymetry, geology and sediments

Bathymetry

12.3.30 Bathymetric surveys of the study area, undertaken by Titan in 2009 [RD2], have been used to define the underlying seabed topography. The bathymetry (features and shape of the seabed) around the Wylfa Newydd Development Area (shown in figure D12-5) (Application Reference Number: 6.4.101) reveals a shallow coastal shelf mostly within the embayments. This shore platform slopes gently away from the coast to approximately -20mOD, before dropping steeply away to depths of -30mOD to -40mOD to the north beyond the headlands.

12.3.31 Within the outer bays, distinctive subtidal rocky seabed knolls (irregular outcrops) rise 4m to 5m above the seabed floor with occasional islands rising above the sea surface.

12.3.32 The coastline around the Wylfa Newydd Development Area is characterised by rocky headlands and intertidal or littoral zones (rock platforms), indented by small coves such as Cemlyn Bay with small areas of shingle and sand beach (pocket beaches) with relatively low cliffs to the rear. Many of the low cliffs are formed of highly erosive superficial deposits of glacial origin, such as those at the coastal drumlin feature, Hen Borth (see appendix D12-1 (Application Reference Number: 6.4.80) for more detail).

12.3.33 At Wylfa Head, large rocky outcrops dominate with the nearshore seabed consisting of an irregular wave-like rock head surface. The seabed offshore rapidly shelves off into deep waters. Here the seabed is generally composed

of exposed diamicton (poorly sorted sediments from terrestrial erosion, suspended in a matrix of mud or sand) and bedrock with a veneer of sand and gravels, associated with local lag deposits (consisting of coarser materials with the fine particles washed out) draped over its surface. The British Geological Survey characterises the seabed in the area (generally) as 'sandy gravels' [RD7].

Geology

12.3.34 The local geology of the study area includes ancient Precambrian metamorphic bedrock types consisting of mica schist and psammite. Alongside these, the oldest formations of the Mona and Gwna groups are exposed at the Geological Site of Special Scientific Interest (SSSI) Llanbadrig – Dinas Gynfor, located east of Cemaes Bay, where they are interbedded with Ordovician sedimentary rock types [RD7].

12.3.35 The underlying geology of the seabed, consisting of the wave cut platform of the continuing geological formations with rocky outcrops, makes the area unfavourable for trawling activity. As a result, the subtidal sediments and associated benthic habitats within the bays remain relatively undisturbed by human activities.

12.3.36 Superficial deposits consist of glacial lag, occurring in some locations as drumlins, and reworked as shingle beaches and bars. Most notable of these is the formation of the Esgair Gemlyn shingle bar (or storm beach) located between Cemlyn Lagoon and Cemlyn Bay. This historic shingle feature provides the shoreward limit of the Cemlyn Lagoon Special Area of Conservation (SAC). Further superficial littoral deposits of sands and fine gravels are found at Cemaes Bay.

12.3.37 Parts of the coastal areas within the study area are designated as RIGS in recognition of their educational value for exposed geological successions. Anglesey has also been awarded UNESCO Global Geopark status [RD8]. The Anglesey Geopark (GeoMôn) was assigned in 2009 for its geological heritage which spans four eras and 12 geological periods. A full assessment of the effects upon local geological receptors, (including the RIGS) is provided within chapter D7 (soils and geology) (Application Reference Number: 6.4.7) of this Environmental Statement.

The Porth Wnal Dolerite

12.3.38 The Porth Wnal Dolerite is an important geological feature which is assessed separately within chapter D7 (Application Reference Number: 6.4.7). The igneous dolerite is a hard metamorphic rock and as such would not be affected by changes in coastal or marine processes during the design life of the Power Station. It is therefore not considered as a coastal geomorphology receptor within this chapter.

Wylfa Newydd Development Area – coastal geomorphology

12.3.39 A summary of the baseline conditions for coastal geomorphology is provided in this section of the report including the receptors identified. Further details

relating to the coastal geomorphology baseline can be found within appendix D12-1 (Application Reference Number: 6.4.80).

12.3.40 Due to the local geology, the coastal environment is extremely varied comprising of rocky headlands with deep coves and embayments as a result of the differential erosion of the many distinctive solid and drift rock types that occur locally.

12.3.41 The coastal and seabed geomorphology around the Wylfa Newydd Development Area has been shaped by dynamic coastal and marine processes operating over a range of spatial and temporal scales. These include complex interactions between tidal currents, waves, cyclical circulation patterns and sediment fluxes within the system. Together these determine the physical form and functioning of the supratidal, intertidal, seabed and sedimentary features along the coastline. The coastal geomorphology walkover assessment (which covered three sub-cells of the Shoreline Management Plan (SMP) [RD9]) was able to identify the likely extent of effects upon the form and functioning of these coastline features.

12.3.42 Whilst significant geomorphological processes (erosion and deposition) can occur at a local scale along exposed littoral zones, the Anglesey coastline is predominantly composed of exposed hard rock and is therefore highly resistant to erosion (see appendix D12-1, Application Reference Number: 6.4.80).

Sediments

Subtidal sediments

12.3.43 Prior to the Holocene marine transgression, the eastern Irish Sea was covered by a complex suite of clastic sediments laid down by the retreating glaciers and their outwash plains. The upper parts of these sediments have been subsequently reworked as sea level rose during the early to mid-Holocene. The modern hydrodynamic regime has been operating for around the last 5,000 years. Approximate albeit dynamic equilibrium has been reached on the sea bed of the Irish Sea whilst coastal forms and features have continued to evolve during this period (see appendix D12-2, Application Reference Number: 6.4.81).

12.3.44 Figure D12-6 (Application Reference Number: 6.4.101) shows the extent of marine sediment sampling and character of sediments based upon seabed samples (grabs, boreholes) around the Wylfa Newydd Development Area. Further benthic habitat investigations including the nature of local underlying materials (i.e. bedrock or sediment characteristics) are reported in appendix D13-2 (Application Reference Number: 6.4.84). These are found to be predominantly rocky and exposed in the intertidal zone, with some mobile sandy sediments within the Porth-y-pistyll area. These findings reflect the mapping of fine sediments and bedrock areas shown on figure D12-7 (Application Reference Number: 6.4.101).

12.3.45 The sediment samples represented on figure D12-6 (Application Reference Number: 6.4.101) have been taken offshore along the north of Anglesey with the majority focused within the Cemlyn Bay and Cemaes Bay subtidal areas.

The points and data shown, represent those recorded in 2010. Analysis of the sediment regime has taken into account all data arising from surveys carried out during 2010, 2011 and 2015 plus the benthic habitat surveys in 2014.

12.3.46 The character of the subtidal seabed and sediment features have been revealed by side-scan sonar surveys undertaken by Titan in 2009 [RD2] (figure D12-7, Application Reference Number: 6.4.101). These surveys show extensive areas of relatively featureless smooth sandy and sandy-gravel seabed, in particular a contiguous area close to the inner part of Cemlyn Bay. One area of coarser gravel sediments is indicated within Cemaes Bay. Additional sediment sampling data from benthic grabs (2010, 2011 and 2015) and boreholes collected during 2010 [RD10] and 2016 by Fugro Seacore Ltd. (Fugro) (appendix 12-2, Application Reference Number: 6.4.81) depicted in figure D12-7, (Application Reference Number: 6.4.101), reveal muddy sands in areas without the influence of tidal currents and wave energy. This was mainly shown to be in Cemaes Bay in the sheltered lee of Wylfa Head at BH101 and WS20.

12.3.47 Figure D12-7 (Application Reference Number: 6.4.101) reveals a significant area of exposed bedrock around the headlands and fringes of Cemlyn Bay and Porth-y-pistyll, with rocky pinnacles also indicated on side scan imagery [RD2]. A patchy and uneven veneer of sandy gravel overlies an extensive region of bedrock offshore of Cemlyn Bay and the north and west of Wylfa Head, with areas of featureless and largely smooth sandy gravel substrate.

12.3.48 Discrete areas of megaripples are weakly apparent within the subtidal sandy seabed. These weak megaripple features represent a relatively stable bedform that reflects the character and direction of near-bed flow patterns [RD11] and do not represent a particular kind of benthic habitat.

12.3.49 The sediment grab sample data have been analysed for particle size with sediment characterisation depicted by percentages of gravel, sand and silt for each site (located in figures D12-6 and D12-7) (Application Reference Number: 6.4.101). The sediment characterisation shows a wide variation of lag deposit textures. These consist mostly of highly unsorted coarser materials overlying a predominantly irregular undulating rockhead surface with some local exposures of diamicton.

12.3.50 These lag deposits have most probably been historically swept up and transported into local bays, contributing to the formation of the subtidal, intertidal and beach deposits within the bays. Additional locations of sediment borehole samples from a geotechnical investigation undertaken in 2010 by Fugro [RD10]. are also presented in figure D12-7 (Application Reference Number: 6.4.101). Borehole sampling was limited to those locations where sediments were of adequate depth. Away from the coastal zone, the rocky seabed has a steep gradient of approximately 1:30, falling away to the north-west. The geotechnical investigation reports that, along the coastal margin, the seabed largely consists of bedrock other than at cove entrances.

12.3.51 In locations where borehole data have been obtained, typically the thickness of sediment layers range from 0.5m of sandy gravels to more than 30m of

mixed sediments (mainly firm sands and gravels) (table D12-6). With depth, there are boulder clay/diamicton sequences formed during and following the last glaciation (when sea levels were much lower, by around 130m).

Table D12-6 Sediment thicknesses (based on Fugro, 2011 [RD10])

Borehole reference	Description of superficial sediment sequences overlying weathered solid bedrock
BH401	Total depth = 3m, comprising from surface down: • 0.5m silty sand; • 1.0m very dense silty sand; • 1.0m very dense gravelly sand; and • 0.5m very coarse sand.
BH402	Total depth = 2.65m, comprising from surface down: • 0.62m of very dense sand; • 0.41m of gravel and cobbles; • 0.08m of rounded cobble; • 0.39m stiff gravelly clay; • 0.42m brown gravelly sand; • 0.23m of gravelly sand; and • 0.5m dense sandy gravel.
BH403	Total depth = 6m, comprising from surface down: • 1.0m loose gravelly sand; • 1.5m medium dense gravelly sand; • 1.0m sand with pockets of gravelly clay; • 1.0m soft to firm gravelly clay; • 1.0m firm gravelly sandy clay; and • 0.5m very dense sandy gravel.
BH404	Total depth = 0.8m, comprising from surface down: • 0.8m gravelly sand.
BH405	Total depth = 2.6 metres, comprising from surface down: • 1.3m very dense silt, gravelly sand; and • 1.3m very dense sandy gravel.
BH406	Total depth = 4.65m, comprising from surface down: • 2.65m dense to very dense clayey sandy gravel; • 1.5m of gravel and cobbles grading to gravelly sandy silt; • 1.0m firm to stiff clayey silt; and • 0.5m gravel.
BH407	Total depth = 1.0m, comprising from surface down: • 1.0m very dense sandy gravel.
BH408	Total depth = 0.5m, comprising from surface down: • 0.5m sandy gravel with a low cobble content.

Borehole reference	Description of superficial sediment sequences overlying weathered solid bedrock
BH410	Total depth = 32.6m, comprising from surface down: • 0.9m sand; • 0.9m soft sandy clay; • 0.7m very sandy gravel; • 6.0m sandy gravel medium dense; • 2.9m stiff gravelly clay; • 0.6m clayey silt; • 16.6m gravelly clay sand; • 2.0m firm medium silty clay; • 0.45m silty sand; • 0.25m sandy gravelly silt; • 0.5m silty clay; and • 0.87m stiff clay.
BH412	Total depth = 1.64m, comprising from surface down: • 1.64m gravel.
BH413	Total depth = 0.5m, comprising from surface down: • 0.5m gravelly coarse sand.

12.3.52 Whilst figure D12-7 (Application Reference Number: 6.4.101) shows a high degree of correlation between the grab sampling and the sediment features, repeat grab sampling in 2010, 2011 and 2015 also indicated changes in the distribution of superficial sediments, reflecting the dynamic nature of the subtidal environment.

12.3.53 Analysis of the present baseline conditions for sediments and their potential for transportation along the seabed within the study area included an investigation of expected bed shear stress. Shear stresses [measured as Newtons per square meter or N/m^2] arise at the seabed due to water motions related to tidal and wave induced currents). Shear stress was calculated using the hydrodynamic Delft3D model for a range of scenarios (appendix D13-8, Application Reference Number: 6.4.90). Characterisation of baseline seabed shear stress for tide only scenarios included investigation of spring and neap phases for mid-flood and mid-ebb conditions.

12.3.54 A range of coupled tide and wave scenarios for these conditions have also been run to include the typical wave condition, the winter wave condition and the high north wave condition (as defined in table D12-3). The results (detailed in appendix D13-8, Application Reference Number: 6.4.90) reveal a wide range of baseline shear stress. The highest (current-induced) bed shear stresses are found during powerful spring tides specifically during the mid-ebb phase; co-occurrence of waves during spring tides potentially enhances the bed shear stress in sufficiently shallow waters. Figure D12-8 (Application Reference Number: 6.4.101) shows bed shear stresses during a spring ebb tide situation under each aforementioned wave condition.

12.3.55 The baseline results for seabed shear stress shown in figure D12-8 (Application Reference Number: 6.4.101) reveal, through a series of 'snap shots' in time, a dynamic marine environment. For all scenarios, the seabed shear stress energy levels remain highest offshore. The lower values are located within the coastal embayments. During the summer wave energy from comparatively small waves does not penetrate to the seabed within the embayments. However, during winter shear stresses, due to the presence of larger waves, increase across these inshore areas in particular, when wave direction is from the north. The most extreme conditions depicted by the high north wave (or P98) scenario have a 1:50 or 2% annual probability of occurrence.

12.3.56 To assess whether, and where geographically, the bed shear stresses (figure D12-8, Application Reference Number: 6.4.101) are sufficiently powerful to mobilise the two most abundant sediment types (sands, gravels), consideration is given to the 'critical' value of stress above which sediments move (table D12-7). Figure D12-9 (Application Reference Number: 6.4.101) shows maps indicating where a) sand (left panel, up to 1mm in diameter) and b) fine gravels (right panel, up to 8mm in diameter) would be expected to be mobilised by a spring ebb tide, plus (respectively) the typical wave (relatively calmer) and the high north wave (more dynamic) condition.

Table D12-7 Critical shear stress by particle-size classification for determining approximate condition for sediment mobility at 20°C (adapted from USGS Scientific Investigations Report 2008-5093 [RD12])

Particle classification name	Ranges of particle diameters (mm)	Critical bed shear stress (N/m^2)
Coarse cobble	128 – 256	112 – 223
Fine cobble	64 – 128	53.8 – 112
Very coarse gravel	32 – 64	25.9 – 53.8
Coarse gravel	16 – 32	12.2 – 25.9
Medium gravel	8 – 16	5.7 – 12.2
Fine gravel	4 – 8	2.7 – 5.7
Very fine gravel	2 – 4	1.3 – 2.7
Very coarse sand	1 – 2	0.47 – 1.3
Coarse sand	0.5 – 1	0.27 – 0.47
Medium sand	0.25 – 0.5	0.194 – 0.27
Fine sand	0.125 – 0.25	0.145 – 0.194
Very fine sand	0.0625 – 0.125	0.110 – 0.145
Coarse silt	0.0310 – 0.0625	0.0826 – 0.110
Medium silt	0.0156 – 0.0310	0.0630 – 0.0826
Fine silt	0.0078 – 0.0156	0.0378 – 0.0630

12.3.57 The results of the foregoing analysis reveal that, under baseline conditions, particles of sand would only be mobilised within the bays under high (north) energy wave and spring tidal regimes, and this area is widespread in inshore regions. Gravel mobilisation is largely confined to the offshore zone, but isolated pockets of gravel transport under the high north wave occur inshore in each of the major bays (Cemaes, Cemlyn, Porth-y-Pistyll) The two scenarios represented in figure D12-9 (Application Reference Number: 6.4.101) reflect two contrasting energy states under spring mid-ebb tidal conditions.

12.3.58 The observational data (captured during the sediment sampling campaign) and sediment regime baseline analysis (reported in appendix D12-2 (Application Reference Number: 6.4.81) generally support the foregoing analyses, but indicate a supply limited system. Across the four oceanographic monitoring stations there is evidence of a very weak (but perceptible) daily tidal (fine particle) resuspension signal, and an associated, but again weak, spring neap lunar variation. These cyclic periods of suspension increase nearbed sediment concentrations (variable according to site) by up to about a factor of five above ambient background concentrations (see table D12-10). Water quality samples (taken using a lund tube which captures an integrated sample of water from the surface to 10 m depth) showed the baseline mean background concentration to be 6.4mg/L. The observed range of 3.1mg/L to 25mg/L (average minimum and maximum values) is relatively low compared to other UK average values for suspended solids. More detail of water quality sampling methodology, data and analyses can be found in appendix D13-1 Water Quality and Plankton Survey Report (Application Reference Number: 6.4.83).

12.3.59 The observational data provide some indication of the change in nearbed suspended sediment concentration during high energy storms; a storm characterised by a maximum offshore wave height of 4m raised nearbed sediment concentrations to 289mg/L at site S4 on 13–15 November, 2010.

Inter and supra tidal sediments

Seabed and intertidal zone

12.3.60 Transport of sand and gravels in the Irish Sea beyond the intertidal or littoral zone has been demonstrated in many studies as having a dominantly eastward direction as shown by the insert in figure D12-5 (Application Reference Number: 6.4.101), [RD3]. However, the observed data suggest an offshore dominance of east to west ebb-flow tidal currents at the Wylfa Newydd Development Area [RD2].

12.3.61 While there could be some exchange across the littoral zone, the movement of sediment into this area from offshore is, however, considered to be minimal [RD13]. Sand and gravel lag deposits remaining within shallower waters following the marine transgression have been swept into the many coves in the area. These then form quasi-permanent littoral deposits such as the beaches around the fringes of Cemlyn and Cemaes bays (see appendix D12-2, Application Reference Number: 6.4.81)

12.3.62 Normally sediments captured in such bays would undergo some longshore drift or recirculation within the bay itself, but the sediment would generally be unable to escape from the enclosed system due to the relatively high wave energy conditions affecting the headlands. A preliminary expert geomorphological assessment undertaken in 2010 stated: "…*embayments along the north Anglesey coast generally act as closed sediment compartments, with little or no exchange of sediment from one bay to the next, and only limited supply of new sediment at the present day from eroding sections of open coast between the bays*…." [RD13].

12.3.63 For example, Cemlyn Bay and Porth-y-pistyll could be described from a geomorphological perspective as bay-head or pocket beaches contained within a low-lying embayment bounded by parallel headlands (between Trwyn Cemlyn and Wylfa Head). As such, Cemlyn Bay could also be described as a re-entrant trap, whereby introduced sediment may undergo longshore drift within the bay itself, but would be unable to escape the bay due to the high wave-energy conditions affecting the headlands [RD14].

Cemlyn Bay

12.3.64 To the west of Porth-y-pistyll within Cemlyn Bay, a substantial deposit of mainly coarse material consisting of gravels, cobbles and some sands has formed a dynamic shingle ridge/storm beach. This feature is open to the north end, where a maintained fixed weir structure regulates the tidal flow exchange with a saline/brackish lagoon landwards of the protective shingle ridge. Due in part to the sheltered conditions afforded by the shingle ridge and resulting attraction to breeding seabirds, the Cemlyn Bay and Lagoon have been designated with SSSI, Special Protection Area (SPA) and SAC status.

12.3.65 The form and function of Cemlyn Lagoon has in part been dependent upon the accumulation and endurance of the shingle barrier beach (Esgair Gemlyn). Previous work has suggested that the origins of the coarse sediments within the shingle ridge feature are a legacy deposit (swept up by the Holocene transgression), likely to be supply-limited and therefore vulnerable to change [RD13].

12.3.66 Preliminary expert geomorphological assessment based largely on previous studies, historical maps and aerial photographs, a site visit and a limited sedimentological analysis indicated: "…*there are no obvious sources of new sediment supply to the barrier and any future acceleration in sea level rise will make it increasingly difficult for the barrier to maintain its relative crest level and an equilibrium cross-sectional profile*…." [RD13].

12.3.67 Characterisation of the present intertidal sediments of the Esgair Gemlyn shingle ridge has been informed by baseline geomorphological field and desk studies supplemented by aerial imagery including LiDAR Digital Terrain Model data. The findings of these studies concur with earlier expert geomorphological assessment and sediment particle size data are summarised below in table D12-8 [RD13].

Table D12-8 Characterisation of sediment on shingle ridge (Source: [RD13])

Location	Sorting	Type	Average particle size (D50)
Upper beach/ridge crest	Moderately well sorted	Medium gravel	20-35mm
Mid-beach	Moderately sorted	Finer gravel	7-17mm
Lower beach	Poorly sorted	Fine/sandy gravel	5-9mm

12.3.68 Desk studies based upon historic map analyses report that the longer term evolution of the Esgair Gemlyn position will be a landward migration (rollback) of the feature by less than 0.2m/year [RD13]. However, future rollback is predicted to be uneven across the feature with the greatest risk of erosion to the east adjacent to the car park area at transect P10 (figure D12-10) (Application Reference Number: 6.4.101).

12.3.69 A topographic investigation into the dynamic nature and form of the Esgair Gemlyn shingle ridge was undertaken via a comparative analysis of LiDAR Digital Terrain Model data surveyed in 2010 and provided online by the Welsh Government [RD15] with new LiDAR data obtained from surveys undertaken by Jacobs in May 2017.

The 2017 (0.25m resolution) and 2010 (1m resolution) LiDAR data have been used to create cross-sectional profiles at the same transect locations established by earlier investigations [RD13]. This enabled a spatial and temporal snapshot comparison of the ridge crest locations and elevations across the transects shown in figure D12-10 (Application Reference Number: 6.4.101). The results provide an indication of the nature and extent of change during this period measured as metres Above Ordnance Datum (mAOD). Of particular interest within this period are changes in the ridge profile which may have occurred during the storm events of 2012/13, which anecdotally may have affected the profile of the shingle ridge [RD16].

12.3.70 Results of the LiDAR investigations shown in table D12-9 and illustrated in figure D12-10 (Application Reference Number: 6.4.101) represent instantaneous snap shots within the recent historic baseline.

Table D12-9 LiDAR data – comparison of 2010 and 2017 transects shown in figure D12-10 (Application Reference Number: 6.4.101)

Transect	Crest height (mAOD)				Crest location		
	2010	2017	Change (m)	% Change	2010	2017	Change (m, degrees)
P10	5.49	5.47	-0.02	-0.42	233494, 393138	233494, 393136	-0.99
P8	5.17	5.36	0.19	3.74	233279, 393213	233279, 393213	0.00
P6	4.69	4.89	0.20	4.21	233097, 393356	233098, 393357	0.99
P3	4.13	4.11	-0.02	-0.57	232987, 393699	232987, 393699	0.00

12.3.71 Comparison of the 2010 and 2017 LiDAR data reveals minor changes in the elevation of the ridge crest, with a slight lowering of the crest (by 0.02m) towards the eastern end at transect P10. In contrast, the middle to western section of the ridge reveals a modest increase in elevation of the ridge crest of approximately 0.2m.

12.3.72 A landward migration of the ridge crest by approximately 1m at the eastern end of the ridge suggests a flattening of the ridge profile, however only a slight (-0.02m) reduction in elevation was observed. The converse seaward migration of an equal distance and crest elevation by +0.2m evident at the western end suggests the possible movement of material from east to west along the ridge; however, more detailed observations would be needed to substantiate this. An increase in the crest level between these two points of +0.19m is also accompanied by a steeper profile on the seaward face (figure D12-10) (Application Reference Number: 6.4.101).

12.3.73 These overall changes within the data support the conclusions of the 2010 and 2016 studies that this is a dynamic feature [RD13] [RD17]. Both investigations reveal the dynamic baseline condition of the shingle ridge feature; and, potentially greater vulnerability of the ridge to coastal processes under existing and future climatic conditions at the eastern end adjacent to the car park.

12.3.74 The greater risk of over-washing and flattening of the profile, potentially leading to connection with small islands within the lagoon, is also recognised within the local SMP: SMP21 St. Ann's Head to Great Orme Head (Western Wales) SMP2, [RD9], especially in relation to predictions of future sea level rise.

Suspended solids

12.3.75 The baseline mobilisation and deposition of fine sediment within the study area have been inferred through modelling using the Delft3D model based on the following data sources:

- Turbidity data gathered at near-bed (Acoustic Doppler Current Profiler, ADCP) mooring locations by Titan Environmental Services during 2010 and 2011 (converted to background suspended solid concentrations of <15mg/L); and
- additional water quality sampling at points indicated in figure D12-6 (Application Reference Number: 6.4.101).

More detail of water quality sampling methodology, data and analyses can be found in appendix D13-1 (Application Reference Number: 6.4.83).

12.3.76 A summary of the water quality data, shown in table D12-10 below, indicates 'background' average suspended solid concentrations to have low variability between sampling locations. Concentrations typically range between 5mg/L and 8mg/L. Maximum concentrations show more variation, ranging between 9mg/L and 46mg/L, with a mean value of 25mg/L.

Table D12-10 Suspended solid concentrations at water quality (WQ) monitoring points

Monitoring point	Average (mg/L)	Maximum (mg/L)	Minimum (mg/L)	No. of samples
WQ1	6	17	3	66
WQ2	6	23	3	68
WQ3	8	47	3	68
WQ4	7	30	3	68
WQ5	6	23	3	68
WQ6	6	10	4	8
Mean	6	25	3	n/a

12.3.77 Results reported by Halcrow [RD4] from their modelled dredging scenario show very moderate sedimentation rates, with less than 1.0mm of fine sediment accumulation in Cemlyn Bay (even considering a long calm period); negligible amounts in Cemaes Bay and predicted accumulation of less than 0.5mm of fine sediment at the location of the breakwater. Over time, waves and currents would redistribute any sediment that is settling out of the suspended load. More detail for the sediment regime baseline, drawing upon all available sediment data and analyses, is provided in appendix D12-2 (Application Reference Number: 6.4.81).

12.3.78 Baseline suspended sediment levels represented within the hydrodynamic model show very low levels of fine sediment deposition up to 2mm in depth during calm conditions at the western side of the heads of all embayments (for details, see appendix 13-8, Application Reference Number: 6.4.90)

Sediment regime

12.3.79 A detailed study of the baseline sediment regime in proximity to the Wylfa Newydd Development Area has been undertaken specifically for this report by Partrac Ltd. The study identifies the sources, transport and supply pathways of sediment types to the different features which function as donors

or receptors within the study area (appendix D12-2, Application Reference Number: 6.4.81).

12.3.80 Utilising the investigations of the existing sediment characteristics, a seabed mobility analysis and knowledge of hydrodynamic processes, this information has been drawn together to develop a conceptual understanding of the baseline sediment regime in the area of the Wylfa Newydd Development Area.

12.3.81 The conceptualisation of the baseline sediment regime, detailed within appendix D12-2 (Application Reference Number: 6.4.81), provides an improved understanding of the interactions, transport and exchange of sediments operating both temporally and spatially along this section of coast in particular within the 'closed' embayments. These interactions have also been considered alongside any external interactions beyond the study area. A detailed explanation of the linkages, processes and in particular sediment exchange is elaborated within appendix D12-2 (Application Reference Number: 6.4.81), from which the resulting conceptual diagram is provided in figure D12-11 (Application Reference Number: 6.4.101).

12.3.82 The conceptual sediment regime presented in figure D12-11 (Application Reference Number: 6.4.101) illustrates the hypothesised direction and dynamics of sediment movement within the study area. The major sediment transport pathways, driven by the offshore tidal currents are shown by the larger arrows. The dominant ebb (east to west) current residual, observed in the fixed monitoring station data, drive the corresponding major sediment pathway towards the west to the north of the headlands.

12.3.83 Around the headlands, with deflection into the embayments weaker potential sediment transport pathways for finer sediments exist and are represented by thinner arrows. Whilst within the bays, the potential for periodic onshore-offshore transport under extreme storm conditions is shown by the dashed and double ended arrows.

12.3.84 Along the rock platform foreshore, thin lags of gravel are present, probably sourced from the local cliffs immediately behind. There is not considered to be significant levels of transport of coarse sediments alongshore or between embayments.

Coastal geomorphology baseline

12.3.85 Coastal geomorphology is typically defined as the landforms and processes under the influence of waves and currents across the tidal range. For the purposes of this chapter, the geomorphological receptors of the coastal zone within the study area are defined as those under the influence of coastal and marine processes. This includes the seabed or sublittoral zone, intertidal or littoral zone and supra-littoral zone where receptors could be affected by storm wave action.

12.3.86 Appendix D 12-1 (Application Reference Number: 6.4.80) and also in chapter B12 (Application Reference Number: 6.2.12), further details of the survey methodology and a photographic record of the key receptors are provided.

The following provides a summary of key features most relevant to this assessment.

12.3.87 Within the survey area, the coastline is composed of mainly hard rock cliffs with pockets of sandy bays. The exposed hard geology and superficial drapes of glacially derived lag deposits (drift/till) have been clearly identified. However, much of the unconsolidated material along the coastline, deposited during the glacial period and subsequent deglaciation following the Holocene marine transgression, has since been removed and redistributed by waves and tidal currents within the marine environment [RD18].

12.3.88 Six key coastal geomorphology types/ features have been identified during the walkover survey (see table D12-11). At the local scale, most key coastal geomorphology features have been represented including a number of beach cusps, a small tombolo and remnant sand dunes. Due to the steep nature of the joining topography, very short lengths of 'tidal estuary' on several unnamed tributary streams have been observed. For example, at Cemaes village approximately 100m of watercourse was determined to have both freshwater and saline influences in appendix D12-1 (Application Reference Number: 6.4.80).

Table D12-11 Geomorphological types, feature description and locations

Type	Description and locations
Type 1	Hard rock cliff. • Generally composed of hard rock types, principally the Gwna 'Melange'. Stack and island formation observed. • Found to have a few isolated (localised) storm beaches composed of small numbers of cobbles and pebbles at spots where there has been preferential erosion of weaker strata, localised pools, possibly a mix of saline and freshwater.
Type 2	Crescent-shaped bay with natural cliffs. • Found in both Cemaes and Cemlyn bays.
Type 2(a)	As above but with artificial wall at head of beach. • Found in both the Cemaes and Cemlyn bays (e.g. Traeth Mawr in Cemaes Bay).
Type 3	Saltmarsh (localised). • Assemblage of plants found in localised patches in Cemaes Bay (total is less than 1ha).
Type 4	Crescent-shaped bay (with shingle beach/barrier). • Found in the Cemlyn Bay (namely the Esgair Gemlyn). • Largely a natural feature, although there is anecdotal evidence that breaches may have

Type	Description and locations
	been artificially repaired in the past. Material forming the beach derived from reworking of glacial sediments over geological timescales along neighbouring cliffs and offshore.
Type 5	Man–made lagoon behind shingle beach. • Found in Cemlyn Bay. • This feature is not or is no longer natural and has been formed (in part) by a weir that dams water back along the shoreline.
Type 6	Hard rock platform exposed at low tide (with cliffs of softer unconsolidated material behind). • The softer cliffs (composed of unconsolidated glacially derived deposits) have been eroded back by the sea, leaving a hard rock platform on the foreshore. • Found in Cemlyn Bay notably at Hen Borth.

12.3.89 The shingle ridge or bar separating the outer Cemlyn Bay from the Cemlyn Lagoon, known as Esgair Gemlyn, has special ecological features (vegetation), and provides a protective function to the designated SSSI, SAC and SPA lagoon habitats inland and the nesting terns. As a result, the shingle above the high water mark is also protected under the SAC designation. It is therefore regarded as a sensitive receptor (including from a geomorphological perspective).

12.3.90 As a dynamic coastal feature, the morphology of the shingle ridge is also responsive to nearshore wave and tidal energy, performing a dissipative role in high energy events. During storm events the dissipation of wave energy will naturally lower the height of the shingle ridge. This adjustment also increases the likelihood of the ridge being overtopped or breached during storm events, for example during December 2013 [RD19].

12.3.91 The shingle ridge is managed by the North Wales Wildlife Trust who monitor the wildlife and habitat of the Cemlyn Bay SAC. The 2016 North Wales Wildlife Trust Cemlyn Wardens Report [RD20] notes that the shingle on the ridge '*will move during prolonged periods of high winds.*'; however, no 'rocky shore transects' were carried out during that period.

12.3.92 The findings of the coastal geomorphology baseline study in appendix D12-1 (Application Reference Number: 6.4.80) indicate stable geomorphological features under typical conditions, with longer term potential instability for sedimentary features under extreme conditions. This is due to the ancient geology, combined with relict features arising from the remnants of glacial lag deposits exposed following the Holocene marine transgression.

Coastal geomorphology receptors

12.3.93 Further to the assessment methodology presented in chapter B12 (Application Reference Number: 6.4.12), the specific coastal geomorphology

receptors identified are listed in table D12-12, together with the value assigned for the purposes of this assessment.

12.3.94 The methodology for determining value of geomorphology receptors is partly based upon the scarcity and characteristics of the feature. However, the structure and processes of some common geomorphological features underpin the resilience of functional habitats that are important to protected species and the integrity of sites designated for their ecological importance. Taking a geomorphological perspective, Cemlyn Bay is treated separately to Esgair Gemlyn and Cemlyn Lagoon, even though all lie within the Cemlyn Bay SAC/SSSI.

Table D12-12 Geomorphological receptors and value

Geomorphology Receptor	Description	Value
The seabed (including intertidal and subtidal)	• This covers the area within Porth-y-pistyll and surrounding bays west of Wylfa Head. • Valued as low due to its sensitivity and tolerance to accommodate coastal and marine processes change. Receptor occupies the study area. • It is also considered to be the only geomorphology receptor potentially effected by dredge disposal at the Disposal Site. • The Porth Wnal Dolerite is included as a receptor in chapter D7 (soils and geology) (Application Reference Number: 6.4.7) and does not form part of the geomorphological value.	Low
Cemaes Bay	• This is situated immediately to the east of Wylfa Head. • Receptor has moderate natural characteristics. It is considered to have a slightly higher sensitivity than the surrounding seabed. • This is part of the Anglesey Terns SPA. • The Porth Wnal Dolerite is included as a receptor in chapter D7 (Application Reference Number: 6.4.7) and does not form part of the geomorphological value.	Medium
Cemlyn Bay	• This is situated immediately to the west of Wylfa Head. Receptor has moderate natural characteristics and is uncommon on a regional scale.	Medium

Geomorphology Receptor	Description	Value
	• Part of the Cemlyn Bay SAC/SSSI and Anglesey Terns SPA.	
Esgair Gemlyn	• A shingle ridge situated about 400m from the Wylfa Newydd Power Station at its central point. • This is considered an important geomorphological feature in its own right and is relatively uncommon. • It provides a protective function to the adjacent designated Cemlyn Lagoon. • Designated as part of the Cemlyn Bay SAC/SSSI, and is part of the Anglesey Terns SPA.	High
Cemlyn Lagoon	• Designated as part of the Cemlyn Bay SAC/SSSI. The existence of the lagoon is dependent on the presence of Esgair Gemlyn. • Designated as part of the Anglesey Terns SPA.	High
Hen Borth Cliff	• A geological SSSI which is an important (cliff) exposure of a glacial drumlin feature located approximately 1,500m from the Wylfa Newydd Power Station at its central point. • Taken to be an important geomorphological feature. • This is part of the Anglesey Terns SPA.	High

Designated sites for coastal geomorphology

12.3.95 Whilst it has been previously noted that descriptions of the Geological SSSI and RIGS (including the Porth Wnal Dolerite coastal outcrops) are reported within chapter D7 (Application Reference Number: 6.4.7), the glacial cliff Hen Borth has been included within this report as a geomorphology receptor. This allowed for the investigation of possible pathways for sediment supply from the cliff to Cemlyn Bay and in particular, the Esgair Gemlyn shingle ridge.

12.3.96 In line with desk study findings, the baseline sediment regime report (appendix D12-2, Application Reference Number: 6.4.81) and Delft3D modelling results (appendix D13-8) confirmed that there is no linkage under baseline conditions between sediment supply from current erosion and sediment transport processes from Hen Borth to receptors within Cemlyn Bay in appendix D12-2 (Application Reference Number: 6.4.81).

Designated WFD water bodies

12.3.97 As noted in chapter B12 (Application Reference Number: 6.2.12), three WFD designated coastal water bodies are located partly or wholly within the Wylfa Newydd Development Area study area. There is no WFD water body at the Disposal Site as it is more than one nautical mile from the coast. The three WFD water bodies are The Skerries, Anglesey North and Cemlyn Lagoon. The status objectives of coastal WFD water bodies depend on the condition of specific quality elements for various characteristics including coastal geomorphology, water chemistry and marine ecology (table D12-13). The Skerries and Anglesey North WFD water bodies have an overall ecological status of 'high' and 'good' respectively.

12.3.98 The Cemlyn Lagoon WFD water body has been designated as a Heavily Modified Water Body due to its use for flood protection. It therefore has an objective to achieve Good Ecological Potential. The Cemlyn Lagoon WFD water body is currently achieving good potential.

12.3.99 The potential effects upon the specific WFD hydromorphological quality elements are assessed separately to those upon the geomorphological receptors indicated above (in table D12-12) for the purposes of this report. The detailed assessment of WFD compliance is reported in a separate supporting report to the application for development consent; however, the WFD objectives for the coastal WFD water bodies have also been taken into consideration in this chapter.

Table D12-13 WFD coastal water bodies [RD21]

Description	The Skerries water body	Anglesey North water body	Cemlyn Lagoon water body
Water body ID	GB611010390000	GB 641010620000	GB610100083000
River Basin District	Western Wales	Western Wales	Western Wales
Heavily Modified Water Body designation (cycle 2)	No	No	Yes – flood protection
2015 Overall status	High	Moderate	Good

Disposal Site

12.3.100 The Disposal Site covers the northern half of the Holyhead Deep (IS040) disposal site which was closed in April 2017, due to consent of the Minesto Deep Green Holyhead Deep Project. The Disposal Site is contained within the geographical area demarking the registered Disposal Site at Holyhead North (IS043), which was opened following consent of that project. Historical environmental data for Holyhead Deep have therefore been utilised for the Disposal Site due to the geographical overlap in these two sites.

12.3.101 The Environmental Statement and supporting technical appendices for the Minesto Deep Green Holyhead Deep Project [RD22] have been drawn upon to understand the baseline and to characterise the marine environment of the Disposal Site.

12.3.102 Horizon has also undertaken bespoke hydrodynamic modelling and benthic habitat investigations of the Disposal Site to supplement the data and information available from Minesto. This is reported in appendix D13-12 (Application Reference Number: 6.4.94) and appendix D13-8 (Application Reference Number: 6.4.90) respectively.

12.3.103 The Irish Sea has been extensively surveyed by numerous researchers and organisations. Information contained within the Minesto Environmental Statement has been further supplemented by published data to provide a more robust and comprehensive assessment of baseline conditions [RD22].

12.3.104 The Disposal Site is a rectangular area off the northwest coast of Anglesey in the Irish Sea. The site is located approximately 12km northwest of Holy Island, Anglesey and 18km from the Wylfa Newydd Development Area. The size of the site is 3.45nm (nautical miles) by 2.4nm [RD23].

12.3.105 High resolution multibeam bathymetry data collected by SEACAMS between 2013 and 2014 [RD22] show that much of the Disposal Site had a depth of between 40m and 60m. A significant part is formed of a trench with depths ranging between 70m and 100m. There are then shallower parts to the north with depths ranging between 35m and 40m.

12.3.106 Under typical wave conditions in the baseline, due to the water depths, wave energy is not anticipated to reach to the seabed. Studies (including previous work by Minesto) 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) then it is possible for some wave interaction on the seabed outside the trench area

Physical processes

12.3.107 The Irish Sea is a high-energy shelf sea [RD24] where tides are principally driven by semi-diurnal lunar and solar forces [RD25]. The tidal range in the eastern Irish Sea is high, with amplitudes of 7m in Liverpool Bay and around 4m at Anglesey resulting in high tidal current velocities. More detail of hydrodynamic data, modelling and analyses can be found in appendix D13-12 (Application Reference Number: 6.4.94).

12.3.108 Within the vicinity of the Disposal Site, depth averaged tidal currents generally range between 1.75m/s and 2m/s, with velocities exceeding 2.5m/s during spring tides. Tidal current velocity tends to vary little with depth, except near the seabed, where there is a high shear layer a few metres thick [RD25].

12.3.109 Bed shear stress in the waters off Anglesey, including at the Disposal Site, is dominated by tidal processes [RD26]. Bed shear stress generally ranges from $6N/m^2$ to $10N/m^2$, decreasing to $4N/m^2$ in the northern most depression (SEACAMS, Johnsson, pers. comm. [RD22]). Minesto stated that current induced scour at this water depth does not bring about any material changes to the seabed.

12.3.110 The North Atlantic Oscillation Index dictates the inter-annual variability in wind and wave climate in the Irish Sea. Owing to the enclosed nature of the Irish Sea, the majority of waves are locally generated and therefore have a short period and significant wave height [RD25].

12.3.111 Due to its location at approximately 12km from Holy Island, waves at the Disposal Site are not affected by the coastline. The effect of local bathymetry on the contemporary wave climate at the site is also greatly reduced by the depth of water. Characterisation of the wave climate can be summarised using maximum values for the 50-year return period, which has a 2% probability of recurrence in any year (table D12-14).

Table D12-14 Maximum 50-year return values for hydrodynamic processes in the Irish Sea [RD24]

Hydrodynamic process	Return values
Wave period	10 seconds within the Irish Sea; 15 seconds at the outer entrance, where it is characterised by high energy swell waves
Significant wave height	Between 8m and 10m within the Irish Sea
Mean wind speed at a height of 10m	Between 34m/s and 36m/s, with gusts up to 50m/s; directed from the north, northeast and southeast.

Geomorphology

12.3.112 Due to the depth of water and distance from the coastline, the geomorphology at the Disposal Site is defined by the local bathymetry, seabed features (bedrock form and sediments) and their interaction with the tidal currents rather than waves.

12.3.113 Sediment pathways defined by [RD3] indicate the movement of mobile materials driven by tidal processes from the southwest to northeast.

12.3.114 Based on an understanding of the site characteristics at the Disposal Site, the seabed is the only geomorphology receptor relevant to this topic. As noted in table D12-12, due to the extensive and common coverage of the seabed receptor, its value is considered to be low.

Evolution of baseline

12.3.115 The evolution of baseline considers the likely changes to coastal and marine processes arising naturally that are expected to have an effect upon geomorphological receptors identified within this report. Such changes could include meteorological/ climatic change effects such as ambient temperature, precipitation, storm frequency and intensity, and sea levels. Whilst the changes to temperature and precipitation are identified as aspects of climate change of primary relevance to other topics (e.g. chapter D8 surface water and groundwater, Application Reference Number: 6.4.8 and in chapter D13 the marine environment, Application Reference Number: 6.4.13), the associated effects of storm frequency and sea levels are

considered relevant to this chapter. As such these are represented within the evolving baseline scenarios.

12.3.116 For the purposes of this report, projected trends are based upon data published by UKCP09 (formerly UK Climate Impacts Programme) [RD27]. Additional refinement based on 2016 Welsh Government guidance [RD28] is also represented within the SWAN wave model results (appendix D12-3, Application Reference Number: 6.4.82).

Sea level rise projections

12.3.117 The projected sea level rise has also been derived using UKCP09 guidance and the latest Welsh Government [RD28] and English [RD29] guidance on relative sea level rise. Within the SWAN model, the 'reasonably foreseeable' future sea level rise allowances from 2008 to 2023, to 2087 and to 2187 are 0.05m, 0.67m and 2.12m, respectively (0.07m, 0.48m and 1.48m in Phase 2) with no additional allowance for surge (appendix D12-3, Application Reference Number: 6.4.82). However, it is recognised that there is continuing uncertainty with respect to sea level rise.

12.3.118 Different sea level rise scenarios could affect the scale of an effect, or the timing of changes, to coastal and marine processes and associated geomorphology.

12.3.119 Within the wave and hydrodynamic models, the effects of future climatic and/or sea level rise are both represented through the application of more extreme wave conditions and elevated wave heights and water levels. appendix D13-8 (Application Reference Number: 6.4.90) provides more detail of how these effects have been included within these modelled outputs.

12.3.120 The Wales Coastal Group Forum (2011) Shoreline Management Plan 2 (SMP2) [RD9] provides a broad-scale assessment of the risks associated with coastal evolution resulting from future sea level rise. It also presents a policy framework to address risk both to people and to the environment in a sustainable manner.

Coastal erosion

12.3.121 The SMP2 [RD9] estimates potential baseline erosion rates from both monitoring and historical maps. It makes a distinction between basic erosion of the shoreline and cliff recession, affecting the crest of cliffs and coastal slopes. SMP units within the study area include Cemaes Bay, Wylfa Head and Cemlyn Bay and headland. Table D12-15 indicates baseline erosion rates for the Cemlyn and Cemaes units provided within SMP2 [RD3].

Table D12-15 Baseline erosion rates [RD9]

Coastal unit	Rate of erosion (m/year)	Comments	100-year range for erosion (m)
Cemlyn	0.05 – 0.1	Roll back of shingle ridge, sensitive to sea level rise	20-45
Cemaes	0.2	Defended frontage	20-70

12.3.122 Within the study area hard rock cliffs are prevalent with rates of erosion that are likely to be substantially lower than the 0.05m/year erosion rate cited in table D12-15 which includes softer gravel areas [RD9].

12.3.123 It is worth noting that the values within the Wales Coastal Group Forum 2011 report [RD9] also concur with those reported for the Esgair Gemlyn feature in Pye and Blott [RD13] and [RD17]. Here analysis of historic maps also determined an average rate of landward migration of the shingle ridge of less than 0.2m/year in the period 1887 to 1990.

Cemlyn Bay and headland

12.3.124 The open western shoreline, composed of relatively hard rocks, will erode slowly. Previous work suggests that the Esgair Gemlyn (figure D12-10) (Application Reference Number: 6.4.101) is in no immediate danger of a major breach and that over-washing is relatively infrequent and small scale [RD13]. However, the frequency of over-washing appears to have increased along the central part of the barrier since 2000 and a severe event could occur at any time.

12.3.125 Studies in 2010 emphasise that there are no obvious new supplies of sediment to the beach. As a result, any future acceleration of sea level rise will make it difficult for the barrier to maintain its height and there could be a rapid landward movement of the shingle ridge as it adopts a flatter profile. By 2100, over-washed shingle could cover the area of the lagoon now occupied by the islands and a new tidal inlet could ultimately develop.

12.3.126 Historical map analysis indicates the greatest movement of the Esgair Gemlyn shingle ridge to be at the eastern end, adjacent to the car park which is currently protected by a short length of sea wall, and frequently inundated by high storm waves.

12.3.127 Future overtopping of the shingle ridge is likely to continue to be focused at this location along the ridge extent under evolving conditions. The potential for large events typically associated with changing climatic patterns to trigger threshold or stochastic events is increasingly acknowledged and recognised. In particular, the cost of ‘holding the line’ in coastal defences has come under scrutiny.

12.3.128 In recognition of the long-term outlook, the SMP2 [RD9] also suggests that for more stable features, such as fully developed shingle beaches, there will be a natural roll back and landward migration potentially in the range of 10m to 40m over 100 years. To prepare for potential stochastic events or adapt

to longer term changes, options including managed realignment have been recommended in SMP2 for consideration.

Wylfa Head

12.3.129 The risk from coastal flooding, sea level rise and erosion are considered to be low due to the predominantly higher ground with hard bedrock. The regulator, Natural Resources Wales, has advised that, based on the current understanding of coastal erosion in the area, the site could potentially be protected from the effects of coastal erosion.

Cemaes Bay

12.3.130 The breakwater at Cemaes village currently provides protection to the harbour. In the absence of defences, the coastal slope to the western side of the village would suffer significant toe erosion and encourage slope instability in the area. The shoreline would realign with significant erosion at its southern end. The wall along the main beach follows the crest of the beach. However, without the defences the beach would roll back exposing the toe of the coastal slope behind.

12.3.131 The SMP2 [RD9] also recognises that where there are softer cliffs and shorelines (not protected with walls), the rate of erosion is likely to increase with sea level rise. This could equate to a factor of 1.7 to 2.5 times the existing base erosion rate over 100 years.

Flood Consequences Assessment

12.3.132 A Flood Consequences Assessment is provided as appendix D8-3 (Application Reference Number: 6.4.28) of chapter D8 (Application Reference Number: 6.4.8).

12.3.133 In particular, the risk of coastal flooding is included within these assessments. For the purposes of coastal and marine processes and geomorphology assessment, the potential for change from existing baseline conditions is first investigated, followed by the likely significance of these changes to the geomorphological receptors identified within the zone of potential effect.

Encroachment

12.3.134 The Anglesey Local Flood Risk Management Strategy [RD30] identifies coastal development as a potential issue in two respects. Apart from its effect on flood and coastal erosion risk, this process can lead to the degradation and loss of intertidal coastal habitats and natural shoreline flood defences. Such habitats are progressively being lost, trapped between coastal development, including defences such as breakwaters or temporary causeways, and rising sea levels.

12.3.135 With a rise in sea level, together with increased wave height and intensity, the potential for inland inundation with a consequential loss of low-lying intertidal habitat becomes more likely.

12.4 Design basis and activities

12.4.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation contained within the Mitigation Route Map (Application Reference Number: 8.14). Mitigation would be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice. It is to be achieved through the Design Access Statement (Application Reference Number: 8.2.1 and 8.2.2), the Code of Construction Practice (Application Reference Number 8.6) and the Marine Works Sub-CoCP (Application Reference Number: 8.8).

12.4.2 As described in chapter D1 (proposed development) (Application Reference Number: 6.4.1), the application for development consent and Licensable Marine Activities is based on a parameter approach. The hydrodynamic and wave modelling reported in this chapter, has been undertaken in line with the tolerances within the Parameter Plans and Works Plans (Application Reference Number: 2.3). The hydrodynamic modelling included sensitivity testing of the model to a change in positioning of the western breakwater and in dredged depth. The hydrodynamic model was shown to be insensitive to a change in dredge depth of 1m; however, it was found to be sensitive to an east west shift in breakwater position. Taking a precautionary approach based on current modelling outputs and professional judgement, it was considered likely that the wave model would also be sensitive to the breakwater position. The assessment described within this chapter has therefore taken into consideration the flexibility afforded by the parameters and a worst case scenario has been assessed within the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction

12.4.3 The construction activities of particular relevance to the determination of potential changes to coastal and marine processes and assessment of effects on geomorphology receptors are described in the text below. Where there is uncertainty in design at this planning stage ahead of detailed final design, this is identified in the discussion of design and assumptions presented in subsequent sections.

12.4.4 Pre-construction activities (Enabling Works) carried out as part of site preparation and clearance with potential to affect coastal and marine geomorphology receptors due to release of fine sediments have been considered separately within the WFD Compliance Assessment (Application Reference Number: 8.26).

12.4.5 Potential effects fall into two main categories: firstly, the physical loss of materials, either through direct action e.g. dredging, or indirectly through adjustment e.g. erosion. Secondly, the physical gain of materials through deposition. These two potential effects are considered for each proposed activity.

12.4.6 The total area of seabed likely to be lost to allow for the construction of the Marine Works is approximately 30ha. This figure represents the worst case scenario given the current design.

Drainage network

12.4.7 The drainage network within the Wylfa Newydd Development Area has the potential to affect the input of sediments to the coastal and marine study area, in particular affecting deposition on the seabed. The preliminary design for surface water drainage network (in appendix D8-8, Application Reference Number: 6.4.33) shows that embedded mitigation including sediment treatment ponds (stated in volume 2 (Power Station Site) of the Design and Access Statement, Application Reference Number: 8.2.2) will reduce total suspended solid concentrations to at or below limits contained within guidance for pollution prevention.

Concrete batching plant

12.4.8 A concrete batching plant and associated infrastructure with a total area of 3.6ha would be integrated with the construction of the Marine Off-Loading Facility (MOLF). Potential effects (loss) would arise where the plant is partially constructed over approximately 2ha of the intertidal zone.

Temporary access ramp

12.4.9 To facilitate installation of the western breakwater, a temporary access ramp would be constructed at the southern end of Porth-y-pistyll. This would consist of a slipway ramp, suitable for specialist landing craft and used to import the large-scale construction plant.

12.4.10 The temporary ramp would be approximately 12m wide and up to 160m long. Construction would be from crushed rock either won from the Power Station Site or imported. Levelling and grading works would be carried out within tidal windows, with the toe of the ramp at low water spring tide level.

12.4.11 There would be temporary effects on the littoral profile and sublittoral bathymetry, potentially affecting nearshore currents, waves and suspended sediment transport.

12.4.12 The ramp would be dismantled after use and materials re-used on site or disposed of appropriately. This is anticipated to be approximately three months after construction.

Temporary barge berth

12.4.13 A temporary berthing and unloading facility would be required to accommodate barges importing construction materials for subsequent Temporary Marine Works (e.g. quay wall materials for the MOLF).

12.4.14 The berth would be located to the south of (and adjacent to) the planned site of the eastern breakwater (see figure D1-9) (Application Reference Number: 6.4.101). Its structure would 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 area

behind the retaining wall would be backfilled to create a working platform for a mobile tracked/crawler crane behind the retaining wall. An area in front of the retaining wall would be filled and levelled with rock to create a platform onto which barges could be grounded as the tidal level falls. An access ramp would be provided from the quay level down to the beach in front of the quay to facilitate plant access for maintenance of the platform.

12.4.15 There would be changes to the seabed receptor (including the intertidal zone) adjacent to the eastern breakwater (in the vicinity of MOLF construction)

12.4.16 Once the MOLF is part-constructed and the temporary barge berth is not required, it would be removed. Materials arising from removal of the temporary barge berth would be re-used on site or off site in accordance with the Contaminated Land: Applications in Real Environments code of practice (CL:AIRE Service)

Temporary cofferdam and temporary causeway

12.4.17 A temporary cofferdam (approximately 350m long) and temporary causeway (approximately 400m long) (see figure D1-9) (Application Reference Number: 6.4.101) would be constructed using rubble stone and rock armour deposited on the seabed and intertidal zone. A water tight seal would be created either using steel pile walls or interlocking steel tubular piles. The construction of the temporary cofferdam and causeway are expected to take approximately 8 months. On completion of the inner harbour works the temporary cofferdam and causeway would be removed over an anticipated period of approximately 12 months. An indicative construction schedule is provided in section 1.5 of chapter D1 Proposed Development (Application Reference Number: 6.4.1).

12.4.18 In terms of coastal and marine processes, the presence of these temporary structures would have a temporary effect on littoral profile; sublittoral bathymetry; currents and waves during temporary exclusion and dewatering of the area. From a geomorphology receptor perspective there would be changes to the seabed (including intertidal zone).

12.4.19 Dewatering of the cofferdam would involve the discharge of pumped water over the side of the cofferdams into the sea. With the exception of the initial dewatering of the inner harbour, the suspended sediment concentrations of marine dewatering activities would be monitored and limited to guidance for pollution prevention.

12.4.20 Construction would take approximately eight months and dewatering approximately ten days, with four pumps in use. The structures would be dismantled after approximately 12 months on completion of Temporary Marine Works using a reversal of installation methods.

Dredging and excavation

12.4.21 Superficial soft sediments will be dredged from the outer harbour to provide a solid foundation for the breakwaters and MOLF, and to ready the area for excavation which is required to create sufficient depth for the intake and

navigation channel. The term 'inner harbour' refers to the area inside the temporary cofferdam whilst the term 'outer harbour' refers to the remaining area in Porth-y-pistyll requiring excavation.

12.4.22 The target dredge depth for the inner harbour is -10mAOD (plus a tolerance of 1m, which is related to excavation by drill-and-blasting in dry condition).

Dredging soft sediments

12.4.23 The superficial soft sediment (mainly sands and gravels) would be removed by conventional dredging plant such as a backhoe dredger, cutter suction dredger or trailing suction hopper. For the purpose of the assessment the worst case upper limit of soft sediment that would be dredged is a bulked volume of 242,000m^3 (equating to a saturated density of approximately 352,000 wet tonnes, based on a specific gravity of 1.6), although the values are likely to be considerably less.

Dredging of the outer harbour

12.4.24 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. The duration of this activity would be about 16 months. For the purposes of the assessment the worst case upper limit of rock that would be removed from the outer harbour by wet excavation is a bulked volume of 368,000m^3 (equating to an in situ density of approximately 709,714 tonnes, based on a specific gravity of 2.7). Dredged bedrock would be re-used for the construction of the cores of the western and eastern breakwaters where appropriate (i.e. geotechnically suitable) and practical (i.e. available when the breakwater construction requires it), or exported off-site for re-use. The remaining dredged bedrock that cannot be re-used would be disposed of at the Disposal Site.

Dry excavation of the inner harbour

12.4.25 Within the inner harbour, dry excavation would take around 14 months in total with preliminary excavation beginning onshore up to the 0mAOD and taking around six months. Once the cofferdam was put in place, drilling and rock fracturing by blasting would be carried out for approximately seven months.

12.4.26 Approximately 500,000m^3 bedrock would be excavated in the dry, including the excavation directly in front of the Cooling Water (CW) intake structure. The excavated material would be re-used or disposed of appropriately.

Re-use and disposal of dredged materials

12.4.27 Dredged material arising from the wet excavation works would be re-used on-site (e.g. for core material in the CW intake breakwaters) or off-site where practicable, and the remaining material would be disposed of at sea.

12.4.28 Disposal of excavated rock and soft sediments would be carried out at the Disposal Site. The worst case volume for material that could require disposal

at sea is approximately 610,000m^3. This would comprise approximately 368,000m^3 of bulked rock material and 242,000m^3 of bulked soft sediment.

12.4.29 Assuming a barge with approximate capacity of 3,500m^3, it would take 35 days to dispose of the sediment. However, this assumes a continual series of disposal events without break and is therefore a worst case with regard to the sediment plume and any corresponding deposition on the seabed (see appendix D13-12, Application Reference Number: 6.4.94).

12.4.30 Rock would be disposed of over the duration of the wet excavation works, taking approximately 16 months (chapter D1 Application Reference Number: 6.4.1).

Vessel movement

12.4.31 Movements of vessels during construction potentially cause changes to surface waves and sedimentation caused by local sheltering or reflection effects.

Western and eastern breakwaters

12.4.32 Two breakwaters are required to protect the CW intake and MOLF from wave action. Their presence would create a sheltered area of water within Porth-y-pistyll to optimise wave conditions for operation of the CW intake equipment. The breakwaters would also ensure safe conditions for vessels accessing and berthing at the MOLF.

12.4.33 The western breakwater would be detached from the shoreline with a crest height of between 10mAOD and 14mAOD and a length of 400m.

12.4.34 The eastern breakwater would be shore-connected with a crest height of between 9mAOD and 12.2mAOD and approximately 150m in length.

12.4.35 Construction and materials for the breakwaters are described in chapter D1 (Application Reference Number: 6.4.1). Both breakwaters would be rock filled structures covered with pre-cast concrete armour arranged as a precise grid and where practical rock armour. The interlocking concrete armour would provide surficial roughness to dissipate the energy of incoming waves, reducing the reflective energy potential. Superficial soft deposits on the seabed would be removed initially by standard dredging plant, such as a cutter suction dredger and/or backhoe dredger, prior to placement of a gravel erosion mat on the breakwater footprint for scour protection, followed by rubble stone mounding. It is expected that the removal of soft sediments would run for approximately 10 months. Approximately 220,000m^3 (in-situ) is the maximum volume of superficial deposits that would be dredged across the site (including both material under the breakwater and elsewhere).

12.4.36 The western breakwater would be constructed predominantly from land, by building a temporary causeway supporting a haul road to allow delivery of material in dump trucks. The causeway and subsequently the permanent western breakwater would be gradually extended as more material is added. Parts of the breakwater could also be constructed by offloading from a barge and placing rock, material or concrete into position.

12.4.37 The eastern breakwater would also be constructed from land working seawards using similar methods, materials and plant as for the western breakwater (see chapter D1, Application Reference Number: 6.4.1). Following subsequent removal of the temporary causeway, the gap between the land and the permanent western breakwater, would maintain a circulating flow of water. This would allow for localised currents to maintain mixing and the dispersion of any fine suspended sediments within the harbour area.

12.4.38 From a coastal and marine processes perspective there would be changes to the littoral profile, sublittoral bathymetry and nearshore currents and waves. There would be potential effects on the seabed (including the intertidal zone).

MOLF

12.4.39 The MOLF is required to facilitate the construction of the Power Station and would therefore be constructed early in the programme and be operational throughout the Power Station construction phase (see figures D1-2). The MOLF has been co-located near the CW intake structure to ensure a marine footprint that is as small as possible.

12.4.40 The MOLF would consist of the following components.

- A Bulk Quay consisting of two platforms with maximum surface area approximately 65m x 30m. The platform level would be +5mAOD to +6mAOD.
- A Roll-on Roll-off (Ro-Ro) MOLF (berthing facility) with a quay length of approximately 100m by 40m width to enable deliveries of bulk materials by sea. The footprint of the Ro-Ro MOLF would be approximately 0.7ha.
- A Layby berth to provide a safe haven for mooring when other berths are occupied.

12.4.41 Further details on the construction and materials for these facilities are provided in chapter D1 (Application Reference Number: 6.4.1). For the purposes of this assessment, a worst case scenario for temporary works with the greatest footprint has been assumed. This is considered to be:

- preparation of the sub-base for both the bulk material and Ro-Ro MOLF would require rock to be cut and profiled using excavation in the dry by drill-and-blasting;
- construction of the bulk material MOLF and Ro-Ro quay would involve the installation of pre-cast concrete block structures placed on the sub-base; and
- the Ro-Ro MOLF would be constructed in the dry behind a cofferdam.

12.4.42 Examples of the types of construction plant required are identified in table D12-16. This is not a complete plant list but the anticipated levels of effects based on this plant list are not significant and not sensitive to any minor variations envisaged.

12.4.43 From a coastal and marine processes perspective there would be changes to the littoral profile and sublittoral bathymetry would potentially affect

nearshore currents, waves and suspended sediment concentrations. From a geomorphology receptor perspective there would be effects on the seabed and intertidal zone.

Table D12-16 Equipment proposed for dredging and excavation activities

Plant required for construction
• jack-up platforms; • variety of cranes; • barges for the transport of materials; • drilling rigs; • dredgers; and • work and safety boats.

12.4.44 The MOLF would operate on a 24-hour basis throughout the whole construction period which is expected to last seven years. Different types of vessels (Ro-Ro, Lo-Lo bulk vessels including barges) would use the MOLF to transport general equipment, cement and aggregate.

Shore protection

12.4.45 Adequate shore protection would be provided where dredging or excavation could lead to shore erosion and/or unacceptable wave overtopping discharges. Locations for shore protection would include:

- between the eastern breakwater and the shoreline (approximately 80m in length); and
- between the two bulk MOLF platforms.

Shore protection would take the form of rock revetments or seawalls and would be tied-in with the adjacent structures (e.g. breakwaters, quay walls). The toe of the shore protection would be below MLWS at the dredged seabed depth, which would be approximately -10mAOD.

Shore protection would affect the littoral profile, nearshore currents and waves. There would be changes to the geomorphology receptor, seabed (including the intertidal zone).

Cooling Water intake and outfalls

12.4.46 The Cooling Water System is described in chapter D1 (Application Reference Number: 6.4.1). The location of the CW intake would be at Porth-y-pistyll, with the CW outfall located at Porth Wnal (adjacent to the outfall of the Existing Power Station).

12.4.47 Cooling Water tunnels would be primarily excavated by controlled drilling and blasting. The discharge channels at the CW outfall would be constructed using a cut-and-cover methodology. At both locations rock excavation would be completed in the dry behind cofferdams.

12.4.48 At the Porth-y-pistyll CW intake, an additional cofferdam constructed using pre-bored piles would be required in front of the intake. This would remain in place after removal of the inner harbour cofferdam as the tunnelling works

and installation of forebay infrastructure would take longer than the marine excavation and construction works.

12.4.49 From a coastal and marine processes perspective, the littoral profile, sublittoral bathymetry and nearshore currents and waves would all be potentially affected. There would also be potential release of suspended sediment during temporary exclusion and dewatering of the area. The seabed would be subject to a soft sediment dredge with bedrock blasted to excavate or ripped out to a level area of -10mAOD.

12.4.50 The cofferdam at the CW outfall would be constructed using one of three options:

- Twin sheet piled wall gravity structures;
- Twin tubular pile wall gravity structure; or
- Rock bund type cofferdams similar to the semi-dry cofferdam (not considered for the Cooling Water intake structure).

12.4.51 It is anticipated that blasting/chemical splitting could be used for local areas of hard rock. Each discharge tunnel would be approximately 1.1km in length from the seal pit to point of discharge (approximately 200m of cut and cover and 900m of bored tunnel).

12.4.52 The CW outfall discharge tunnels would have a common concrete apron. Construction would take approximately eight months and removal around 12 months. There would be a temporary effect on littoral profile, sublittoral bathymetry, currents and waves during temporary exclusion and dewatering of the area.

Basis of assessment and assumptions

12.4.53 This section sets out where any additional assumptions have been made to enable the assessment of construction activities to be carried out at this stage in the evolution of the design.

12.4.54 The assessment of potential changes to coastal and marine processes resulting from the construction activities described above has been investigated through two model platforms. The hydrodynamic model, Delft3D, primarily investigates the fully built condition, while the wave model, SWAN (with ARTEMIS inside the harbour area) investigates potential changes in waves for the construction activities under two scenarios to reflect the presence of temporary as well as the permanent structures present during the construction period. The two construction scenarios are summarised as:

- ‘partially built’ – with cofferdam area and partial extent of western breakwater; and
- ‘fully built’ – with full extents of MOLF Ro-Ro quay and western/eastern breakwaters.

12.4.55 Embedded and good practice mitigation has been considered in the initial assessment to ensure that realistic scenarios (including a worst case) have been assessed as a starting point before consideration of further mitigation.

Embedded mitigation

12.4.56 The design and construction of the breakwaters, MOLF, CW intake and outfall structures and dredging activities would include a number of features consistent with reducing changes to coastal and marine processes and effects on coastal geomorphology receptors (as shown in volume 2 of the Design and Access Statement, Application Reference Number: 8.2.2). These primarily include footprints as small as practicable for the breakwaters and the temporary causeway and compressing the length of time for construction.

12.4.57 Potential effects of additional fine sediments in watercourses discharging to the marine environment would be mitigated through the construction drainage system designed to reduce the mobilisation and transport of fine suspended sediments, as detailed in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) and the Main Power Station Site sub-CoCP (Application Reference Number: 8.7).

Good practice mitigation

12.4.58 Good practice mitigation during construction would include adhering to the following:

- Wylfa Newydd Code of Construction Practice (Application Reference Number: 8.6);
- Main Power Station Site sub-CoCP (Application Reference Number: 8.7); and
- Marine Works sub-CoCP (Application Reference Number: 8.8); and

These documents contain specific mitigation measures in relation to air, noise, traffic, and water quality, including the implementation of appropriate guidance for pollution prevention.

Operation

12.4.59 Potential effects arising from construction may continue into the operational phase. Licensable Marine Activities specifically carried out during operation and relevant to coastal and marine processes and geomorphology are detailed in the text below.

MOLF and breakwaters structures

12.4.60 All or part of the MOLF may be retained for use during Power Station operation. Whilst the bulk quay is expected not to be required, the Ro-Ro quay may be used for delivery of replacement parts which are Abnormal Indivisible Loads (AIL) to avoid road transport. It is currently assumed that only one vessel per year would use the MOLF during operation.

12.4.61 During operation the western breakwater would be a standalone structure with no connection between the breakwater and the land to allow through flow of water.

Power Station operation

12.4.62 The process of abstraction of seawater is not regarded to be applicable to coastal geomorphology receptors.

12.4.63 Discharges from the CW outfall could cause localised changes to coastal and marine processes and effect the seabed as a consequence of locally increased shear stresses.

Maintenance dredging and disposal

12.4.64 Dredging is likely to be required to maintain sufficient depth in front of the intake and to allow continued access to the MOLF. The dredged material would be deposited at the Disposal Site. The volume of dredged material (sediment) would be significantly smaller than that for the capital dredging programme and consist largely of dispersive material.

Basis of assessment and assumptions

12.4.65 The following assumptions are made to determine potential changes to coastal and marine processes and coastal geomorphological receptors:

- The CW abstraction and associated discharge would vary according to the state of the tide during the lifetime of the Power Station Site resulting in a variation of flows.
- Vessel movements inside the harbour would be limited to maintenance dredging activities and very infrequent movements (<1 per year) linked to the delivery of abnormal indivisible loads during operation.

Embedded mitigation

12.4.66 The key embedded mitigation for operation of the western breakwater (after removal of the temporary causeway) would be a gap between it and the land to enable continued throughput and flushing of water and sediment as defined in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2).

12.4.67 As stated in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2), the western breakwater would be designed to include interlocking concrete armour. The function of this armour would be to increase surface roughness on the west and north-west facing perimeter increasing the absorption of incident wave energy thus reducing the reflection of that energy. Such features also have additional potential environmental benefits with respect to habitat provision, as described within chapter D13 (Application Reference Number: 6.4.13).

12.4.68 The management of the intake and outfall flows includes a number of features intended to reduce changes to erosion or deposition, as stated in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2). These include designing as small a footprint to the structures as practicable and compressing the length of time taken to construct.

12.4.69 As stated in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) the CW intake velocity has been designed not to exceed 0.3m/s at Lowest Astronomical Tide which is 3.6m below AOD. This has been designed to mitigate localised erosion and scour as far as practicable inside the inner harbour area.

Good practice mitigation

12.4.70 Management strategies would be set out in the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13). This would outline how targets, to be agreed with regulators, would be achieved with respect to management and implementation.

Decommissioning

12.4.71 Licensable Marine Activities associated with decommissioning are detailed in chapter A1 (Application Reference Number: 6.1.1). Of particular relevance to coastal geomorphology receptors would be removal of structures including the cooling water intake and outfall.

Basis of assessment and assumptions

12.4.72 The details of decommissioning are not known at this time and to facilitate assessment a number of assumptions have been made:

- Wylfa Newydd Power Station would operate for 60 years;
- both reactors would be decommissioned simultaneously;
- removal of structures including the intake, outfall and MOLF, but not the breakwaters.
- civil structures greater than 1m depth would be left in situ and backfilled or grout filled, including the discharge water channel and the discharge water tunnels; and
- removal of structures would be carried out using the same type of equipment and methods as for construction.

Embedded mitigation

12.4.73 Embedded mitigation during decommissioning would be based upon standard construction best practice applicable at the time.

Good practice mitigation

12.4.74 Good practice mitigation during decommissioning would be based upon standard construction best practice applicable at the time.

12.5 Assessment of effects

12.5.1 This section presents the findings of the changes to coastal and marine processes and assessment of effects on geomorphology receptors associated with construction, operation and decommissioning at the Wylfa Newydd Development Area, and disposal of material at the Disposal Site.

12.5.2 Building upon previous studies [RD4], new evidence within this assessment includes wave, current and sediment modelling using the best available information with industry-accepted approaches including Delft3D hydrodynamic and SWAN wave models (as detailed in chapter B13; (Application Reference Number: 6.2.13)). The 2012 assessment [RD4] was undertaken for a similar layout for the Marine Works, but with a western breakwater greater than 500m in length and permanently connected to the shoreline. The current design of the western breakwater is for a structure 400m in length and disconnected from the shoreline. The design has evolved to reduce the effects upon the marine environment, as described below.

12.5.3 The assessment that follows firstly considers potential changes to coastal and marine processes as a result of the construction and operation of Marine Works. Decommissioning is considered here only in brief as this would be subject to a separate and more detailed Environmental Impact Assessment investigation.

12.5.4 Coastal and marine processes (comprising of waves, tidal currents and sediments) are driven by the levels and patterns of prevailing energy including (but not limited to) the wind, gravity, temperature, tidal cycles, diurnal patterns etc. Such patterns can be predictable, periodic (cyclical) or unexpected and subject to random (or stochastic) changes depending upon seasonal and/or climatic variations, for example sudden extreme storm events, with the ability to bring about shifts in boundary thresholds.

12.5.5 Analyses of the scale of potential changes (to waves, currents and bed shear stresses leading to effects upon the sediment regime, including fine sediment plumes) informs the assessment of potential effects upon coastal geomorphology receptors.

12.5.6 Comparative analyses of the modelled results have been undertaken to compare the baseline without the Power Station or ‘no PS’ conditions and those with the Power Station or ‘with PS’. These two conditions have been used to assess the potential effects of the Power Station for both the construction and operational periods. More information on the assessment approach is provided in chapter B12 (Application Reference Number: 6.2.12) with further details of modelling methodology and results provided in appendix D13-8 (Application Reference Number: 6.4.90).

12.5.7 It is important to note that detection of differences (between the ‘with PS’ and ‘no PS’ model scenarios) are limited by the sensitivity of the model to small changes in flow field and other variables. As such they should not be interpreted as absolute values but as indications of the likely scale and direction of potential change.

Construction

12.5.8 The proposed Licensable Marine Activities described in section 12.4 could have the potential to affect already complex and dynamic coastal and marine processes over short and longer term time frames and at different scales. The following assessment is focused upon potential changes to these

processes which could lead to a significant effect upon the geomorphology receptors.

Determination of changes to coastal and marine processes

12.5.9 Changes to coastal and marine processes associated with construction within the Wylfa Newydd Development Area have been identified through hydrodynamic (Delft3D) (appendix D13-8, Application Reference Number: 6.4.90) and wave (SWAN) (appendix D12-3, Application Reference Number: 6.4.82) modelling investigations.

12.5.10 Investigations of potential changes to coastal and marine processes during construction have been focused upon two key sets of modelled results. These include both the predicted changes to surface wave conditions (in SWAN at the Wylfa Newydd Development Area); as well as the predicted changes to coupled tidal currents and wave (in Delft3D at the Wylfa Newydd Development Area and at the Disposal Site) in relation to:

- effects upon wave height adjacent to Esgair Gemlyn;
- effects upon seabed shear stress and associated sediment mobilisation patterns resulting from new structures and Licensable Marine Activities associated with the Power Station; and
- the dispersal and deposition of material arising from sediment plumes generated by drainage discharge and dredging activities within the Wylfa Newydd Development Area and for dredging at the Disposal Site.

Waves and tidal currents

12.5.11 To investigate the possible effects of the proposed Licensable Marine Activities upon waves and tidal currents, a selection of 'with PS' scenarios have been run (primarily within SWAN) at various stages of the proposed construction activities ('partially built' and 'fully built', as noted in section 12.4 under *Basis of assessment and assumptions*). These scenarios have then been compared to the baseline model predictions. It is important to note the rarity of the northerly 99th percentile wave conditions (i.e. with a 1 in 100 probability of occurrence) which have been selected for this assessment, to represent 'worst case scenario' winter storm conditions. For the assessment of effects around Cemlyn Bay, Cemaes Bay and the wider offshore marine environment, an investigation of significant wave heights has been undertaken.

12.5.12 Additional model runs have been undertaken to test the sensitivity of the results for a wider range of wave directions, taking in additional wave directions from the west to the north-east at 5 degree intervals. The additional sensitivity runs have been reported within appendix D12-3 (Application Reference Number: 6.4.82). Localised changes in wave height modelled during the extreme 99th percentile condition for waves approaching from the north-west and west under a future foreseeable scenario (2087) are shown to be minimal, occurring over the widest area for the lowest band wave heights (below 1m). Potential increases between 0.1m and 0.2m in localised

areas would remain within the range of existing variability under baseline conditions.

12.5.13 The Delft3D hydrodynamic model has been used to assess the potential influence of the Licensable Marine Activities associated with the Wylfa Newydd Project on the tidal currents during construction (appendix D13-8, Application Reference Number: 6.4.90). This work has allowed a determination of changes to current speeds and associated bed shear stresses. Overall the work has shown that changes of tidal current speeds are minimal. These changes, specifically in relation to bed shear stress, are described below.

12.5.14 Analysis of all wave scenarios run within SWAN has revealed the greatest potential changes in wave heights for the largest waves approaching the near shore occurs with the most severe winter storm (99th percentile) waves arising from the northwest. As noted in the baseline section (12.3) waves entering Cemlyn Bay from the north-east wave direction are aligned with the headlands and the orientation of the western breakwater, therefore the marine structures have a lesser effect upon the height of waves entering from that direction. In contrast, waves entering from the north-west are directed towards the breakwater, therefore a reflection off the structure is observed (figure D12-12, Application Reference Number: 6.4.101).

12.5.15 Figure D12-12 (Application Reference Number: 6.4.101) shows two indicative comparisons of modelled wave height for the strongest (99th percentile) winter wave arriving from the north-west. The upper images allow comparison between the baseline and partially built scenario (with cofferdam and partial breakwater), whilst the lower images compare the baseline and the fully built scenario (with breakwaters and MOLF). Please note, for the fully built scenario, results within the wave modelling report were found to be very similar for both time periods modelled (appendix D12-3, Application Reference Number: 6.4.82). Hence the foreseeable future scenario shown, is indicative of a worst case rare winter storm event irrespective of time period. Both pairs of images show the effect of wave reflection at the western breakwater under severe storm conditions, with localised increases in wave height. However, within Cemlyn Bay, wave heights are low and changes in wave height appear to be very small.

12.5.16 Figure D12-13 (Application Reference Number: 6.4.101) compares the differences in wave height using images generated by the SWAN model for four paired scenarios, selected for different wave directions and conditions. The first (top left image) shows present day summer wave conditions with a small decrease in wave height behind the western breakwater ranging between -0.1m to -0.2m. The lower left image depicts severe winter storm conditions, with waves from the north-east under a present day fully built scenario. Here the small decrease in waves adjacent to the western breakwater reflects the alignment of waves to the structure. Some small areas of increased wave height immediately north of and within the harbour area are depicted alongside of decreases in wave height in more sheltered areas.

12.5.17 For the summer (typical) and winter (worst case) wave conditions shown in figure D12-13 (Application Reference Number: 6.4.101), the SWAN model outputs show extensive areas where the change in wave height ranges between -0.1m and +0.1m (shown in white).

12.5.18 The upper and lower right images of figure D12-13 (Application Reference Number: 6.4.101), showing the differences in wave height for severe storm conditions with winter waves from the north-west, complement those presented in figure D12-12 (Application Reference Number: 6.4.101) for a present day partially built scenario (top right) and a foreseeable future fully built scenario (lower right). By looking at difference maps (figure D12-13) (Application Reference Number: 6.4.101) increased wave heights resulting from the reflection of the waves from the western breakwater can be seen. This contrasts with a decrease of wave heights within the sheltered harbour area itself. In both scenarios the increased height of reflected waves west of the breakwater is localised and dissipates within outer parts of Cemlyn Bay.

12.5.19 A very small area of increased wave height is also depicted towards the rear of Cemlyn Bay under the foreseeable future fully built scenario. On figure D12-12 (lower left image) (Application Reference Number: 6.4.101), it can be seen that baseline wave height values in this location are relatively low, within the range of 1.0m to 1.2m, potentially rising to 1.2m to 1.4m and therefore lower than the baseline values for storm waves from the north-east (shown in figure D12-3) (Application Reference Number: 6.4.101) in the same location. These differences have been further investigated through time series data generated by the SWAN model and reported in appendix D12-3 (Application Reference Number: 6.4.82).

12.5.20 Within the SWAN model, a set of points were chosen to investigate modelled data outputs through time series generated by the 35.5-year model run (appendix D12-3, Application Reference Number: 6.4.82). This assessment used two points to interrogate the data:

- Point 8: immediately west of the western breakwater; and
- Point 6: within Cemlyn Bay, adjacent to Esgair Gemlyn.

12.5.21 Statistical analyses of the data for time series at points west of the western breakwater (point 8) and adjacent to Esgair Gemlyn (point 6) were undertaken to further investigate to potential effects under worst case winter storm scenarios. Selected results for the present day northerly winter storm conditions for partially built and fully built scenarios are provided in table D12-17.

Table D12-17 Changes in wave height (SWAN model results) for worst case (winter, 99th percentile wave) present day (2023) scenarios over 35.5-year model period

Point	Difference (partially built minus baseline) in significant wave heights for present day winter wave from north-west sector		Difference (fully built minus baseline) in significant wave heights for present day winter wave from north-east sector	
	Difference as mean significant wave height (%)	Difference as 99%ile significant wave height (%)	Difference as mean significant wave height (%)	Difference as 99%ile significant wave height (%)
6 (Cemlyn Bay)	+2%	+1%	+1%	-1%
8 (Western Breakwater)	+7%	+9%	-14%	-10%

Source: SWAN (appendix D12-3, Application Reference Number: 6.4.82)

12.5.22 The differences in wave heights for the partly built and fully built structures under present day (2023) scenarios (shown in table D12-17) are extracted from the 35.5-year time series for the 50th and the 99th percentile values. These metrics were chosen to represent the average and worst case, respectively. These data have been chosen to match the 'difference' (scenario minus baseline) images shown in figure D12-13 (Application Reference Number: 6.4.101) for the present day winter storm 99th percentile conditions for partially built (top right image) and fully built (lower left image) scenarios presented as the worst case.

12.5.23 The results for the present day fully built scenario with storm waves approaching from the northwest are very similar to the foreseeable future result, which are presented in the operational assessment section. More detail of the full set of scenario results can be found in appendix D12-3 (Application Reference Number: 6.4.82).

12.5.24 Immediately west of the western breakwater (point 8) the differences in wave height predicted by the wave model include the following potential changes.

- Under a partially built scenario, with the cofferdam in place, and storm waves approaching from the north-west, there could be a change in wave height ranging between +7% to +9%.
- Under a fully built scenario, with storm waves approaching from the north-east, there could be a change in wave height ranging between -14% to -10%.

12.5.25 Adjacent to the Esgair Gemlyn within Cemlyn Bay (point 6).

- Under a partly built scenario, when the cofferdam is in place, with storm waves approaching from the north-west, there could be a change in wave height ranging between -1% and +2%.

- Under a fully built scenario, with storm waves approaching from the north-east, there could be a change in wave height ranging between +1% and -1%.

12.5.26 In 2012, investigations by [RD4] predicted a potential increase in wave height of 0.25m west of the proposed western breakwater, due to the reflection of waves from a breakwater structure greater than 500m in length and connected to the shoreline. The increase in wave height adjacent to the Cemlyn Bay shingle barrier beach, Esgair Gemlyn, was predicted to be in the range of 10cm to 15cm. This increase was associated with only a very narrow band of wave directions (approaching from a westerly direction), for smaller waves and not for the most extreme waves [RD4].

12.5.27 By comparison, for the partially-built condition the 2017 SWAN investigations (appendix D12-3, Application Reference Number: 6.4.82) for a 400m breakwater, disconnected from the shoreline presented in this report found localised decreases in wave height under all wave conditions and small areas of increased wave height for winter storm conditions only. The SWAN results have shown the greatest potential increases in wave heights under winter storm conditions arising from the north-west to occur in small areas up to a maximum of 0.4m (figure D12-13) (Application Reference Number: 6.4.101). Statistical analysis of data from immediately to the west of the western breakwater (at point 8), shows an increase ranging between +7% and +9% upon a baseline wave height of 3.0m to 3.5m (figure D12-3) (Application Reference Number: 6.4.101). At the head of Cemlyn Bay adjacent to Esgair Gemlyn (at point 6), under the same winter storm conditions, an increase in wave height ranging between +1% and +2% is indicated upon a baseline wave height of 1.0m to 1.2m (figure D12-3) (Application Reference Number: 6.4.101).

12.5.28 At the same locations, decreases in wave height of up to -14% west of the western breakwater (at point 8) and -1% adjacent to Esgair Gemlyn (at point 6) are calculated for storm waves arising from the northeast. This is due in part to sheltering effects and the broad alignment of the western breakwater structure with the more powerful waves entering the bay from the northeast.

12.5.29 Additional wave simulations, carried out using the SWAN wave model, were conducted to explore the sensitivity to offshore wave direction, providing results at 5° spacing within the W, NW, N and NE sectors for the ‘2087 reasonably foreseeable’ conditions, applying the same wind conditions as for the 99th percentile condition in the sector. The full set of results are provided in appendix D12-3 (Application Reference Number: 6.4.82). The results indicate, for waves approaching from the west, a larger extent of potential increase in wave height, ranging between 0.1 and 0.2m occurring to the west of Cemlyn Bay. Comparison with the baseline wave conditions shows this change to be effective upon smaller wave heights up to 1m. Therefore. the predicted potential increases in height for storm waves approaching from the west would be within the range of wave conditions currently occurring within Cemlyn Bay for storm waves approaching more directly from the north east. The modelled results showing a small extent of change on the largest waves are confirmed as those approaching from the north-west sector, as

presented in figure D12-13 (Application Reference Number: 6.4.101) and reported above. All results for baseline and changes in wave height are provided in appendix D12-3 (Application Reference Number: 6.4.82).

Sediment processes

12.5.30 Alterations to combined waves and tidal current patterns indicated by the Delft3D hydrodynamic model have been used to investigate potential changes to sediment mobilisation and transport processes which could cause scour and/or deposition to geomorphological receptors identified in the baseline section (table D12-12). In particular, these investigations focused on the potential effects arising from predicted local changes in coastal and marine processes upon the shingle ridge feature (Esgair Gemlyn) and lagoon of the Cemlyn Bay SAC, both identified as receptors of high value.

12.5.31 Encroachment associated with construction of the breakwaters and MOLF within Porth-y-pistyll could also affect tidal currents and waves in that location. In combination with the excavation of the seabed (to -10mAOD), it is expected that the overall potential changes to the hydrodynamics within the harbour area could lead to an increase in the deposition of fine sediments. Based upon the hydrodynamic model results for changes in bed shear stress, this effect would be periodic and of a small magnitude. Furthermore, the baseline concentrations of fine suspended sediments within Cemlyn Bay reported in section 12.3 are shown to be relatively low. Embedded mitigation within the design, comprising the opening at the landward end of the western breakwater, would allow tidal currents to maintain a circulation of flow, keeping deposition to a minimum.

12.5.32 Hydrodynamic model investigations into the potential effect of fine sediment deposition from combined natural and artificial sources during the construction period have also been carried out. Changes to bed shear stress and sediment entrainment have been used specifically to determine where, and to what extent, existing sediment pathways could be affected. The findings of the investigations reported below are those considered as significant to the assessment of potential effects. Further information on the methodology and additional model results for waves and hydrodynamic processes are located within appendix D13-8 (Application Reference Number: 6.4.90).

Changes in bed shear stress

12.5.33 Bed shear stress acts to mobilise material at the seabed. Tidal currents then transport the suspended material either by saltation (i.e. particles ‘bounce’ along the seabed) or in suspension, depending on the size of particle and their specific density. Spring tidal conditions over a flood-ebb cycle have been selected as the most dynamic to represent worst case scenario for the determination of changes in bed shear stress for the fully built condition. It is important to note that potential changes in bed shear stress have been assessed in relation to baseline values, sediment mobility potential (table D12-7) and the presence of local sediments, to determine the significance of effect upon the geomorphological receptors.

12.5.34 Critical to the assessment of potential effects is the determination of localised changes in bed shear stress which could lead to additional scour/erosion or deposition. [RD4] reported maximum differences in bed shear stresses that would be typically low, ranging between 0.2N/m² and 0.3N/m² following construction of an extended (500m) breakwater connected to the shoreline.

12.5.35 The modelling outputs presented in figure D12-14 (Application Reference Number: 6.4.101) show the bed shear stresses for fully built 'with PS' scenarios (including a 400m breakwater, disconnected from the shoreline) for the same range of wave and (spring mid-ebb) tidal conditions presented in the baseline section (figure D12-8) (Application Reference Number: 6.4.101). Comparison between the two sets of figures confirms that the same areas of highest bed shear stress have been predicted to occur close to the shore near the headlands to the west of Cemlyn Bay (Trwyn Cemlyn) for all wave conditions. Comparatively high levels of bed shear have also been indicated to the west of Porth-y-pistyll for winter waves. Under both baseline and fully built scenarios, values of greater than 12N/m² (with potential to mobilise coarse gravels where present) have been predicted in the same locations, with slightly different spatial coverage predicted at Porth-y-pistyll due to the presence of the new structures.

12.5.36 Changes over a full spring cycle are indicated in figure D12-15 (Application Reference Number: 6.4.101). For the high north wave scenario, the patterns of bed shear over a full spring tidal cycle are changed by the presence of the breakwaters but do not increase in their magnitude. At the Esgair Gemlyn, a small decrease in bed shear stress has been indicated towards the eastern end of the shingle ridge (figures D12-8 and D12-15, lower right image) (Application Reference Number: 6.4.101).

12.5.37 Within the bays (Cemlyn, Porth-y-pistyll and Cemaes) the changes to bed shear stress are minimal and, with the exception of Porth-y-pistyll, highly localised. In the head region of Cemlyn Bay near to the ridge the results show no change in bed stress, save except for a small localised zone to the north and associated with the ebb tidal delta of the lagoon drainage system. Within Porth-y-pistyll the changes are clearly dominated by a reduction in bed shear stress (figure D12-15) (Application Reference Number: 6.4.101) with the only increases occurring to the north of the bay, between the breakwaters, and then only during the infrequent high north wave scenario.

12.5.38 In terms of the modelled decreases to bed shear stress, values in most areas range between -0.1N/m^2 and -0.5N/m^2 with some very small pockets of maximum bed shear stress decreasing to between -0.5N/m^2 and -1.0N/m^2.

12.5.39 As with the predicted decreases, the modelling of bed shear stress has predicted comparatively small increases from the baseline environment (see above), and in the context of these changes, the greatest increases were generally shown to occur in areas dominated by bedrock e.g. Cerrig Brith and Trwyn Cemlyn, with almost all modelled increases <1.0N/m^2. The exception are some highly localised areas where bed shear stress is predicted to increase, under certain wave conditions, to between 1.0N/m^2 and 3.0N/m^2. These increases are constrained to bedrock areas at Cerrig Brith and Trwyn Cemlyn, and during the high north wave an area just west

to the mouth of the Cooling Water outfall. In areas of sediment floored seabed, where an increase is bed shear stress was predicted, it was usually less than 0.5N/m^2.

12.5.40 Changes adjacent to the breakwaters are generally predicted to manifest as reductions in bed shear stress, the main exceptions being increases in a small area between the breakwaters during the infrequent high north wave condition and also around Cerrig Brith under all spring tide conditions (figure D12-15) (Application Reference Number: 6.4.101).

12.5.41 For the high north wave, the increase in bed shear between the marine structures coincides with wave model outputs which indicate a wave funnelling effect in the same area.

12.5.42 Based upon the results of the modelling studies, overall changes in bed shear stress have been found to range mostly between -0.1N/m^2 and +0.1N/m^2 (figure D12-15) (Application Reference Number: 6.4.101). Changes in bed shear stress ranging between -0.1N/m^2 and +0.1N/m^2 are judged to generate no more than minor differences in terms of the transportable sediment fraction for both sands and gravels. Far larger differences in stress are required to generate significant changes to mobilisation of these grain sizes (if indeed sand or gravel materials are present).

12.5.43 As noted above, these positive and negative changes in maximum bed shear stress represent potential increases or decreases in sediment entrainment where they coincide with soft sediments. The significance of these changes upon the geomorphological receptors is discussed in the following sections.

Changes to fine sediments

12.5.44 Within the Delft3D model, predictions of changes to coupled waves and tidal currents have been used to investigate the potential effects of dispersal and deposition of a fine sediment plume which could be generated during construction by spillage from dredging activities and the introduction of suspended sediments from the drainage discharge across the Wylfa Newydd Development Area (appendix D13-8, Application Reference Number: 6.4.90).

12.5.45 The modelling shows, for a range of hydrodynamic scenarios the extent and depth that sediment could be dispersed and deposited on the seabed from dredging activities and drainage discharge. A primary objective of the modelling has been to determine whether any changes in the mobilisation and subsequent deposition of fine sediment could arise from construction activities; and the potential distribution and depth of changes in deposition patterns resulting from such changes.

12.5.46 The Delft3D model investigation included potential sources of increased suspended sediment concentrations from:

- the dredging of softer sediments (overburden) in breakwater locations;
- the excavation and removal of weathered bedrock in the CW intake channel and breakwater locations;

- barge disposal of dredged materials at the Disposal Site (appendix D13-12, Application Reference Number: 6.4.94); and,
- discharge to the marine environment from the drainage system at various locations from within the Wylfa Newydd Development Area (appendix D13-8, Application Reference Number: 6.4.90).

12.5.47 Increased fine sediment input could also come from dewatering of the dredged materials in the barge hold during construction at the Wylfa Newydd Development Area (to maximise capacity) as well as the subsequent release of sediment from the barge at the Disposal Site.

12.5.48 Halcrow [RD4] showed that where the settling velocity of larger particles is higher (e.g. 1mm/s) then the sediment would deposit nearer to the source. Smaller particles with a lower settling velocity (e.g. 0.2mm/s) would travel further and become more widely distributed, having therefore a potentially reduced effect over a wider area. The finest sediments with the lowest settling velocities (e.g. around 0.05m/s) would tend to remain in suspension and are therefore carried much greater distances.

12.5.49 Calm conditions (with no waves) have been represented within the hydrodynamic model Delft3D as a worst case scenario for the modelling of suspended fine sediment. This is due to the enhanced potential for fine sediments to settle locally to greater thicknesses or to be deposited at geomorphologically sensitive locations, such as the Esgair Gemlyn. Results indicate the extent to which fine sediments could still be carried under calm conditions, by tidal currents without surficial wave action, and the predicted settling depth and distribution on the seabed.

12.5.50 Results from the modelling indicate the dispersal of fine sediment under the action of tidal currents alone during calm conditions would take place rapidly. The potential deposition from dredging activity (see figure D12-16) (Application Reference Number: 6.4.101) will be greatest under the footprint of the dredging and therefore coincide with the area removed during dredging. Hence consideration is given to the seabed and thus geomorphological features that are beyond the footprint, with maximum deposition on the seabed being 0.5cm or less out-with the Wylfa Newydd Development Area. The greatest deposition from drainage discharge will be around the various discharge points to the marine environment (see figure D13-29, Application Reference Number: 6.4.101).

12.5.51 Within the inner area of Cemlyn Bay (see figures D12-16 and D13-29, Application Reference number 6.4.101), deposition of less than 0.1cm depth of sediment (equivalent to approximately the diameter of a coarse sand grain) would potentially occur during calm conditions (for details see appendix D13-8 (Application Reference Number: 6.4.90)). Due to the likely depth and location of deposition on existing soft sediments, the magnitude of this change upon the (low value) seabed is therefore considered to be negligible.

12.5.52 Under typical wave conditions, previous studies [RD4] indicate that within Cemlyn Bay and near to the proposed dredging locations, tidal currents and wave activity would combine to rapidly redistribute sediment which could

have settled on the seabed. According to the literature, increased suspended sediment concentrations from Marine Works are generally short term (reverting to background levels less than one week after activity) and deposited within less than 1km from activity [RD4]. The hydrodynamic model results also show that the addition of a typical wave would assist the dispersal of fine sediments so deposition would be less than 0.1cm depth across the whole study area (see figure D12-16, lower image) (Application Reference Number: 6.4.101).

12.5.53 Other proposed Licensable Marine Activities (described in section 12.4) likely to release fine sediments into the water column would include the removal of the temporary causeway. In comparison with the proposed main dredging activities, the quantity of possible spillage would be considerably lower, the effects localised and shorter term. The magnitude of potential change in fine sediment deposition compared to background levels would therefore be negligible. The potential effects of increases in suspended sediment upon water quality are reported within chapter D13 (Application Reference Number: 6.4.13).

12.5.54 Table D12-18 summarises the changes to coastal and marine processes from the combined Licensable Marine Activities based on the outputs of the SWAN and Delft3D models.

Table D12-18 Summary of changes to coastal and marine processes during construction (partially built scenarios)

Coastal process	Change anticipated
Wave climate	Wave height: ranging between -14% to +9% in localised areas (for 1% probability events).
Tidal currents/waves	Bed shear stresses: ranging between +/- 1.0N/m^2 in localised areas.
Sediment dispersion and deposition	Deposition associated with dredging activities: <1mm maximum in localised areas.

Assessment of effects on coastal geomorphology receptors

12.5.55 This section presents the findings of the assessment of potential effects upon the coastal geomorphology receptors during construction. The effects at the Disposal Site are discussed under a separate section owing to its different offshore characteristics and geographical location away from the coastline.

The seabed and intertidal zone

12.5.56 Potential effects on the seabed and intertidal zone are summarised as:

- increased fine sediment deposition transported via new drainage pathways to the sea;
- increased fine sediment deposition due to dredging/excavation works;
- increased fine sediment input into the sea during construction of permanent structures;

- short-term changes to seabed and intertidal zone associated with temporary structures and their removal;
- loss of seabed and intertidal zone geomorphological features associated with permanent structures; and
- sediment mobilisation (erosion / deposition) caused by changes of bed shear stress.

12.5.57 New drainage pathways to the sea from the land surface and modified watercourses at Porth-y-pistyll and Cemlyn Bay would increase the potential for release and transport of suspended fine sediment and subsequent deposition on the seabed. Embedded mitigation measures to control fine sediment supply at source would include a new sustainable drainage system with settling ponds to trap particles at source (chapter D8; Application Reference Number: 6.4.8). Mitigation for fine sediment release from the land surface is covered in the Mitigation Route Map (Application Reference Number: 8.14) and the Code of Construction Practice (Application Reference Number 8.6). Within the dynamic coastal environment adjacent to the proposed Wylfa Newydd Development Area, any additional suspended sediment released would be rapidly dispersed, temporary and of short duration (see figure D13-23, Application Reference Number: 6.4.101). The resultant potential for increased sediment deposition from the drainage discharge is shown in figure D13-29 (Application Reference Number: 6.4.101) and is shown to be localised around the points of discharge. Worst case deposition of less than 1cm would be seen within 10s of metres from the point of discharge. Within Cemlyn Bay deposition would be less than 0.2cm under worst case conditions. Therefore, the magnitude of the change on the seabed (a low value receptor) would be small, resulting in a negligible significance of effect.

12.5.58 As noted above, the release of suspended sediments into the sea during construction dredging activities would have the potential to deposit no more than 0.5cm depth of fine sediment upon the seabed outside of the Wylfa Newydd Development Area (see figure D12-16, Application Reference Number: 6.4.101). Furthermore, hydrodynamic investigations confirm that tidal currents would rapidly disperse fine sediment inputs to near background concentrations even during calm conditions. There would be little or no degradation of the receptor. Therefore, the magnitude of effect of sediments released during construction dredging activities upon the low value seabed has been assessed to be negligible, resulting in a negligible significance of effect.

12.5.59 The release of suspended fine sediments into the sea during construction of temporary structures would also have the potential for deposition on the seabed. However, hydrodynamic investigations confirm that tidal currents would rapidly disperse fine sediment inputs to near background concentrations even during calm conditions. There would be little or no degradation of the receptor, with recovery expected relatively quickly. Therefore, the magnitude of effect of sediments released during construction dredging activities upon the low value seabed is considered to be negligible, resulting in a negligible significance of effect.

12.5.60 The release of suspended sediment into the sea during construction of permanent structures (including the two breakwaters and the Ro-Ro MOLF) would have potential for deposition. However, due to Licensable Marine Activities taking place within cofferdam exclusion areas, the effects would be contained within the enclosure. Any dewatering activities would monitor fine sediments, to ensure levels did not exceed limits given in the Environment Agency Pollution Prevention Guidance Notes. Although these have been withdrawn and are being replaced in Wales by Guidance for Pollution Prevention the contractor would be required to follow these. If required additional procedures such as settlement would be provided to meet this limit in chapter D1 (Application Reference Number: 6.4.1).

12.5.61 Therefore, the magnitude of effect of sediments released during construction of permanent structures upon the seabed (a low value receptor) has been assessed as negligible effect.

12.5.62 The footprint of the non-permanent structures (temporary ramp, berth and cofferdams) would represent a temporary loss of a relatively small area of the seabed (a low value receptor) and would experience a short-term and reversible effect. Embedded mitigation would include the removal of all temporary structures, with restoration of the seabed to its previous condition. The temporary structures would therefore lead to a small magnitude of change on the seabed (a low value receptor), resulting in a negligible effect.

12.5.63 The construction of the MOLF and breakwater structures would result in loss of natural seabed but would have a relatively small footprint totalling approximately 30ha.

12.5.64 As part of the embedded mitigation to mitigate the loss of seabed, the footprint of excavation has been reduced as far as practicable. The effect of Licensable Marine Activities upon the surrounding seabed could lead to some limited degradation, with recovery expected in the short-term. In this context, with the small magnitude of change in coastal and marine processes and low sensitivity of the seabed receptor, the significance of effect of the construction of permanent structures upon the seabed has been assessed as minor.

12.5.65 As noted in the previous section of the assessment, changes in bed shear stress (and associated sediment mobilisation) due to the presence of the new breakwater structures would be of small magnitude. The resulting significance of this localised effect upon the low value seabed receptor has therefore been assessed as minor.

12.5.66 Based on the of the potential changes in bed shear stress (spatial distribution, magnitude and extent), the baseline characteristics of underlying substrate in the location of change (where sediments are present), the overall significance of the effect on the seabed (a low value) receptor is assessed to be negligible.

Cemaes Bay

12.5.67 Potential effects on Cemaes Bay during construction are summarised as:

- increased fine sediment deposition associated with construction dredging activities and drainage discharge; and
- increased coarse sediment mobilisation or erosion associated with changes in coastal and marine processes.

12.5.68 Cemaes Bay is separated by the headland of Wylfa Head from any localised effects of scour or deposition resulting from construction activities within Porth-y-pistyll. Hydrodynamic (Delft3D) model investigations of the sediment plumes from dredging and drainage discharge show the pattern of fine sediment dispersion and deposition. The model results show no deposition in Cemaes Bay from dredging and only localised plumes and deposition (within 10's metres) at the drainage discharge points from the Wylfa Newydd Development Area (see figures D12-16 and D13-29, Application Reference Number: 6.4.101). Due to the dynamic nature of the coastal environment around Wylfa Head and Cemaes Bay, suspended sediment would be rapidly dispersed to background concentrations.

12.5.69 As noted above, the potential effect of fine sediment inputs associated with construction dredging activities reported within appendix D13-8 (Application Reference Number: 6.4.90) confirm no change to the suspended sediment load within Cemaes Bay and therefore no effect on Cemaes Bay, a low value receptor.

12.5.70 The potential magnitude of the change of fine sediment transported via new drainage pathways upon Cemaes Bay has also been assessed to be negligible, and therefore there would be no effect on Cemaes Bay, a low value receptor.

12.5.71 Similarly, small magnitudes of change in bed shear stress would also have little to no effect on coarse sediment mobilisation in Cemaes Bay. Small pockets of increased and decreased bed shear, predicted in various locations under all wave scenarios, lie within the lowest ranges of +0.1N/m^2 to +0.5N/m^2 and -0.1N/m^2 to -0.5N/m^2 respectively. Areas where increased bed shear have been predicted are mainly coincidental with bedrock seabed or rocky intertidal zone. Changes to coastal and marine processes would be of negligible magnitude, resulting in little or no degradation with no permanent effect upon the integrity of the low value Cemaes Bay receptor. It is therefore considered that the significance of effect on this receptor would be negligible.

Cemlyn Bay

12.5.72 Potential effects on Cemlyn Bay during construction are summarised as:

- increased fine sediment deposition transported via new drainage pathways and/or dredging/excavation works;
- short-term changes to seabed and intertidal zone associated with temporary structures and their removal; and
- loss of seabed and intertidal zone geomorphological features associated with permanent structures.

12.5.73 As noted above and shown in appendix D13-8 (Application Reference Number: 6.4.90) modelling from the drainage discharge confirm a negligible magnitude of change in the fine sediment deposition within Cemlyn Bay. Results from the drainage discharge show a minor increase in sediment deposition under worst case conditions of less than 0.2cm in Cemlyn Bay (also see figure D13-29, Application Reference Number: 6.4.101). Deposition results from dredging activities in Cemlyn Bay also show minor increases of sediment deposition under worst case conditions of less than 0.5cm in the outer bay and less than 0.1cm in the inner bay (see figure D12-16, Application Reference Number: 6.4.101). However, these worst case results would not affect the integrity of the receptor with little or no degradation. The potential magnitude of the change of fine sediment transported via new drainage pathways and from dredging activity deposited within Cemlyn Bay, a medium value receptor, has therefore been assessed to be negligible, resulting in a minor significance of effect.

12.5.74 Similarly, small magnitudes of change in bed shear stress would also have little effect on coarse sediment mobilisation in Cemlyn Bay. Areas of increased and decreased bed shear, that have been predicted in various locations under all wave scenarios, lie mainly within the lowest ranges of +0.1N/m^2 to +0.5N/m^2 and -0.1N/m^2 to -0.5N/m^2 respectively, with some very small patches within the higher ranges of +0.5N/m^2 to +1.0N/m^2 and -0.5N/m^2 to -1.0N/m^2 respectively.

12.5.75 Embedded mitigation would include the concrete armour at the western breakwater along the seaward perimeter to increase roughness and dissipate the energy of incoming waves thus reducing the extent of changes to wave energy through reflection. Areas where increased bed shear have been predicted are mainly coincidental with bedrock seabed or rocky intertidal zone. Comparison with the baseline values in areas of soft sediments has shown these changes would be of negligible magnitude with little or no degradation likely and no permanent effect upon the integrity of the medium value Cemlyn Bay receptor. It has therefore been assessed that the proposed construction of both temporary and permanent structures would have a minor significance of effect upon Cemlyn Bay.

Esgair Gemlyn

12.5.76 Potential effects on Esgair Gemlyn during construction are summarised as:

- increased fine sediment deposition on the shingle ridge, Esgair Gemlyn resulting from construction activities; and
- changes to form and/or integrity of Esgair Gemlyn due to changes in coastal and marine processes (e.g. wave action) resulting from construction activities at Porth-y-pistyll.

12.5.77 The potential risk of increased deposition of additional suspended load from the marine environment upon the high value Esgair Gemlyn receptor has been investigated through the hydrodynamic (combined tidal currents and waves) plume modelling scenarios (appendix D13-8, Application Reference Number: 6.4.90). Potential effects from a change in fine sediment deposition

upon the Esgair Gemlyn could include smothering or could impair the hydrological connection between the sea and Cemlyn Lagoon.

12.5.78 The outcomes of baseline studies (reported in appendix D12-2, Application Reference Number: 6.4.81) show no linkage or pathway between potential sources of fine sediment from fluvial sources and Esgair Gemlyn. Furthermore, the modelling investigations (see appendix D13-8, Application Reference Number: 6.4.90) also depict the potential movement and deposition of fine sediment from dredging activities and drainage discharge during construction under calm conditions (representing a worst case scenario) to be limited to a localised area close to where the dredging of sediment would occur and at the point of discharge from the Wylfa Newydd Development Area. Potential worst case deposition is predicted to be less than 0.1cm at Esgair Gemlyn. The magnitude of potential change in fine sediment deposition upon Esgair Gemlyn, which is a high value receptor, has therefore been assessed to be negligible, resulting in a negligible significance of effect.

12.5.79 With regard to coarse sediments Esgair Gemlyn has been identified in the literature as a legacy feature with no significant longshore sediment processes [RD13] and is therefore assessed in this context. Wave action, when influenced by the long fetch of open water of the Irish Sea to the north, has the potential to maintain geomorphological processes during high energy conditions. Potential changes in wave height indicated by model outputs suggest there could be an effect during a narrow band of high energy waves coming from northerly directions. During typical summer conditions the increase has been shown to be negligible (appendix D12-3, Application Reference Number: 6.4.82). For several wave scenarios, a decrease in wave height has been predicted by the model, especially for waves from the northeast.

12.5.80 For worst case scenarios, such as rare (99th percentile) winter waves arising from north-westerly directions during construction activities, this could represent a potential increase in wave height up to approximately +2% (for a partially built scenario; see table 12-17) and up to approximately +4% (for a fully built scenario; table 12-19). These percentages would affect baseline values in the range of 1.0m to 1.2m resulting in an increase of up to approximately +0.05m under present day winter storm conditions. The increased wave height is lower than that of baseline storm waves arising from the northeast, consequently this change is within the range of natural variation.

12.5.81 Due to the uncertainty of climate change effects upon the magnitude and frequency of storm events and the high value of the Esgair Gemlyn receptor, a precautionary approach has been taken. The magnitude of change has been assessed to be small, resulting in a minor significance of effect on Esgair Gemlyn, a high value receptor.

12.5.82 A topographic assessment of Digital Terrain Model data of the Esgair Gemlyn comparing historic LiDAR data [RD15] with recent cross profile dimensions (obtained by Jacobs in 2017) shows short-term adjustments cannot be relied upon as firm indicators of change, but do confirm the

dynamic nature of the feature. When assessed in combination with the historic data presented by earlier studies [RD13], the evolving baseline condition for the shingle ridge feature appears to be that infrequent high energy events could have a small effect upon the eastern end of the shingle ridge leading to a lowering and landward movement of the ridge crest.

12.5.83 Within this context, the potential maximum increase in a relatively low winter wave height of 4% is confirmed as negligible. The significance of effect on the shingle ridge (Esgair Gemlyn), a high value receptor, is considered to be negligible Cemlyn Lagoon.

12.5.84 Potential effects on Cemlyn Lagoon during construction are summarised as:

- Increased wave height leading to overtopping into Cemlyn Lagoon.

12.5.85 For the Nant Cemlyn (which drains to the Cemlyn Lagoon) specific measures to manage the discharge of sediment would be undertaken during construction of Mound E (as stated on the Main Power Station Site sub-CoCP, Application Reference Number: 8.7). Flow would be diverted into the Afon Cafnan until vegetation establishes and risk of sediment discharge (as agreed with NRW) would be low

- No polyelectrolyte dosing will be employed for discharge E1;
- From the point of commencement of earthworks on the west of Mound E onwards, no water will be discharged into Nant Cemlyn via discharge E1 until vegetation has re-established and risk of sediment run off is agreed with NRW to be low;
- After establishment of vegetation, if there are any additional bulk earthworks on the west of Mound E resulting in a risk of sediment discharge, no water will be discharged into Nant Cemlyn via discharge E1 until re-establishment has been again been agreed in writing with NRW; and
- During the above period(s) all water to be diverted and discharged into the Afon Cafnan via discharge E2.

12.5.86 Therefore, the magnitude of change has been assessed as negligible. The significance of effect of fine sediment runoff from drainage pathways upon the high value Cemlyn Lagoon has therefore been assessed as negligible.

12.5.87 The small magnitude changes in wave height during construction at times of extreme events and their potential effect upon the lagoon boundary, Esgair Gemlyn are discussed above. Taking a precautionary approach, the magnitude of potential effects upon Cemlyn lagoon, a high value receptor, due to possible increases in overtopping has been assessed to be small, resulting in only a minor significance of effect.

Hen Borth

12.5.88 Due to the distance of Hen Borth from the proposed marine construction activities at the Wylfa Newydd Development Area and prevailing tidal currents (detailed in appendix D13-8, Application Reference Number: 6.4.90), there is very little potential for this high value geomorphological

receptor to be affected. Analysis of the sediment regime baseline (reported in appendix D12-2, Application Reference Number: 6.4.81) further explains and supports these findings.

12.5.89 Assessment of potential effects of construction activities upon coastal and marine processes has determined that there would be negligible changes which could result in either deposition or the accelerated erosion of the Hen Borth cliff formation. It is therefore assessed that there would be negligible significance of potential effects during the period of construction at Hen Borth (a high value receptor).

Disposal Site (seabed)

12.5.90 During construction, the Disposal Site would be used to receive a combination of fine and coarse sediment as well as rock material generated by dredging activities at the Wylfa Newydd Development Area. It is intended that the rock material will be microsited near to the eastern margin of the Disposal Site.

12.5.91 Characterisation of the site and the assessment of potential effects at the Disposal Site are based upon the results of 3D sediment transport modelling within Delft3D.

12.5.92 Dispersal and deposition investigations for the expected disposal regime of sands and silts considered the potential effects of two daily disposals of 3,500m^3 for 35 days up to a total volume of 242,000m^3 of bulked soft sediment. Rock disposal comprising approximately 368,000m^3 of bulked rock material has been investigated in relation to possible changes in seabed processes (appendix D13-8, Application Reference Number: 6.4.90). The worst case volume for all material that could require disposal at sea is approximately 610,000m^3.

12.5.93 Specific potential effects could be:

- deposits building up the seabed and altering the bathymetry; and
- alteration of flow velocities due to deposits from dredging.

12.5.94 The Modelling shows only very limited build-up of sediment on the seabed in terms of both thickness (0.43m) and lateral extents (figure D12-17) (Application Reference Number: 6.4.101). This compares to water depths at the Disposal Site which range from approximately 45m and 90m (Application Reference Number: 6.4.101). The model runs have indicated rapid dispersal of fine material with concentrations reducing to background levels within 48 hours (Application Reference Number: 6.4.94).

12.5.95 In comparison to other Licensable Marine Activities at the previous Holyhead Deep Disposal Site, the Wylfa Newydd Development Area dredge operations (fine fraction estimated at 1,568m^3/day) would be considerably smaller than other disposals e.g. port dredge operations (fine fraction estimated at 15,000m^3/day). The magnitude of the potential effect upon the seabed (a low value receptor) specifically as a result of sediment disposals from the Wylfa Newydd Development Area has been assessed to be small, resulting in a negligible effect.

12.5.96 Disposal of rock on the seabed has been shown to have a small magnitude of effect on surrounding flow velocities (local flow accelerations) (Application Reference Number: 6.4.94). The significance of effect has therefore been assessed to be negligible in the context of seabed (a low value receptor) at that location (appendix D13-12, Application Reference Number: 6.4.94).

12.5.97 On the basis of the Delft3D modelling results, the overall magnitude of effect of the combined dredge disposal activities for the Wylfa Newydd Development Area construction activities has been assessed as small and the significance of the effect upon the seabed (a low value receptor) is therefore minor.

Operation

Operation of the MOLF, the CW intake and outfall

12.5.98 The operational lifespan of the Power Station Site (60 years) is expected to begin after approximately 10 years of construction. The assessment of potential effects has involved investigations into the likely changes in coastal and marine processes (i.e. waves and tidal currents) which could lead to changes in geomorphological processes (i.e. sediment erosion, transport and deposition) which over time are likely to establish a new dynamic equilibrium.

Determination of potential changes to coastal and marine processes

12.5.99 Longer term conditions, including progressive sea level rise and other episodic changes such as the magnitude and frequency of storm events, have been represented in the evolving baseline and post-development model outputs. However, it is noted that the uncertainty of prediction is greater for future scenarios in appendix D13-8 (Application Reference Number: 6.4.90). A breakdown of the assessment of potential changes to coastal and marine processes has been considered first, followed by the associated effects upon geomorphological receptors.

Waves, tidal currents and seabed shear stresses

12.5.100 The same effects on waves, tidal currents and seabed shear stresses from the marine layout are taken to occur in the operational phase as those towards the end of the construction phase. Therefore, the assessment on geomorphology receptors is taken to be the same already made.

12.5.101 Additionally, during operation, the potential changes to waves have been investigated in comparison with the current and evolving baseline using the SWAN modelling results (appendix D12-3, Application Reference Number: 6.4.82). Wave changes during the operational period for the ‘worst case’ winter storm scenario (represented by the 2087 reasonably foreseeable winter 99th percentile, north-west sector results) is illustrated in figure D12-13 (lower right image) (Application Reference Number: 6.4.101).

12.5.102 This map shows extensive areas of no discernible change in wave heights under future ‘worst case scenario’ storm conditions. Areas of decreased

wave height appear alongside of localised increases in wave height, mainly adjacent to the new marine structures and within the new harbour area.

12.5.103 Further statistical analyses of the model time series were carried out to investigate local changes west of the western breakwater and at the head of Cemlyn Bay adjacent to Esgair Gemlyn. A summary of the predicted percentage changes in wave height at model points 6 and 8 is presented in table D12-19 below.

Table D12-19 Changes in wave height (SWAN model results) for reasonably foreseeable (2087) scenarios over 35.5 -year model period

Point	Difference (fully built minus baseline) in significant wave heights for reasonably foreseeable (2087) winter wave from north-west		Difference (fully built minus baseline) in significant wave heights for reasonably foreseeable (2087) winter wave from north-east	
	Difference in mean significant wave height (%)	Difference in 99% significant wave height (%)	Difference in mean significant wave height (%)	Difference in 99% significant wave height (%)
6 (Cemlyn Bay)	+4%	0.8%	0%	0%
8 (Western Breakwater)	+10%	+11%	-14%	-12%

Source: SWAN (appendix D12-3, Application Reference Number: 6.4.82)

12.5.104 The results provided in table D12-19 show the differences in wave heights for the two wave height metrics for the partly built and fully built structures under the reasonably foreseeable future (2087) scenarios extracted from the 35.5-year time series. Both baseline and partially/fully built foreseeable future datasets represent an increase in wave heights and wind speeds by 10%, and a corresponding increase in wave period of five seconds, as representative of the future climatology. The foreseeable future datasets also correspond to increased water levels of 0.62m.

12.5.105 These data correspond to difference plots (images) shown in figure D12-13 (Application Reference Number: 6.4.101) for the reasonably foreseeable future (2087), winter storm 99th percentile conditions for fully built northwest and fully built northeast scenarios, presented as a common wave direction) and the worst case (northeast).

12.5.106 Immediately west of the western breakwater (point 8) the differences in wave height predicted by the wave model include the following potential changes:

- Under a fully built scenario and storm waves approaching from the north-west, there could be a change in wave height ranging between +10% to +11%.

- Under a fully built scenario, with storm waves approaching from the north-east, there could be a change in wave height ranging between -12% to -14%.

12.5.107 Adjacent to the Esgair Gemlyn within Cemlyn Bay (point 6):

- Under a fully built scenario with storm waves approaching from the north-west, there could be a change in wave height ranging between +4% and 0.8%.
- Under a fully built scenario, with storm waves approaching from the north-east, there could be no change in wave height.

12.5.108 During model runs for the northwest wave direction, a localised area to the west of Cemlyn Bay of slightly elevated wave height (figure D12-13, lower right image) (Application Reference Number: 6.4.101) is evident; potentially a result of shoaling across the ebb tidal delta deposit formed by the long term drainage from the lagoon. Elsewhere, and across the majority of Cemlyn Bay, changes in wave height within the bay are negligible.

12.5.109 Potential changes to wave heights in Cemlyn Bay under future storm conditions i.e. for the highest waves arising from the northwest, are depicted across most of Cemlyn Bay as having no discernible change (figure D12-13) (Application Reference Number: 6.4.101). Statistical analysis of data adjacent to Esgair Gemlyn (at point 6), show a change in wave heights ranging between +0.8% and +4% upon a baseline wave height of 1.2m to 1.4m (figure D12-3) (Application Reference Number: 6.4.101). The lower right image in figure D12-13 (Application Reference Number: 6.4.101) shows a very small area of increase in wave height at an area of shallow seabed associated with the lagoon ebb tidal delta. Here the shoaling of waves in combination with the angle of wave reflection and deflection around the Trwyn Cemlyn headland combine to generate a small increase in wave height under winter storm conditions with waves from the north-west. It is however important to note that this locally increased wave height would remain lower than the predicted height of storm waves arising from the northeast.

12.5.110 For storm waves arising from the northeast, statistical analysis identified no change in wave height at Esgair Gemlyn (point 6). West of the western breakwater (at point 8), the results indicate a potential decrease in wave height ranging between -12% to -14% upon a baseline wave height of 3.0m to 3.5m (appendix D12-3, Application Reference Number: 6.4.82).

Sediment processes

12.5.111 The potential for effects upon the sediment regime due to wave action under increased sea level and/or increased frequency or intensity of storm conditions associated with climatic change would potentially have an effect in the near shore zone (appendix D12-2; Application Reference Number: 6.4.81). In this context, within the evolving baseline there is a recognised potential for higher waves and more intense storm surges to act upon mobile sediments in sensitive parts of the coastline. The implications for the high value Esgair Gemlyn shingle ridge receptor are discussed below.

Sediment plume study and deposition

12.5.112 Dredging is likely to be required to maintain sufficient depth in front of the intake and to allow continued access to the MOLF, but is not considered within the assessment.

Assessment of effects on coastal geomorphology receptors

12.5.113 During operation, potential effects upon the geomorphology receptors have been assessed using the Delft3D model and SWAN model outputs for tidal currents and waves over longer term scenarios. The geomorphology receptors potentially affected during operations include the seabed (low value) and high value Esgair Gemlyn.

The seabed (and intertidal zone)

12.5.114 The Delft3D model investigations include the ongoing operation of the cooling water structures upon coastal and marine processes, including the discharge flows from the CW outfall. Changes to bed shear stress depicted in figure D12-15 (Application Reference Number: 6.4.101) indicate small areas of increased bed shear at the CW outfall location. However, these coincide with locations where soft sediments are not present and therefore no changes to sediment mobilisation would occur. At the CW intake some decreases in bed shear are predicted under winter and high north wave scenarios; however, under no wave and typical wave scenarios, there would be no discernible change. It has therefore been assessed that the magnitude of effect upon the seabed (a low value receptor), of the operation of both the cooling water intake and outfall would be negligible, resulting in a negligible significance of effect.

12.5.115 Changes in sediment entrainment patterns due to the presence of permanent structures over the medium and long-term would be expected to be similar to those reported for construction activities (above) but with potentially increased frequency for high energy events. There would be no changes to the pathway or linkage between the current seabed sediment supply and other geomorphological receptors. Potential changes are likely to be of small magnitude, with increases or decreases falling within the range of natural variability under the full range of conditions, with opportunities for recovery. Therefore, significance of potential longer term effects of permanent structures upon the low value seabed receptor would be minor.

12.5.116 There is uncertainty associated with sea level rise as part of the evolving baseline. The Delft3D model results predict that long-term changes to seabed shear stress would not be discernibly affected by a rise in sea level, as the percentage change in water depth would be minimal. The frequency of storm events could however have implications for the magnitude and frequency of bed shear stress.

Cemaes Bay

12.5.117 Due to the distance between the Power Station Site and Cemaes Bay, and the limited extent of the effects of operational activities, the magnitude of longer term effects has been shown by the modelling results to be negligible.

Therefore, the significance of effect on Cemaes Bay (a low value receptor) has been determined to be minor.

Cemlyn Bay

12.5.118 Potential effects on Cemlyn Bay during operation could include changes to the seabed and intertidal zone geomorphological features resulting from the presence of permanent structures.

12.5.119 Over longer time periods, changes in wave heights predicted by the SWAN wave model for the worst case scenario, winter 99th percentile storm waves from the northwest sector (figure D12-13, lower right images) (Application Reference Number: 6.4.101) predict no change in significant wave heights for the majority of the area across Cemlyn Bay. In some sheltered areas decreases in wave height have been shown, whilst in other locations, small areas of slight increase up to a maximum of +11% (immediately west of the western breakwater) are predicted. Adjacent to Esgair Gemlyn, statistical analysis indicates more modest increases of up to +4% (table D12-19).

12.5.120 For storm waves arriving from the northeast, statistical analysis has confirmed a 0% wave height increase adjacent to Esgair Gemlyn and a -12% to -14% decrease to the west of the western breakwater (table D12-19).

12.5.121 Changes in bed shear stress arising in construction would be expected to continue (as noted earlier). The hydrodynamic modelling results indicate only localised changes in sediment mobilisation in the outer bay and offshore areas. The longer term magnitude of changes in bed shear stress on the medium value receptor, Cemlyn Bay is considered to be small, with disturbance in the range of natural variability and short term recovery. Therefore, the significance of effect has been determined as minor.

Esgair Gemlyn

12.5.122 Longer term potential effects of increased significant wave height upon the Esgair Gemlyn shingle ridge have been investigated through wave model reasonably foreseeable (2087) scenarios, which have taken account of climate change influences. The predicted changes in wave height for a worst case scenario winter storm discussed above (see also figure D12-13, lower right image) (Application Reference Number: 6.4.101), show that the magnitude of the changes to wave height would be relatively small compared to the evolving baseline conditions. Therefore, the significance of effect upon the high value Esgair Gemlyn has been assessed to be minor.

12.5.123 Predicted changes due to climatic change alone recognised within the SMP2 [RD9], would be unchanged with or without the Power Station.

Cemlyn Lagoon

12.5.124 Modelling has demonstrated that the magnitude of effects on Cemlyn Lagoon arising from changes in coastal and marine processes (including changes in wave height) resulting from the operation of the Power Station would be small. The effect of potential changes in wave height and associated risk of overtopping would be small and within the range of natural variation. The

value of the receptor is high but the significance of effect has been assessed as minor.

Hen Borth

12.5.125 Due to the distance of Hen Borth from the Power Station Site and the limited extent of the effects of operational activities, the magnitude of longer term effects on coastal and marine processes has been shown by the modelling results to be negligible. Therefore, the significance of effect of operation activities upon Hen Borth, a high value receptor, has been determined to be negligible.

Disposal Site

12.5.126 During operations, the Disposal Site would be used to receive occasional inputs of fine sediment material generated by maintenance dredging activities. The volume of the material required to be removed would be considerably lower than that for the capital dredging work undertaken during construction, possibly representing less than ten percent. The dredged material would be fines and highly dispersive in nature. The magnitude of change would be negligible. The significance of the effect upon the seabed (assessed as a low value receptor) has therefore been determined to be negligible.

Decommissioning

Determination of changes to coastal and marine processes

12.5.127 Since decommissioning would not commence until after the 60-year operating period, there are uncertainties associated with the specific characteristics of the environmental baseline conditions that would apply at that time. The works required to decommission the Power Station Site would be subject to a separate Environmental Impact Assessment assessing the effects in detail against the baseline conditions at that time. The effects summarised below mainly relate to the construction works required to remove the structures.

12.5.128 Construction activities required during decommissioning would be likely to result in a temporary increase of fine sediment input to the sea. This additional suspended sediment could also lead to increased deposition, potentially affecting coastal geomorphology receptors such as the seabed at Porth-y-pistyll and Cemlyn Bay. Potential sources of additional material could include:

- changes in the suspended sediment load of runoff and discharges reaching the sea from land surfaces;
- removal of inland drainage systems; and
- removal of Permanent Marine works.

12.5.129 These potential effects would be reduced by the incorporation of mitigation, including adherence to construction good practice, sediment control and government planning policy. The magnitude of change on any of the coastal

geomorphology receptors has been assessed as being small and therefore resulting in a minor significance of effect.

Transboundary effects

12.5.130 The physical distances between the Power Station Site and Disposal Site and the nearest point of land on the Irish coast is in excess of 100km. The assessment has shown that changes to waves and currents are localised to Cemlyn Bay (including Porth-y-pistyll) and to the Disposal Site and do not extend for more than a couple of kilometres. The suspended sediment plume arising from dredging and disposal is potentially more extensive, the modelling showing that it can extend for up to about 12km. However even at these distances the amounts of sediment deposition on the seabed would be negligible and probably not detectable. There would therefore be no transboundary effects arising from changes to coastal or marine processes.

12.6 Additional mitigation

12.6.1 In accordance with chapter B1 (Application Reference Number: 6.4.1), embedded and good practice mitigation measures relevant to coastal and marine processes and coastal geomorphology were taken into account when determining the 'pre-mitigation' significance of effects. These are detailed in section 12.4 of this chapter: Design basis and activities.

Construction

12.6.2 No significant effects have been identified through the assessment work carried out and therefore there would be no need for additional mitigation.

Operation

12.6.3 No significant effects have been identified through the assessment work carried out and therefore there would be no need for additional mitigation.

Decommissioning

12.6.4 No significant effects have been identified through the assessment work carried out and therefore there would be no need for additional mitigation.

12.7 Residual effects

12.7.1 No significant adverse effects were identified for coastal and marine processes and geomorphology.

12.7.2 Minor effects identified in the assessment of effects section are summarised in appendix I3-1 (master residual effects table) (Application Reference Number: 6.9.8).

12.8 References

Table D12-20 Schedule of references

ID	Reference
RD1	Welsh Office. 1998. *Technical Advice Note (Wales) 14: Coastal Planning*. [Online]. [Accessed: 03 December 2016]. Available from: http://gov.wales/docs/desh/publications/110805tan14en.pdf
RD2	Horizon Nuclear Power. 2012. *Wylfa Oceanographic Interpretative Report.* Titan Environmental Surveys Ltd. for Horizon Nuclear Power, WYL-TES-PAC-REP-00024 CS0268/V1/Final.
RD3	Holmes, R. and Tappin, D. R. 2005. DTI Strategic Environmental Assessment Area 6, Irish Sea, seabed and surficial geology and processes. British Geological Survey Commissioned Report, CR/05/057.
RD4	Halcrow. 2012. *Wylfa MOLF Coastal Processes Study* HNP-ENG-CV-REP-00004. Halcrow for RWE/HNP.
RD5	UK Hydrographic Office. 2011. Tidal range data at Cemaes Bay.
RD6	Department for Environment, Food and Rural Affairs/Environment Agency. 2011. *Extreme sea level events*. London: Department for Environment, Food and Rural Affairs.
RD7	Natural Environment Research Council (NERC). 1995. *British Geological Society interactive mapper*. [Online]. [Accessed: 01 December 2016]. Available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html.
RD8	GeoMôn - UNESCO Global Geopark. [Online]. [Accessed: 01 May 2017]. Available from: http://www.geomon.co.uk/.
RD9	Wales Coastal Group Forum. 2011. SMP21 St Ann's Head to Great Ormes Head (Western Wales) Shoreline Management Plan 2 (SMP2).
RD10	Fugro Seacore Ltd. (Fugro). 2011. Wylfa New Build, Intermediate offshore ground investigation 2010. Geotechnical Ground Report: C1369/ NEA101007.
RD11	Clifton, H.E. and Dingler, J.R. 1984. Wave-formed structures and paleoenvironmental reconstruction. In: B. Greenwood and R.A. Davis, Jr. (Editors), *Hydrodynamics and Sedimentation in Wave-Dominated Coastal Environments*. Mar. Geol., 60: 165-198. [Online]. [Accessed: 15 February 2017]. Available from: http://www.geo.arizona.edu/geo5xx/geos544/pdfs/nearshore/clifton%26dingler-84.pdf.
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ID	Reference
RD13	Pye, K. and Blott, S.J. 2010. *Cemlyn Bay and Adjoining Areas, Anglesey: Geomorphological Assessment*. Report prepared for the National Trust, Swindon by Kenneth Pye Associates Ltd, External Investigation Report EX1208.
RD14	Haslett, S. 2008. *Coastal systems*. London: Routledge.
RD15	Lle Geoportal for Wales. [Online]. [Accessed: 01 May 2017]. Available from: www.lle.wales.gov.uk.
RD16	Natural Resources Wales (NRW). Personal communication at HNP Marine Modelling Meeting, Bangor. 27 April 2017.
RD17	Pye, K. and Blott, S. J. 2016. *Cemlyn, Anglesey: Further Geomorphological Assessment.* KPAL External Investigation Report No. EX20671. 10 March 2016.
RD18	May, V.J. and Hansom, J.D. 2003. Coastal Geomorphology of Great Britain, Geological Conservation Review Series, No. 28, Joint Nature Conservation Committee, Peterborough. [Online]. [Accessed: 01 May 2017]. Available at: http://jncc.defra.gov.uk/pdf/GCRDB/v28chap1.pdf.
RD19	Wright D. and Wilde D. 2015. Cemlyn North Wales Wildlife Trust Nature Reserve Wardens Report (2015).
RD20	Holton A. and Wilde D. 2016. Cemlyn North Wales Wildlife Trust Nature Reserve Wardens Report (2016).
RD21	Natural Resources Wales, 2015. *Water Framework Directive water body quality elements.* [Online.] [Accessed: 23 February 2017]. Available from: http://waterwatchwales.naturalresourceswales.gov.uk/en/.
RD22	Minesto. 2016. Minesto Deep Green Holyhead Deep Project.
RD23	Atkins, (2017). Holyhead North (IS043) Disposal Site Characterisation Report. Consultancy Report to Horizon Nuclear Power. Document No. 5154744/301/001 69 pp.
RD24	Simpson, J.H. and Hunter, J.R. 1974. *Fronts in the Irish Sea*. Nature, 250(5465), pp.404-406.
RD25	Howarth, M.J. 2005. *Hydrography of the Irish Sea.* SEA6 Technical Report, UK, Department of Trade and Industry offshore energy Strategic Assessment programme.
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ID	Reference
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RD28	Welsh Government. 2016. *Flood Consequence Assessments: Climate change allowances*. [Online]. [Accessed: 01 May 2017]. Available from: http://gov.wales/docs/desh/publications/160831guidance-for-flood-consequence-assessments-climate-change-allowances-en.pdf.
RD29	Environment Agency. 2016. Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. Update to 2011 publication. LIT 5707.
RD30	Isle of Anglesey County Council 2013. *Anglesey Local Flood Risk Management Strategy*. [Online]. [Accessed: 01 May 2017]. Available from: https://www.anglesey.gov.uk/Journals/2013/07/30/a/x/l/flooding-strategy.pdf.

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HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.13 ES Volume D - WNDA Development D13 - The marine environment

PINS Reference Number: EN010007

Application Reference Number: 6.4.13

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00045

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Contents

13 The marine environment

13.1 Introduction

13.1.1 This chapter describes the assessment of potential marine environment effects resulting from the construction, operation and decommissioning of the Power Station, other on-site development as described in chapter A1 (introduction) (Application Reference Number: 6.1.1) of this Environmental Statement), Marine Works and the Site Campus within the Wylfa Newydd Development Area. It also considers potential effects at the Disposal Site of Holyhead North.

13.1.2 Please refer to chapter B13 (the marine environment) (Application Reference Number: 6.2.13) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the marine environment assessment; and assessment methodologies and criteria.

13.1.3 The assessment herein supports the Development Consent Order application and also the application for a Marine Licence to cover Licensable Marine Activities, required separately under the Marine and Coastal Access Act 2009.

13.2 Study area

13.2.1 This section describes the study area relevant to the marine environment assessment for the Wylfa Newydd Development Area and the Disposal Site.

13.2.2 Since 2010, surveys to determine the marine ecology baseline have focused on an area 5km from the Wylfa Newydd Development Area. This survey area is termed the 'central study area' in this chapter (see figure D13-1, Application Reference Number: 6.4.101).

13.2.3 The spatial extent of the central study area was defined based on an understanding of the tidal excursion along the north coast of Anglesey and the results of preliminary hydrodynamic modelling, which provided an initial indication of the dispersion of the Cooling Water discharge from the Power Station. As a worst case, it was considered that potential effects were most likely to occur within the central study area.

13.2.4 For certain marine receptors, additional data and/or information have been gathered from outside the central study area to further characterise the marine ecology baseline. This included mobile receptors such as marine mammals, seabirds and fish to allow the potential effects on populations to be assessed.

13.2.5 The term 'wider study area' is used to describe the full spatial extent of baseline survey data and information considered within the assessment of effects for the Wylfa Newydd Development Area (if greater than the 5km central study area). The spatial extent of the wider study area is receptor-specific and has been described under the relevant headings within section 13.3.

13.2.6 The marine environment assessment also considers effects on marine receptors at the Disposal Site and a further study area has been defined specific to this assessment. The 'Disposal Site study area', much like the wider study area, encompasses the spatial extent of all baseline survey data and information considered within the assessment of effects. The spatial extent of the Disposal Site study area is receptor-specific and has been described under the relevant headings in section 13.4.

13.2.7 It is acknowledged that marine receptors will exhibit a degree of connectivity between the two study areas delineated. Consequently, characterisation of the baseline environment for the Wylfa Newydd Development Area (section 13.3) and the Disposal Site (section 13.4) marine assessments may have drawn upon the same survey data and information where appropriate.

13.3 Wylfa Newydd Development Area baseline environment

13.3.1 This section provides a summary of the baseline conditions for the marine environment within the central study area described in section 13.2. Where a wider study area has been defined to characterise the baseline for a particular receptor, further description is provided below.

13.3.2 The environmental baseline data within this section (13.3) are supported by the following appendices and are cross-referenced in the text where relevant:

- D9-16 Wylfa Freshwater Baseline Surveys 2011 to 2015 (Application Reference Number: 6.4.49);
- D13-1 Water quality and plankton surveys report (Application Reference Number: 6.4.83);
- D13-2 Benthic ecology report (Application Reference Number: 6.4.84);
- D13-3 Porth-y-pistyll biotope Survey Report (Application Reference Number: 6.4.85);
- D13-4 Fish surveys report (Application Reference Number: 6.4.86);
- D13-5 Subtidal dive surveys at the Cooling Water outfall at the Existing Power Station (Application Reference Number: 6.4.87);
- D13-6 Marine mammal baseline review (Application Reference Number: 6.4.88);
- D13-7 Seabirds baseline review (Application Reference Number: 6.4.89);
- D13-8 Marine hydrodynamic modelling report – Wylfa Newydd Development Area (Application Reference Number: 6.4.90); and
- D13-10 Entrapment of marine organisms at the Existing Power Station (Application Reference Number: 6.4.92).

Conservation designations

13.3.3 There are a number of sites subject to nature conservation designations of international and national importance within and surrounding the Wylfa Newydd Development Area. These include Special Areas of Conservation (SACs), Special Protection Areas (SPAs), and Sites of Special Scientific Interest (SSSI).

13.3.4 The designated and candidate sites of national/international importance that are considered to be relevant to the assessment are listed in table D13-1 and shown in figure D13-1 (Application Reference Number: 6.4.101). A separate Shadow Habitats Regulations Assessment (HRA) Report (Application Reference Number: 5.2) has been undertaken which considers internationally designated sites on a wider geographic scale which are not listed in table D13-1. The Shadow HRA (Application Reference Number: 5.2) is provided as a separate supporting report to the Development Consent Order and Marine Licence application.

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Table D13-1 Statutory designated sites for nature conservation relevant to the marine environment in proximity of the Wylfa Newydd Development Area

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
Bae Cemlyn/ Cemlyn Bay	SAC	Approximately 100m north-west of the Wylfa Newydd Development Area	The coastal lagoon habitat, including a bryozoan (*Conopeum seurati*), the lagoon cockle (*Cerastoderma glaucum*) and the lagoonal mud snail (*Ecrobia ventrosa*) as well as a number of uncommon plant species such as the brackish water-crowfoot (*Ranunculus baudotii*) and beaked tasselweed (*Ruppia maritima*). Perennial vegetation of stony banks is present as a qualifying feature but is not the primary reason for designation [RD1].
Morwenoliaid Ynys Môn / Anglesey Terns	SPA	Within the Wylfa Newydd Development Area	In January 2017, a marine extension to the existing Ynys Feurig, Cemlyn Bay and The Skerries SPA was designated to include the marine area used by foraging terns during the breeding season. The site, now incorporating the nesting birds of Ynys Feurig, Cemlyn Bay and The Skerries SPA,

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
			and their foraging areas, was renamed the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA.' The SPA supports four species of breeding tern: Arctic tern (*Sterna paradisaea*) (five year mean of 1,290 pairs representing 2.9% of population in the UK, 1992–1996); common tern (*Sterna hirundo*) (five year mean of 189 pairs representing 1.5% of population in the UK, 1992-1996); roseate tern (*Sterna dougallii*) (five year mean of three pairs representing 5% of population in the UK, 1992–1996); Sandwich tern (*Thalasseus sandvicensis*) (five year mean of 460 pairs representing 3.3% of population in the UK, 1993 to 1997) [RD2]. Terns are known to nest on the islands in Cemlyn Lagoon.
Gogledd Môn Forol / North Anglesey Marine	Candidate SAC (cSAC)	Within the Wylfa Newydd Development Area	Proposed for harbour porpoise (*Phocoena phocoena*).

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
Cemlyn Bay	SSSI	Approximately 100m north-west of the Wylfa Newydd Development Area	The breeding bird assemblage comprising Arctic tern, common tern, roseate tern and Sandwich tern is the primary reason for designation. Vegetated shingle which is characterised by sea kale (*Crambe maritima*), sea radish (*Raphanus raphanistrum* subsp. *maritimus*) and yellow horned-poppy (*Glaucium flavum*).
Puffin Island	SSSI	35km	Sea cliffs, maritime grassland, intertidal rocks, breeding seabird assemblage.
The Skerries	SSSI	8km	Low maritime cliffs, maritime grassland, rockpools, breeding bird assemblage, grey seals.
Holy Island Coast	SSSI	15km	Vegetated sea cliffs, European dry heaths, maritime grassland, vascular plants assemblage, breeding bird assemblage.

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Value of receptors

13.3.5 The nationally/internationally designated and candidate sites identified in table D13-1 are considered under the receptor 'all designated sites of nature conservation importance and supporting features' which has been assigned a high value.

Water quality

13.3.6 Marine water quality sampling was carried out at nine sites which were all located within the central study area (5km from the Wylfa Newydd Development Area) between May 2010 and November 2014 (figure D13-2, Application Reference Number: 6.4.101). In addition, four long-term, fixed-point mooring buoys were deployed within the central study area between July 2010 and August 2011 which recorded temperature, salinity, currents and waves (figure D13-2, Application Reference Number: 6.4.101). Data collected by National Resources Wales (NRW) have been used to provide information on Water Framework Directive (WFD) water bodies and bathing water quality [RD3]. Following cessation of the discharge from the Existing Power Station, two additional water quality surveys were carried out in close proximity to the Cooling Water outfall (OF1 and OF2) in December 2015 and February 2016 to provide an indication of non-operational water quality conditions (figure D13-2, Application Reference Number: 6.4.101).

13.3.7 There are three coastal water bodies designated under the WFD in close proximity to the Power Station. The Anglesey North water body is currently achieving 'moderate' ecological status and The Skerries water body is at 'high' ecological status; the central study area intersects both water bodies. These water bodies are characterised by strong tidal currents and a maximum tidal range of 7.5m. Cemlyn Lagoon water body is located within the central study area, approximately 100m north-west of the Wylfa Newydd Development Area. The lagoon habitat is separated from the coastal waters by a permeable shingle bank, with a narrow channel at the western end; it is fed by water from the Cemlyn catchment and from the sea. This water body is currently achieving 'good' ecological status.

Physico-chemical parameters

Temperature

13.3.8 The maximum, minimum and mean monthly temperatures recorded during each survey ranged from 6.08°C in March 2013 to 16.84°C in August 2014 (figure D13-3) and seasonal variation was consistent across the years with the highest temperatures typically observed in summer and the lowest in winter.

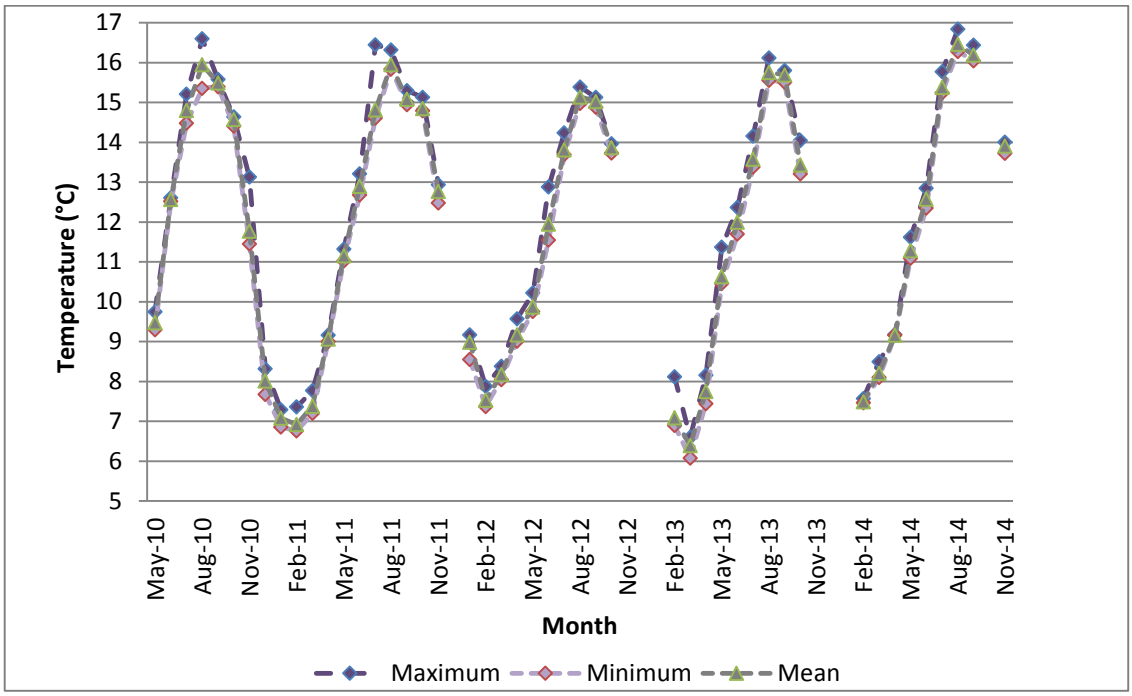
13.3.9 Temperature values were found to be stable throughout the water column (depth ranged between approximately 10m and 45m) and were indicative of a well-mixed water body over all seasons. The difference in temperature recorded within the water column (between surface and seabed) was generally lower than 0.4°C. A weak thermal stratification was occasionally observed at sites WQ2 and WQ6 (figure D13-2, Application Reference

Number: 6.4.101) which was likely to be the result of a number of factors including depth, weather conditions and tidal state, with possible localised short-term effects of the Cooling Water discharge from the Existing Power Station.

13.3.10 The Existing Power Station operated at half-load (with one reactor shut down) from April 2012 to December 2015, and there were no measurable differences recorded in temperature between the years preceding this and the years since half-load operation began.

13.3.11 Water temperatures in close proximity to the outfall (OF1 and OF2; figure D13-2, Application Reference Number: 6.4.101) were affected by the Cooling Water discharge of the Existing Power Station. This is evidenced by site OF1, situated 50m from the outfall, which showed temperatures ranging between 11.0°C at the bed to 15.2°C at the surface.

Figure D13-3 Maximum, minimum and mean water temperatures recorded monthly from sites WQ1 to WQ9 during water quality surveys



Salinity

13.3.12 Salinity ranged between a minimum of 32.80 in September 2012 and a maximum of 35.29 in May 2011. Salinity values were typically stable throughout the water column indicating a well-mixed water body; very weak haloclines were observed occasionally but no trends were observed in the location or timing of these. All values are in line with the expected values for inshore coastal waters of the Irish Sea (as reported by Turekian [RD4]).

Suspended solids

13.3.13 Monthly mean total suspended solids concentrations varied between 3.2mg/L in April 2011 and 21.6mg/L in March 2014; samples taken from

surface and mid-depth from across the survey area (see appendix D13-1, Application Reference Number: 6.4.83). Calculated annual averages (AAs) ranged from 6.1mg/L in 2011 to 13.0mg/L in 2014. Based on the criteria for classifying water bodies in relation to turbidity conditions as set out by the WFD (Standards and Classification) Directions (England and Wales) 2015, the Anglesey North water body and The Skerries water body would be classified as clear to intermediate.

Oxygen

13.3.14 Dissolved oxygen saturation levels recorded from May 2010 to November 2014 ranged from 90.2% in September 2014 to 121.1% in October 2013, which would equate to a WFD Environmental Quality Standard (EQS) of high status. Values were found to be similar at all sites with only slight variations, which were observed infrequently. Vertical profiles typically followed the same pattern, with high dissolved oxygen at the surface and a decreasing level of dissolved oxygen saturation with depth. In some months during spring and summer, the highest levels of saturation were found at approximately 5m to 10m depth, which corresponded with the depth of maximum chlorophyll concentrations. The dissolved oxygen levels recorded in December 2015 and February 2016 were comparable across all sites.

pH

13.3.15 Values of pH ranged between 6.94 in June 2011 to 8.46 in July 2013 and June 2014, which is within the range expected for coastal waters [RD5].

Chlorophyll

13.3.16 Chlorophyll-a *in vivo* concentrations were generally higher within 5m of the water surface, with the highest concentrations typically recorded between May and August. Mean monthly values that were below 10µg/L, indicating good status of this parameter under WFD United Kingdom Technical Advisory Group guidance [RD6].

Chemical and biochemical parameters

13.3.17 Annual averages, monthly averages and maximum concentrations of chemical and biochemical parameters were calculated to compare the status of the coastal waters around the Wylfa Newydd Development Area (i.e. within the central study area) to WFD EQS. This showed that, between May 2010 and November 2014, the parameters that were measured in the two water bodies (Anglesey North and The Skerries) would meet the threshold EQS for good status.

13.3.18 All metals except mercury were consistently reported as below their relevant EQS. The mean monthly value for mercury (total fraction) exceeded the Maximum Allowable Concentration EQS (known as MAC-EQS) in only one month, October 2010, over the whole survey programme.

13.3.19 Mean monthly concentrations of nitrogen (as N), nitrogen oxidised (dissolved and total), ammoniacal nitrogen and nitrite were typically reported at close to

or below the Minimum Reporting Value (MRV)[1]. Average concentrations of dissolved inorganic nitrogen (calculated from dissolved oxidised nitrogen and ammoniacal nitrogen) between November and February in 2010/2011 and 2011/2012 indicated high dissolved inorganic nitrogen standard (<12µmoles/L) under the WFD classification in 2010 to 2011 and 2011 to 2012. Nutrient concentrations (nitrate, nitrite, orthophosphate and silicate) in December 2015 and February 2016 were found at similar levels to those reported for the survey area during the 2010 to 2014 baseline surveys and also to NRW data from north Anglesey from 1998 to 2012. Total organic nitrogen, dissolved inorganic nitrogen and Kjeldahl nitrogen were all reported as below MRV.

13.3.20 All monthly means for total petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) were consistently found to be below the MRV. Volatile organic compounds were typically recorded below the MRV, with a few exceptions which were occasionally reported slightly above the MRV:

- toluene;
- bromoform;
- ethylbenzene;
- dimethylbenzene;
- 1,3-dichloropropene; and
- di-2-ethylhexyl phthalate.

13.3.21 The majority of phenolic compounds were reported as below the MRV in all samples; only 2-methylphenol, 4-methylphenol and 4-chloro-3-methylphenol were occasionally reported marginally above the MRV.

13.3.22 Chemical concentrations in water samples collected in December 2015 and February 2016 did not differ from those taken in May 2010 and November 2014.

Cemaes bathing water

13.3.23 Bathing water quality is monitored to protect human health and the environment under the European Commission Bathing Water Directive (2006/7/EC). Two microbial parameters – *Escherichia coli* (*E.coli*) and *intestinal enterococci* – are assessed using four years of sampling data. There are four classifications for bathing water quality: ‘excellent’, ‘good’, ‘sufficient’ and ‘poor’ [RD3]. The objective set out in the Bathing Water Directive is for all bathing waters to achieve sufficient status by 2015. Until 2015, Cemaes bathing water achieved sufficient status. However, in 2016 Cemaes bathing water was classed as poor for the first time.

[1] The MRVs are minimum concentrations selected for reporting purposes. MRVs are often higher than the statistically derived Limits of Detection method and provide higher confidence that a sample is different from a blank sample containing no determinand of interest.

13.3.24 Cemaes Bay is subject to short-term pollution issues which are caused when heavy rainfall washes faecal material into the sea from livestock, sewage and urban drainage via rivers and streams. There is a risk of reduced water quality after rainfall, but this typically returns to normal after one to three days [RD7].

Value of receptors

13.3.25 Two receptors have been identified in relation to marine water quality; EU-designated WFD water bodies (The Skerries, Anglesey North and Cemlyn Lagoon) and the EU-designated bathing water (Cemaes Bay). The WFD water body supports designated features of nature conservation importance. The bathing water is designated at European level, has high economic value and is nationally important. These receptors are of international importance and are assigned a high value.

Sediment quality

13.3.26 Bed sediments represent the ultimate sink for contaminants in marine environments and therefore they give a good indication of both spatial and temporal patterns of contamination. Sediment features and contamination may influence spatial and temporal patterns of benthic communities.

13.3.27 In 2010 and 2011, samples were collected as part of the subtidal benthic survey using a Hamon and mini-Hamon grab from 22 and 21 sites, respectively with the addition of a further three sites in 2011 (figure D13-4, Application Reference Number: 6.4.101). A total of 21 samples were collected within the central study area (5km from the Wylfa Newydd Development Area) with a further five samples collected from a wider study area which encompassed the north coast of Anglesey from Church Bay in the west to Red Wharf Bay in the east.

13.3.28 In 2011 and 2014 divers collected sediment samples in Porth-y-pistyll for faunal and particle size analysis. Sediment samples were also collected annually in summer between 2011 and 2014 from two sites in Porth-y-pistyll adjacent to sites WI04 and WI12, during the intertidal benthic survey.

13.3.29 Sediments were analysed for compounds known to be hazardous to aquatic life. The suite of substances included organics, PAHs, List I and II metals as designated under the Priority Hazardous Substances under Annex X of the WFD and Specific Pollutants under Annex VIII of the WFD.

13.3.30 Sublittoral substrates in the study area were found to be a mix of exposed rocks and sandy sediments while further offshore, mixed sediments were prevalent, which concurred with previous studies [RD8]. Further information on sediment characteristics within the study area is provided in appendix D13-2 (Application Reference Number: 6.4.84).

Metals and tributyltin

13.3.31 At present, there are no statutory EQSs for marine and estuarine sediments in the UK. However, Cefas have provided chemical Action Levels (sometimes known as sediment action levels) for the disposal of dredged

material which can be used to assess sediment quality. Action Levels are not statutory contaminant concentrations for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material at sea. In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 are generally considered unsuitable for sea disposal.

13.3.32 Comparison with Centre for Environment Fisheries and Aquaculture science (Cefas) Action Levels found no exceedance of Action Level 2 in any sample. A number of samples showed elevated metal concentrations above Action Level 1 including:

- nickel;
- chromium;
- arsenic;
- zinc; and
- lead.

13.3.33 The number of exceedances were low (see appendix D13-2, Application Reference Number: 6.4.84). These exceedances were predominantly at sites WS20 and WS24 (in Cemaes Bay) and at WS02 (just north of Wylfa Head) (figure D13-4, Application Reference Number: 6.4.101).

13.3.34 Threshold effect levels (TEL) and probable effect levels are defined by the Canadian sediment quality guidelines [RD9]. These are referred to in the absence of equivalent UK guidelines. The TEL of a substance is the concentration below which sediment associated chemicals are not considered to represent significant hazards to aquatic organisms. The probable effect level represents the lowest concentration of a substance that is known to have an adverse effect on aquatic organisms. Comparison with these thresholds found sediment-bound concentrations below the relevant TEL for:

- copper;
- zinc;
- cadmium;
- mercury;
- lead; and
- chromium.

13.3.35 Concentrations of arsenic exceeded the TEL at three sites (WS02, WS06 and WS16; figure D13-4, Application Reference Number: 6.4.101). The nickel TEL was also slightly exceeded at two sites (WS02 and WS20; figure D13-4, Application Reference Number: 6.4.101).

13.3.36 Concentrations of tributyltin in samples were below Cefas Action Level 1, with one exception in 2011 from Cemaes Bay (0.4mg/kg at site WS23; figure D13-4, Application Reference Number: 6.4.101), which was slightly above Action Level 1 but below the threshold for Action Level 2.

Organic contaminants

13.3.37 Several PAHs are highly toxic to aquatic organisms and a number are known to be carcinogenic and mutagenic. The relevant thresholds for comparison are the TELs and probable effect levels as defined by the Canadian sediment quality guidelines [RD9]. All PAH concentrations were below the probable effect level and the majority were lower than the TEL. Generally, PAH concentrations were higher in sediments at inshore sites, particularly in Cemaes Bay (site WS20; figure D13-4, Application Reference Number: 6.4.101) where, in 2011, one sample contained eight PAHs at concentrations above their respective TELs.

13.3.38 PCBs are organic compounds, which are highly toxic and persistent in the environment and are readily bioaccumulated in animals. Sediments were analysed for the International Council for the Exploration of the Sea (ICES) seven indicator PCB congeners (28, 52, 101, 118, 138, 153 and 180) which are known to be persistent in the environment. All total PCB concentrations were below Action Level 1 and the majority of individual sediment-bound PCB concentrations were less than the MRV.

Value of receptor

13.3.39 Sediment quality is not a receptor in itself; however, it supports a number of marine receptors including subtidal communities, invertebrates, general fish and fisheries, fish of conservation and commercial importance and seabirds. It is not therefore assigned a value but is considered within the receptor subtidal benthic communities, as it supports the communities present.

Phytoplankton and zooplankton

13.3.40 Phytoplankton and zooplankton sampling commenced in May 2010 and continued until June 2014 for zooplankton and September 2014 for phytoplankton. Samples were collected within the central study area (5km from the Wylfa Newydd Development Area). Five sites were monitored on a monthly basis from May 2010 to April 2012. An additional site, located in Porth-y-pistyll, was added to the programme in August 2011 and was monitored monthly until October 2012. Sampling resumed in March 2014 at a revised selection of the original sites including the site located in Porth-y-pistyll and an additional one in Cemlyn Bay. Sampling locations were the same as for the water quality surveys (see figure D13-2, Application Reference Number: 6.4.101).

Phytoplankton

13.3.41 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. There were no statistically significant differences in phytoplankton abundance or composition between the sites monitored. The start of the phytoplankton production period was characterised by a spring peak in abundance in May/June. Maximum phytoplankton abundances during the sampling period were typically around 81,000cells/L with a maximum of approximately 300,000cells/L on one

occasion (April 2012), which do not indicate bloom concentrations under WFD guidelines [RD6] (bloom threshold >10^6cells/L).

13.3.42 Low phytoplankton abundance was also mirrored in the low chlorophyll-a concentrations observed between 2010 and 2014, and average values during the spring peak in abundance did not exceed 6.4mg/m^3 (maximum 8.2mg/m^3). Chlorophyll-a values were also below the indicator value set for chlorophyll-a bloom conditions under the WFD guidelines (bloom threshold >10µg/L or mg/m^3).

13.3.43 Diatoms were the most abundant phytoplankton group between 2010 and 2014, and they generally dominated the peak abundance in spring during all years that were sampled, in agreement with other observations from the Irish Sea. However, other groups such as microflagellates can represent an important component of the spring bloom.

13.3.44 During the monitoring period, 11 nuisance/harmful and 12 toxic algal species were reported at the sampling locations. The following algae which are listed among the nuisance or toxic species recorded were present at densities of approximately 1,000-6,000cells/L:

- *Phaeocystis globose*;
- *Chaetoceros danicus*;
- *Heterocapsa* sp.;
- *Karenia mikimotoi*;
- *Pseudo-nitzschia delicatissima*;
- *Pseudo-nitzschia seriata*; and
- *Protoperidinium* spp.

13.3.45 The remaining nuisance or toxic species were recorded at densities of <1,000cells/L. All cell densities were considered to be very low compared to the number at which an individual taxon is considered to reach bloom densities (>250,000cells/L).

13.3.46 Two non-native diatom species were recorded during the monitoring period: *Coscinodiscus wailesii* and *Odontella sinensis*. Only one cell (40cells/L) of *C.wailesii* was recorded from the samples between 2010 and 2014, in December 2010. *O.sinensis* was recorded on 10 occasions in total, in 2011, 2012 and 2014; this species was found at several of the monitoring sites, including Porth-y-pistyll, but at very low abundances of 40cells/L to 160cells/L. Both of these diatoms are well established in British and European waters.

Zooplankton

13.3.47 Zooplankton abundance was umerically dominated by Arthropoda, specifically Copepoda, and exhibited a lag response to the seasonal peaks in phytoplankton abundance. In all years, the highest zooplankton abundances were recorded in spring, whilst lowest numbers were recorded during winter. There were no statistically significant differences in zooplankton abundance or composition between the sites monitored.

13.3.48 Monthly total zooplankton abundance averaged 742 individuals/m^3 with the highest average abundance recorded in April 2012 (4,509 individuals/m^3). Other than Arthropoda, the phyla Annelida, Chordata, Mollusca and Bryozoa were also key contributors to the community assemblage.

13.3.49 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. The zooplankton community recorded was similar to other observations from the Irish Sea (e.g. [RD10] and [RD11]).

13.3.50 No protected species of zooplankton have been identified from the waters off north Anglesey; 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 and their presence within the zooplankton community, is expected. These species are:

- *Mytilus edulis* (blue mussel); blue mussel beds on sediment are a Section 7 of The Environment (Wales) Act 2016 priority habitat;
- *Modiolus modiolus* (horse mussel, previously named *Mytilus modiolus*); horse mussel beds are an Annex I of the Habitats Directive habitat;
- *Sabellaria spinulosa* and *S.alveolata*; Sabellaria reefs are an Annex I of the Habitats Directive habitat; and
- *Palinurus elephas* (spiny lobster); spiny lobster is a Section 7 of The Environment (Wales) Act 2016 priority species.

13.3.51 *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.

13.3.52 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. larvae were 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.

Value of receptors

13.3.53 Phytoplankton and zooplankton are not considered to be of specific conservation value themselves, even though larval stages of species of conservation importance found around the coast of north Anglesey are expected to be found within the zooplankton community. 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. Plankton is of local importance and is relatively common in the coastal waters of north Anglesey, and therefore, the value assigned to this receptor is low.

Marine benthic habitats and species

13.3.54 Baseline data on marine benthic habitats and species were collected since between 2010 and 2016. Various techniques have been used to collect information on benthic habitats and species and these are outlined below.

13.3.55 The Joint Nature Conservation Committee (JNCC) habitat classification system [RD12] has been used to describe the distribution and location of habitats and species in the marine environment. The term 'biotope' is used to holistically describe a habitat in terms of the physical nature of the seabed and the plant and animal communities that are associated with the seabed. The biotope classification system uses a hierarchy of codes, beginning with the seabed type (e.g. 'LR' for littoral rock) and then defining the key characterising species (e.g. 'Lhyp' for *Laminaria hyperborea* (kelp)). The intertidal and subtidal biotopes in Porth-y-pistyll are shown in figure D13-5 (Application Reference Number: 6.4.101) and figure D13-6 (Application Reference Number: 6.4.101). The biotopes are referred to using codes and a full description of each biotope is provided in appendix D13-3 (Application Reference Number: 6.4.85).

Intertidal habitats and species

13.3.56 To characterise the intertidal benthic habitats and species, an initial quadrat survey and walkover was completed in 2010 followed by annual surveys from 2011 to 2014 covering upper, mid and lower shore heights at 13 different sites (figure D13-4, Application Reference Number: 6.4.101). Of these, 11 were located within the central study area whilst a further two were sampled from a wider study area which encompassed the north-east coast of Anglesey as far as Dulas Bay. The results showed a complex array of communities on exposed rocky substrates between Cemaes Bay and Cemlyn Lagoon which are clearly influenced by natural factors such as substrate, exposure and tidal height.

13.3.57 Upper-shore communities at all sites were consistently assigned the biotope *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock (LR.MLR.BF.PelB).

13.3.58 Mid-shore communities were characterised by brown seaweeds and two biotopes were identified: *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser) and *Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock (LR.MLR.BF.FspiB).

13.3.59 Two biotopes were consistently recorded on the lower shore: *Corallina officinalis* on exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Coff) and *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser).

13.3.60 The majority of the intertidal area surveyed was fissured bedrock which can often form a continuation with the sublittoral rocky habitats. Where the reef extends from the sublittoral uninterrupted into the intertidal zone, it is considered to be an example of 'reef' habitat listed at Annex I of the Habitats Directive, although it is not a qualifying feature of any nearby designated site.

This feature is present over considerable areas of the UK coastline, including extensive parts of the north Anglesey coast.

13.3.61 The Annex I habitat 'perennial vegetation of stony banks' is present within the Cemlyn Bay SAC.

Intertidal biotope mapping

13.3.62 An intertidal biotope validation mapping survey was carried out in and around Porth-y-pistyll. This survey identified 37 discrete biotope communities between Cerrig Brith in the east and Porth Gwartheg in the west (figure D13-5, Application Reference Number: 6.4.101). The intertidal areas of the bay were composed of a mosaic of habitats, ranging from muds and sands to exposed bedrock. The following habitats were recorded which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016:

- *Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders (LR.MLR.BF.Fser.Bo);
- *Fucus ceranoides* on reduced salinity eulittoral rock (LR.LLR.FVS.Fcer);
- coastal saltmarsh (LS.LMp.Sm); and
- blue mussel (*Mytilus edulis*) beds on littoral mixed substrata (LS.LBR.LMus.Myt.Mx).

13.3.63 The blue mussel bed and *F.ceranoides* and coastal saltmarsh communities comprised small areas of the habitats mapped, therefore are not considered to be particularly important examples of the habitats, although it is recognised that their presence adds to the diversity of habitats and species within Porth-y-pistyll.

13.3.64 Many rock pools were recorded from the low to high shore at Porth-y-pistyll and Cerrig Brith, the majority of which were described as 'seaweed and sediment floored' pools. This habitat is noted as a feature of 'special interest' within the nearby Cemlyn Bay SSSI and, being relatively uncommon, rock pools are thought to add ecological value to the bay.

Subtidal habitats and species

13.3.65 The selection of sites for the benthic invertebrate sampling survey was informed by data from geophysical investigations (appendix D12-1 Coastal Geomorphology Baseline for the Wylfa Newydd Development, Application Reference Number: 6.4.80)). In 2010 quantitative benthic invertebrate sampling was carried out at 22 sites; this was repeated in 2011 with four further sites sampled (figure D13-4, Application Reference Number: 6.4.101). Additional benthic invertebrate sampling was undertaken during 2015 to determine the ongoing validity of earlier data. Of the total number of different sites sampled, 20 were located within the central study, with six additional sites sampled from a wider study area which encompassed the north coast of Anglesey from Church Bay in the west to Red Wharf Bay in the east.

13.3.66 Drop-down camera images were acquired from 68 and 54 sites sampled in June 2010 and 2011, respectively (figure D13-7, Application Reference Number: 6.4.101). Survey effort was concentrated within the central study area; the wider study area encompassed the north coast of Anglesey with further concentration of sampling in Church Bay and The Skerries in the west and Point Lynas in the east. Outfall diving surveys were carried out to consider the influence of the Cooling Water discharge from the Existing Power Station on the intertidal and subtidal benthic ecology around Wylfa Head (figure D13-7, Application Reference Number: 6.4.101).

13.3.67 The subtidal habitats and communities along the north Anglesey coast were found to be highly heterogeneous, driven by the complex seabed topography and tidal streams in the area (appendix D12-1, Application Reference Number: 6.4.80). The lack of demersal fishing activity, on account of the topography, means the North Anglesey Marine communities have received only low levels of physical anthropogenic disturbance.

13.3.68 Granulometric data from sedimentary habitats and field observations from the 2010 and 2011 subtidal surveys indicated that substrates varied considerably over the study area from muds to coarse gravel and cobbles. The pattern of sediments was clearly related to the scouring effects of the prevailing high-energy currents with a high degree of exposed bedrock surrounding the headland sites. Muddy sands were evident within Cemaes Bay, Cemlyn Bay and to the north of Porth-y-pistyll, which is consistent with their more sheltered locality.

13.3.69 The tide-swept headlands of Wylfa Head, Llanbadrig Head and beyond support diverse sponge and cnidarian (hydroids, soft corals, anemones, etc.) communities, particularly in the circalittoral (area of subtidal habitat below the algal zone, dominated by animal fauna).

13.3.70 Several habitats recognised as part of broader habitats ('subtidal mixed sediments', 'fragile sponge and anthozoan communities on rocky habitats' and '*Musculus discors* beds') listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, were identified during the subtidal benthic grab surveys including:

- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (shallow sites in Cemaes Bay and between Wylfa head and Cemlyn Bay);
- mixed turf of bryozoans and erect sponges with *Dysidea fragilis* and *Actinothoe sphyrodeta* on tide-swept wave-exposed circalittoral rock (approximately 3km east of Wylfa head, inshore at Llanlleiana Head); and
- Musculus discors beds on moderately exposed circalittoral rock (Cemaes Bay) (see appendix D13-2, Application Reference Number: 6.4.84).

Sabellaridae

13.3.71 Biogenic reefs are those, which are created by reef-building animals, such as tube-building worms, which can form aggregations. A reef is a structure that is solid (although it may be fragile), is at least several centimetres thick, raised above the seabed and remains in place for many years [RD13]. Biogenic reefs of *S.spinulosa* are recognised as part of the reefs habitat listed at Annex I of the Habitats Directive.

13.3.72 The results of the subtidal grab surveys were used in conjunction with the drop-down camera images to help assign appropriate *S.spinulosa* biotopes. Based on the criteria for determining presence of a biogenic reef, three offshore sites were identified with structures that represented elevations greater than 2cm (WS08, WS13 and WS18; figure D13-4, Application Reference Number: 6.4.101), but are not reefs [RD14]. Only one site contained several small (2cm to 5cm), elevated fragments from a single replicate in 2011. Despite many fragments recorded from a single replicate at WS18 in 2010 (figure D13-4, Application Reference Number: 6.4.101), the replicates in 2011 recorded small amounts of crusts with a single, small (2cm to 5cm) elevated fragment.

13.3.73 Site WS13 in Church Bay was the only site identified as a potential biogenic reef site, in respect of all parameters considered (see appendix D13-2, Application Reference Number: 6.4.84). WS08 and WS18 (figure D13-4, Application Reference Number: 6.4.101) had recorded elevated tube structures in the grab samples but are not considered representative of a reef when also considering the low patchiness of tubes observed (less than 10%).

13.3.74 During subtidal fish surveys, large areas of seabed were trawled using a beam trawl. Some crusts of *S.spinulosa* were occasionally observed, most notably at SF05 on the west of Anglesey, which is close to WS13. During the outfall surveys at the Existing Power Station, divers recorded the occasional presence of *S.spinulosa* but only as crusts and not in densities which would meet the criteria for a biogenic reef.

13.3.75 *S.spinulosa* reef was not recorded during the subtidal biotope mapping survey in Porth-y-pistyll in 2014. Further diver surveys were carried out in June 2016 to determine the presence of *S.spinulosa* within Porth-y-pistyll and the adjacent coastline (see appendix D13-2, Application Reference Number: 6.4.84). These surveys were designed to cover as much ground as possible and provide greater confidence in the likelihood of presence/absence of *S.spinulosa* reef structures in the area. *S.spinulosa* crusts were found but reef habitat was not recorded anywhere within or near the Wylfa Newydd Development Area (see appendix D13-2, Application Reference Number: 6.4.84).

Subtidal biotope mapping

13.3.76 A biotope mapping exercise of the subtidal habitats in Porth-y-pistyll was carried out by divers in June 2014 using a combination of rapid assessment transects and the Marine Nature Conservation Review phase II methodology [RD15].

13.3.77 The survey identified 19 biotopes (figure D13-6, Application Reference Number: 6.4.101). The gradation of biotopes from the infralittoral fringe to the sublittoral sediments is described as *Laminaria digitata* (kelp) communities leading down to dense forests of *L.hyperborea* (kelp) and on to sparser, but even more extensive, *L.hyperborea* parks (lower density of kelp). Within the middle of the bay were large patches of 'dense foliose red seaweeds on silty, moderately exposed infralittoral rock' (IR.MIR.KR.XFoR) and to a lesser extent 'infralittoral muddy sand' (SS.SSa.IMuSa).

13.3.78 Many of the subtidal biotopes recorded in and around the bay are recognised as part of broader habitats ('subtidal sands and gravels' and 'subtidal mixed muddy sediments') listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, including:

- infralittoral coarse sediment (SS.SCS.ICS);
- infralittoral muddy sand (SS.SSa.IMuSa);
- *Arenicola marina* in infralittoral fine sand or muddy sand (SS.SSa.IMuSa.AreISa);
- circalittoral muddy sand (SS.SSa.CMuSa); and
- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc).

13.3.79 Also present was the biotope complex 'Bryozoan turf and erect sponges on tide-swept circalittoral rock' (CR.HCR.XFa.ByErSp), which is recognised as part of the broader habitat 'fragile sponge and anthozoan communities on rocky habitats', which itself is listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Non-native species

13.3.80 The North Wales Wildlife Trust (NWWT) has identified 17 non-native species of concern in north Wales (table D13-2). These invasive species have either already been recorded in Wales or are expected to arrive soon. In 2014, the Wales Marine Non-native Species Inshore Monitoring Network [RD16] recorded four of these species in Holyhead Harbour; carpet sea squirt (*Didenmum vexillum*), Japanese skeleton shrimp (*C.mutica*), orange-tipped sea squirt (*Corella eumyota*) and orange cloak sea squirt (*Botrylloides violaceus*).

13.3.81 Surveys undertaken in 2014 as part of the Welsh Government Resilient Ecosystems Fund [RD17] recorded three additional Invasive Non-Native Species (INNS) in Holyhead Harbour that have not been previously recorded; the leathery sea squirt (*Styela clava*), a colonial sea squirt (*Aplidium* cf *glabrum*) and Japanese kelp (*Undaria pinnatifida*).

Table D13-2 Non-native marine species of concern in north Wales [RD18]

Scientific name	Common name	Status	Distribution in Wales
Didemnum vexillum	Carpet sea squirt	Great Britain rapid response alert species	Established in Holyhead marina in north Wales.
Undaria pinnatifida	Japanese kelp / Wakame	High alert species	Recorded from Holyhead Harbour and Pembroke Dock [RD17].
Rapana venosa	Rapa whelk	High alert species	Not yet recorded in Wales; however, it is likely to arrive and will quickly spread.
Watersipora subtorquata	Red ripple bryozoan	High alert species	Not yet recorded in Wales; however, it is likely to arrive and will quickly spread.
Crepidula fornicata	American slipper limpet	Strategic priority species	Established in parts of south Wales.
Megallana gigas	Pacific oyster	Strategic priority species	No known self-recruiting populations though frequently farmed in aquaculture.
Sargassum muticum	Wireweed	Strategic priority species	Established in parts of Wales, particularly along the Lleyn Peninsula and Anglesey.
Eriocheir sinensis	Chinese mitten crab	Strategic priority species	Established in the River Dee.
Grateloupia turuturu	Devil's tongue weed	Strategic priority species	Established in Milford Haven.
Ostrea chilensis	New Zealand flat oysters	Strategic priority species	Established in the Menai Strait.
Corella eumyota	Orange-tipped sea squirt	Low alert species	Known to be present in north Wales.
Hemigrapsus sanguineus	Asian shore crab	None given	Several sightings in the UK, with one sighting in south Wales.

Scientific name	Common name	Status	Distribution in Wales
Codium fragile	Gree sea- fingers	None given	Reported in waters off the Scilly Isles, the Channel Islands, areas of South Wales and the south coast of England and also as far as the west coast of Scotland (Argyll).
Caprella mutica	Japanese skeleton shrimp	None given	Limited reports of this species in Wales (includes Holyhead Harbour in 2014). Found in UK waters on the south coast of England, the west coast of Scotland and the Western Isles.
Styela clava	Leathery sea squirt	None given	Predominantly the south coast of England. Occurs on the west coast of Wales and Scotland. Recordings in Anglesey and the Lleyn, as well as other parts of north Wales.
Botrylloides violaceus	Orange cloak sea squirt	None given	Found in few areas of the UK, including Milford Haven and the south-west coast of England.
Asparagopsis armata	Harpoon weed	None given	Recorded on the Lleyn Peninsula and in areas of South Wales; however, it is more common in south-west England and has spread as far as the Shetland Isles.

13.3.82 The carpet sea squirt (*D.vexillum*) represents a significant risk to biodiversity and socioeconomic assets owing to the speed at which it can colonise artificial structures (e.g. marinas and aquaculture). Once established it can form large colonies, growing over existing sessile hard structure communities, resulting in significant alterations to the native species composition. It is thought to be native to the north-west Pacific and is likely to have spread from Japan to the UK via France through fouling of vessels, particularly leisure craft, movement of aquaculture stocks and ballast water. Natural dispersal is limited but outgrowths on floating structures can drop off and reattach.

13.3.83 The carpet sea squirt was first recorded in Holyhead Harbour in 2008 and, despite multiple eradication programmes; small colonies were still found to be present in September 2013. To date, the carpet sea squirt has not been recorded in any of the marine ecology surveys carried out for the Wylfa Newydd Project.

13.3.84 The leathery sea squirt (*S.clava*) is classified as having a high impact level [RD19]. It attaches to solid surfaces in shallow water, especially in harbours and marinas but also on wrecks and natural rock substrate. This species can reach high densities, dominating shallow sheltered habitats resulting in a decline in the abundance of other native shallow-water suspension feeding sessile invertebrates [RD20].

13.3.85 The Japanese kelp (*U.pinnatifida*) is listed by the NWWT as a high alert species, having been recorded in Holyhead Harbour. Originally from Japan, China and Korea [RD21], this species has spread around the world by international shipping and mariculture. It can tolerate a wide salinity and temperature range; its morphological and reproductive characteristics allow it to outcompete native kelp species in the shallow sublittoral/infralittoral zone [RD22].

13.3.86 The Japanese skeleton shrimp (*C.mutica*) is considered a moderate impact species under the WFD [RD19]. It was reported in Holyhead Harbour in 2014 [RD16]. It is an aggressive species and even at low densities can outcompete the native skeleton shrimps for food and space. They are found on a wide range of natural and artificial substrate including attached ropes, boats hulls and floating pontoons and can spread on drifting seaweed or artificial materials.

13.3.87 Recording of non-native benthic species has been carried out as part of the analysis of results from marine ecology surveys covering the north Anglesey coastline between Holyhead Bay and Red Wharf Bay since 2010 (see appendix D13-2 (Application Reference Number: 6.4.84), D13-3 (Application Reference Number: 6.4.85) and D13-5 (Application Reference Number: 6.4.87)). Non-native benthic species recorded during the survey programme are already known to occur around the coast of north Anglesey and are not unique to any particular area. These include red algae (*Asparagopsis armata*, *Anotrichium furcellatum* and *Dasysiphonia japonica*); green alga (*Codium fragile* sub sp. *tomentosoides*), brown alga (*Sargassum muticum*) and a barnacle species (*Austrominius modestus*) (see appendix D13-3, Application Reference Number: 6.4.85).

13.3.88 *D.japonica* was found during the diving surveys at three sites in 2011, at one site in 2012 and 2014, and at two sites in 2015. *A.armata* was recorded in fairly high densities in all years. The non-native red alga *A.furcellatum* was recorded for the first time in 2014 to the north-west of Cerrig Brith. *C.fragile* was recorded in the subtidal outfall surveys in 2011, 2012 and 2015 in abundances ranging from 'rare' to 'frequent'.

13.3.89 Non-native species are not considered receptors in themselves; however, the potential effects associated with non-native species has been discussed, and the potential effects on other receptors considered, as part of the assessment.

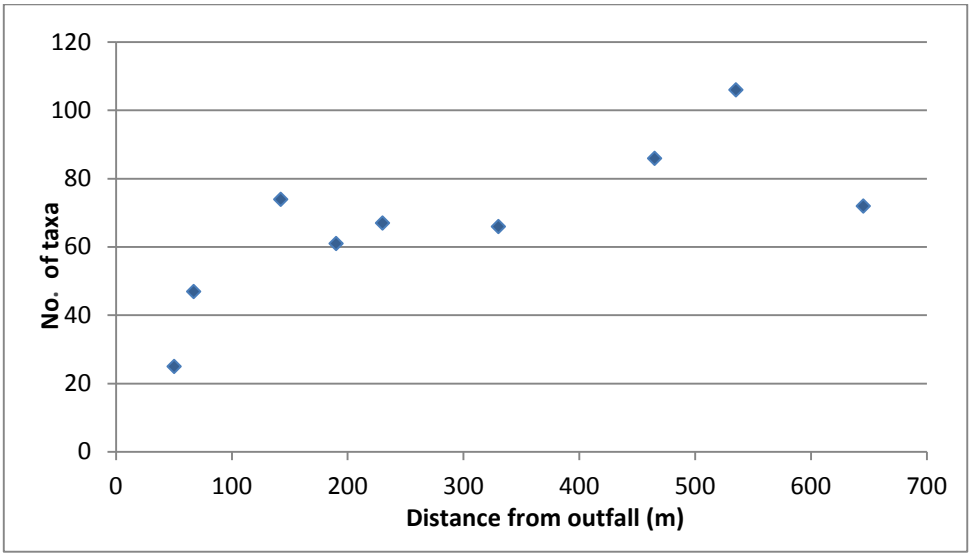
Outfall surveys

13.3.90 An intertidal outfall survey was carried out in 1987 to assess the changes in populations of dogwhelks (*Nucella lapillus*), barnacles and limpets (*Patella vulgata*), with increasing distance from the Existing Power Station outfall [RD23]. This survey was repeated using the same methodology in 2010 and 2015 (appendix D13-5, Application Reference Number: 6.4.87). The effect on intertidal habitats and species at the outfall was detectable up to a distance of 250m from the outfall, after which there were no measurable differences with comparable surrounding communities.

13.3.91 Dive surveys were carried out in 2011 and 2012 to gather baseline data on the influence of the Cooling Water discharge from the Existing Power Station on subtidal habitats and species (figure D13-7, Application Reference Number: 6.4.101). These surveys were repeated in 2015 to consider the effects on the benthic communities of a reduction in discharge from the Existing Power Station.

13.3.92 In all years, the subtidal surveys in the existing outfall channel, the existing outfall bay and beyond demonstrated a clear, acute effect on the infralittoral rocky reef communities within 100m (figure D13-8). Changes in the community were observed up to 300m of the existing outfall with noticeable changes in the dominant cover of algal species and numbers of sponge and tunicate taxa, despite species richness being similar in value to that obtained at reference sites.

Figure D13-8 Total number of taxa recorded (including all flora and fauna) during diver transect surveys in June 2011



Invertebrates (of conservation and commercial importance)

13.3.93 Two species listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016 were recorded in baseline surveys. During the outfall surveys in 2012, one European spiny lobster (*Palinurus elephas*) was recorded at Llanbadrig Head. In 2016 during a 'rapid assessment' diver survey, a single ocean quahog (*Arctica islandica*) (a species of edible clam) was recorded in Porth-y-pistyll (see appendix D13-2, Application Reference Number: 6.4.84). The invertebrate species that are fished commercially are considered in paragraphs 13.3.136 to 13.3.143.

Value of receptors

13.3.94 The Habitats Directive Annex I habitats 'coastal lagoons' and 'perennial vegetation of stony banks' were assigned high values, as they are a qualifying feature of the Cemlyn Bay SAC.

13.3.95 The intertidal and subtidal habitats that are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, which are rare or uncommon on a national scale, have been assigned a value of medium.

13.3.96 Much of the intertidal rocky shore is colonised by marine flora and fauna, and this is considered to be an example of reef habitat listed at Annex I of the Habitats Directive, although it is not a qualifying feature of any nearby designated site. Rock pool habitat is noted as a feature of special interest within the nearby Cemlyn Bay SSSI, and this habitat is considered to have ecological value in relation to the immediate surrounding area. Based on the important biodiversity characteristics of the intertidal rocky shore and rock pools, these receptors are assigned a medium value.

13.3.97 Other subtidal habitats identified throughout the surveys are common in the local area, have some biodiversity characteristics (e.g. naturalness, contribution to diversity) and are of local importance. *S.spinulosa* is

commonly recorded as is the congeneric *S.alveolata* though at much lower abundances; however, there have been no biogenic reef structures recorded within the zone of influence. Habitats and species that are common and do not have any particular conservation importance are considered as part of the subtidal habitats and communities' receptor group, which is assigned a low value.

13.3.98 Given the likely presence of the spiny lobster and ocean quahog within the study area, these species have been included within the receptor category of 'invertebrates (of conservation and commercial importance)' and are assigned a value of medium. Table D13-4 sets out the receptors relevant to the marine environment and their assigned values.

Marine fish

13.3.99 Baseline data on fish communities were collected from within the central study area between 2010 and 2015. To capture the mobile nature of fish and to fully characterise fish communities, additional information from published literature has been gathered from a wider study area.

13.3.100 The wider study area primarily covered the eastern Irish Sea which is known to support important spawning and nursery grounds for both commercial and non-commercial species [RD24]. The abundance and distribution of these species along the north coast of Anglesey is considered to be related to source populations in the east.

13.3.101 For commercial species, landings data from coastal waters around the Isle of Anglesey have also been considered. The ICES considers this wider study area within the assessment rectangle 35E5 [RD25].

Ichthyoplankton

13.3.102 Ichthyoplankton communities were sampled from 2010 to 2014 to provide data on early life stages to include larval fish and eggs. During the first full year, surveys were carried out monthly with samples collected on both flood and ebb tides at five sites (figure D13-9, Application Reference Number: 6.4.101). Following analysis of these initial results, the sampling programme was rationalised to a single random tide and additional sites were added in Porth-y-pistyll.

13.3.103 Between 2010 and 2014, a total of 10,160 fish were recorded from filtering 35,685m^3 of seawater through Gulf sampling nets, representing 52 distinct taxa. Ichthyoplankton abundance followed a similar seasonal pattern at all sites with the highest abundances occurring from February to May and the lowest from October to January.

13.3.104 Samples were dominated by individuals from the family Ammodytidae (sandeel), which accounted for the highest proportion of total abundance (4,124 individuals, 41%), followed by Pleuronectidae (flatfish) (1,191 individuals, 12%), Clupeidae (herring family) (1,064 individuals, 11%) and Gobiidae (gobies) (633 individuals, 6%). The dominance of Ammodytidae and Pleuronectidae is unsurprising owing to the abundance of sandeel in the area and the location of a plaice spawning ground.

13.3.105 The ichthyoplankton communities at each site were found to be similar, although there were differences in overall abundance (averaged for all replicate samples per month and adjusted to numbers/10^6m^3) over sampling period, with a peak in abundance at site 1 in February 2012 (approximately $2.6x10^6$ individuals/10^6m^3; figure D13-9, Application Reference Number: 6.4.101). Peaks in ichthyoplankton abundance were also observed at sites 4 and 5 during March and April 2011 ($1.8x10^6$ individuals/10^6m^3 to $2.3x10^6$ individuals/10^6m^3) whilst lower abundances were observed at sites 2 and 3 (figure D13-9, Application Reference Number: 6.4.101).

13.3.106 The average egg abundance between May 2010 and September 2014 showed a similar pattern of abundance at all sites with a peak in spring months, followed by a decrease in abundance into summer and then very low numbers in autumn and winter. Peak egg abundances are thought to be largely driven by the spawning of sandeel, Dover sole (*Solea solea*) and dab (*Limanda limanda*).

13.3.107 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) have been recorded during the ichthyoplankton survey programme (see table D13-3). With the exception of Atlantic mackerel (*Scomber scombrus*) and cod (*Gadus morhua*) which were each observed on less than three occasions, these species occurred frequently over the survey programme.

13.3.108 The ichthyoplankton surveys confirmed the presence of low intensity spawning grounds for sandeel, whiting (Merlangius merlangus) and Dover sole around the north coast of Anglesey; high intensity spawning grounds for these species are present in the eastern Irish Sea [RD24]. According to Ellis et al., [RD24], the north coast of Anglesey (including the Wylfa Newydd Development Area) is a high intensity spawning ground for plaice (Pleuronectes platessa). Densities of larval plaice recorded during recent ichthyoplankton surveys did not suggest the presence of high intensity spawning; these data are considered to provide a more accurate indication of inshore spawning patterns within the vicinity of the Wylfa Newydd Development Area owing to the high spatial and temporal resolution of sampling.

Intertidal fish

13.3.109 Intertidal fish communities were sampled quarterly between 2010 and 2015 using a multi-method approach owing to the rocky nature of the near-shore environment. Seine netting was completed at 11 target sites (figure D13-9, Application Reference Number: 6.4.101). Baited fish traps were set at two sites and were left for up to 24 hours before retrieval. In 2010, dedicated diver surveys were carried out to examine fish communities associated specifically with exposed rocky habitats.

13.3.110 Between spring 2010 and autumn 2015, 45 taxa were identified in the seine nets and traps. Dominant species were:

- sandeel (*Ammodytes* spp.);
- clupeids;

- sand smelt (*Atherina presbyter*);
- plaice; and
- gobies (*Pomatoschistus* spp.).

13.3.111 The fish traps caught several that were not found in the seine nets:

- tompot blenny (*Parablennius gattorugine*);
- rock goby (*Gobius paganellus*);
- three-bearded rockling (*Gaidropsarus vulgaris*);
- lesser-spotted dogfish (*Scyliorhinus canicula*); and
- nursehound (*Scyliorhinus stellaris*).

13.3.112 An additional eight species were recorded during the diver surveys including:

- leopard spotted goby (*Thorogobius ephippiatus*);
- reticulated dragonet (*Callionymus reticulatus*);
- rock cook wrasse (*Centrolabrus exoletus*);
- butterfish (*Pholis gunnellus*);
- topknot (*Zeugopterus punctatus*);
- cuckoo wrasse (*Labrus mixtus*);
- black goby (*Gobius niger*); and
- conger eel (*Conger conger*).

13.3.113 The mean number of fish caught per net and the number of species caught per survey varied noticeably between seasons and from year to year (figure D13-10). From the 22 surveys between spring 2010 and autumn 2015, the highest catch per net was recorded in summer 2015: a result mainly owing to large numbers of fish caught at sites IF09, IF07, IF11 and IF12 (figure D13-9, Application Reference Number: 6.4.101), particularly clupeids, sandeel and sand smelt.

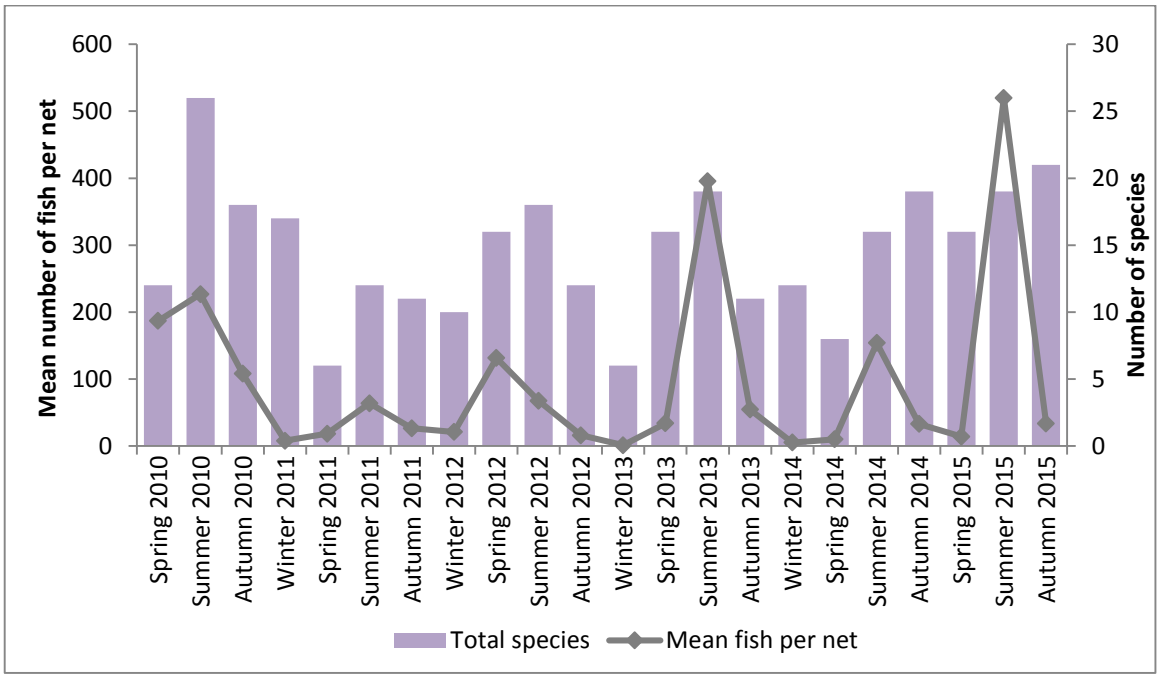
13.3.114 Overall, the highest abundances of fish in intertidal areas were found on the north-east coast of Anglesey; this is likely to be owing to the proximity of sampling sites to known spawning and nursery grounds in the eastern Irish Sea [RD24]. The lowest abundances of fish were observed on the north-west coast of Anglesey, with a clear gradient of overall fish abundance evident along the intervening coastline from east to west. Species-specific variations in abundance and distribution were however evident; these are believed to be linked to life history characteristics and habitat preferences. For example, a notable absence of flatfish and a lower abundance of sandeel were recorded in Porth-y-pistyll compared to other areas (e.g. Cemaes Bay) which is not unexpected as these taxa exhibit a preference for sandy substrates.

13.3.115 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016 have been recorded during the intertidal fish survey programme (see table D13-3).

13.3.116 Sea trout (*Salmo trutta*) were identified in low numbers during surveys between 2010 and 2013 (none were recorded in 2014). Most individuals were recorded as smolts with a size range of 135mm to 205mm; however, a single parr was identified in the summer of 2010 measuring 45mm.

13.3.117 Of the other species of conservation importance, herring (*Clupea harengus*), plaice and Raitt's sandeel (*Ammodytes marinus*) constituted the highest abundances in the sampling programme.

Figure D13-10 Mean number of fish per seine net and total number of species recorded per season from spring 2010 to autumn 2015



Subtidal fish

13.3.118 Subtidal fish communities were sampled on a quarterly basis at five sites around north Anglesey between 2010 and 2014 (figure D13-9, Application Reference Number: 6.4.101). Otter trawls were used to characterise pelagic fish (those living in the water column or above the seabed) and demersal fish (those living just above the seabed), and beam trawls were used to characterise demersal fish and invertebrates within the subtidal zone.

13.3.119 Between spring 2010 and autumn 2014, a total of 75 taxa were identified. The most abundant species were dab and whiting, which represented approximately 47% and 33%, respectively, of all catches during the survey programme. Species such as the following also contributed heavily to the subtidal catches:

- poor cod (*Trisopterus minutus*);
- common dragonet (*Callionymus lyra*);
- plaice;
- lesser-spotted dogfish; and
- sprat (*Sprattus sprattus*).

13.3.120 Sandeel and herring abundances within the vicinity of the Wylfa Newydd Development Area were low; individuals were recorded most often and in the highest abundance at site SF05 in Church Bay.

13.3.121 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) have been recorded from subtidal fish surveys (Table D13-3). Many of these were recorded infrequently; however, throughout the programme, large numbers of whiting and, to a lesser degree, plaice and herring were present in the catch.

13.3.122 Of the elasmobranchs (sharks, skates and rays), thornback rays (*Raja clavata*) were the most commonly caught species listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Impingement

13.3.123 Impingement and entrainment surveys were completed for 24-hour periods at the drum screens of the Cooling Water intake of the Existing Power Station at a rate of 40 surveys per annum. Surveys were scheduled on a random basis to avoid tidal bias. In total, 55 surveys were completed between 22 March 2011 and 31 July 2012.

13.3.124 Over the impingement-monitoring period, a total of 66 fish species were identified from screen surveys at the Existing Power Station. The most dominant species by abundance was sprat, and by biomass was lesser-spotted dogfish.

13.3.125 Fish classed as benthic species (living largely on or in the seabed) dominated the catches, representing 53% of all taxa, demersal species represented 39.4% and pelagic species represented 7.6%.

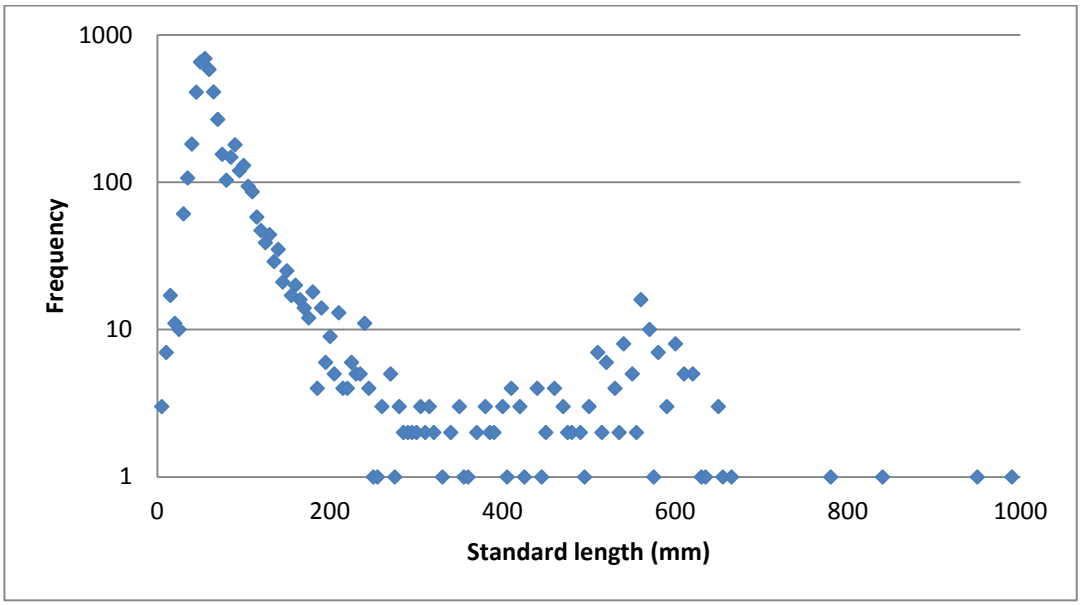
13.3.126 Several species of conservation importance (listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) were identified within the impingement catches (table D13-3). Of the species with conservation designations, whiting and herring were the most frequently encountered. One river lamprey (*Lampetra fluviatilis*) was recorded during the survey, and this species is only considered as transient through the area for purposes of migration. Although European eel (*Anguilla anguilla*) was not recorded in these surveys, previous studies from the 1980s have observed this species at the intake of the Existing Power Station [RD26]. It is also known to be present in watercourses within the Wylfa Newydd Development Area (see chapter D9, terrestrial and freshwater ecology, Application Reference Number: 6.4.9 and appendix D9-16 Application Reference Number: 6.4.49).

13.3.127 The length-frequency distribution of fish impinged is shown in figure D13-11 and was dominated by fish smaller than 24cm. Larger individuals were also caught, but these were occasional and included species such as the conger eel, nursehounds (*Scyliorhinus stellaris*), lesser-spotted dogfish and rays. The high frequency of small fish was composed mainly of sprat, sand smelt and whiting.

13.3.128 Seasonal peaks in abundance and biomass were evident in the results, with peaks in abundance observed between late December and March when increased numbers of sprat, herring, dragonets (*Callionymus* sp.), long-spined sea scorpion and lesser-spotted dogfish were recorded.

13.3.129 The invertebrate fauna impinged represented 164 different taxa, with a large proportion being sessile in nature, suggesting that they had been dislodged from the seabed in the surrounding area or were growing within the Cooling Water intake itself; however, a combination of the two is most likely. Peaks in invertebrate impingement were observed to coincide with strong winds (autumn 2011 and winter 2012) and seasonal blooms of ctenophores and jellyfish (spring and early summer).

Figure D13-11 Length-frequency distribution of fish species impinged at the Existing Power Station between March 2011 and July 2012



13.3.130 On average, edible crab (*Cancer pagurus*) impinged was 206 individuals per 24 hours. Impingement of European lobster (*Homarus gammarus*) was uncommon with only seven individuals recorded over the whole monitoring period.

13.3.131 The dominant seaweed species varied with month and season and included kelps and wracks (*Laminaria* spp. and fucoids), red and green algae.

Entrainment

13.3.132 In total, 50 species were sampled, and the highest contributing families to larval abundance were dragonets (Callionymidae), gobies (Gobiidae) and blennies (Blenniidae). All species identified from the samples were as expected for the biogeographical region. Species with conservation designations were entrained in low numbers and included herring, whiting, plaice, Dover sole and lesser sandeel (*Ammodytes tobianus*).

13.3.133 Highest larval fish entrainment abundance was observed between early February and late August, with the lowest abundance occurring over autumn

and winter. The abundance of eggs followed a similar trend with lowest abundance over the winter period and highest abundance in March/April.

Fish species of conservation importance

13.3.134 The species of conservation importance, which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, that have been identified during all fish surveys are listed in table D13-3.

Table D13-3 Adult and larval fish species of conservation importance

Species	Ichthyoplankton	Intertidal	Subtidal	Impingement
Raitt's sandeel (*Ammodytes marinus*)	✓	✓	✓	
Lesser sandeel (*Ammodytes tobianus*)	✓	✓	✓	
Plaice (*Pleuronectes platessa*)	✓	✓	✓	✓
Herring (*Clupea harengus*)	✓	✓	✓	✓
Mackerel (*Scomber scombrus*)	✓		✓	
Cod (*Gadus morhua*)	✓	✓	✓	✓
Dover sole (*Solea solea*)	✓		✓	✓
Whiting (*Merlangius merlangus*)	✓	✓	✓	✓
Sea trout (*Salmo trutta*)		✓		
Nursehound (*Scyliorhinus stellaris*)		✓		
Spurdog (*Squalus acanthias*)			✓	
Tope (*Galeorhinus galeus*)			✓	
Scad/horse mackerel (*Trachurus trachurus*)			✓	✓ (single record)
Anglerfish (*Lophius piscatorius*)			✓	
Blonde ray (*Raja brachyura*)			✓	
Thornback ray (*Raja clavata*)			✓	✓
Ling (*Molva molva*)				✓ (single record)
River lamprey (*Lampetra fluviatilis*)				✓ (single record)
Spotted ray (*Raja montagui*)				✓ (single record)

13.3.135 Atlantic salmon (*Salmo salar*) has not been recorded in any marine baseline surveys between 2010 and 2015 (including entrapment surveys at the Existing Power Station from 2011 to 2012), nor has it been recorded in any freshwater baseline surveys (see appendix D9-16, Application Reference Number: 6.4.49). The North Wales Environmental Information Service (Cofnod) however, has a single individual recorded in Cemlyn Bay in July 2005. Although there are no known Atlantic salmon spawning streams in the central study area (within 5km of the Wylfa Newydd Development Area), it recognised that Atlantic salmon could potentially reside as juvenile life stages in optimal freshwater environments, with migration through the marine environment. Atlantic salmon is listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Commercial fisheries

13.3.136 Within the ICES fisheries assessment area 35E5 [RD25], which encompasses Anglesey, the most important commercial species are whelk (*Buccinum undatum*), queen scallop (*Aequipecten opercularis*), king scallop (*Pecten maximus*) and European lobster. These species contributed 50%, 37%, 11% and 1%, respectively to the total tonnage landed from this sea area between 2010 and 2014 [RD25]. Dover sole, common prawn (*Palaemon* spp.) and edible crab each contributed less than 1% [RD25].

13.3.137 Commercial potting for shellfish is the primary fishery that operates along the north Anglesey coastline. Species targeted by inshore potting includes European lobster, edible crab and common prawns. To the west, potting for whelk occurs further offshore whilst an inshore fishery is present around the east coast of Anglesey [RD27]. Bottom set nets targeting demersal fish species are known to operate in isolated regions around Cemlyn Bay, Amlwch and to the north between The Skerries and Middle Mouse. Dredging for queen scallop occurs approximately 8km off the north coast of Anglesey whilst a king scallop fishery operates to the east in the vicinity of Red Wharf Bay and west of Holyhead [RD27]. No commercial trawling activities are known to operate off the north coast of Anglesey.

13.3.138 Within the Wylfa Newydd Development Area and wider study area the intensity of commercial potting is low (fewer than 730 pots lifted and dropped per 100ha/day) although medium and high intensity fisheries (730 to 1,825 and over 1,852 pots lifted and dropped per 100ha/day, respectively) operate to the east around Middle Mouse [RD28]. Hand gathering of periwinkles is also believed to occur within the study area [RD28]. The highest densities of queen and king scallop occur to the east of the study area in Liverpool Bay where reported densities exceed 19 individuals/100m^2 and six individuals/100m^2, respectively [RD29]. This area is dredged for queen scallop up to 10 times a year and up to three times a year for king scallops [RD28].

13.3.139 The main commercial fishing ports on Anglesey include Cemaes, Amlwch and Holyhead. Between 2010 and 2014, scallop (queen and king) constituted over 70% (13,291 tonnes) of all landings at these three ports whilst whelks, lobster and edible crab constituted 28% (5,406 tonnes), 0.46% (87 tonnes) and 0.17% (37 tonnes), respectively [RD25].

Value of receptors

13.3.140 A number of individual fish species have no specific conservation value themselves but need to be considered as a community owing to the importance they play in the wider environment. Fish communities are therefore considered as 'ichthyoplankton not of commercial or conservation value' and 'general fish and fisheries (intertidal and subtidal)', both of which are considered to be of low value.

13.3.141 There are two fish species of national/international importance which are known to be present in the central study area. River lamprey, which is listed on Annex II of the Habitats Directive, and European eel, which is protected by the Eels (England and Wales) Regulations 2009, are both considered high-value receptors. River lamprey and European eel must pass through the coastal environment during migration and therefore are considered as individual receptors.

13.3.142 As a precautionary approach, the assessment for the Wylfa Newydd Development Area has also given consideration to effects on Atlantic salmon. This species is listed on Annex II of the Habitats Directive and is considered to be of high value. Where relevant, this species has been considered as a separate receptor.

13.3.143 A number of fish species identified in surveys, listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, are considered to be important on a regional level and have therefore been assigned a medium value. Table D13-4 sets out the receptors relevant to the marine environment and their assigned values.

Marine mammals

13.3.144 To account for the mobility of marine mammals and their feeding ranges, the study area for marine mammals incorporates the relevant Marine Mammal Management Units and takes account of populations from SACs that have been designated for one or more Annex II species within the Celtic and the Irish Sea. These data are complemented by site-specific survey work undertaken by specialist surveyors trained as marine mammal observers. Full details of the surveys undertaken are provided in appendix D13-6 (Application Reference Number: 6.4.88) and include the following.

- Dedicated vessel transect surveys covering 12 transects monthly carried out from May 2016. Data obtained from up to January 2017 are reported (figure D13-12, Application Reference Number: 6.4.101).
- Site-specific C-POD (autonomous underwater noise cetacean click detector) surveys using three C-PODs (figure D13-12, Application Reference Number: 6.4.101).
- Dedicated Vantage Point (VP) surveys carried out between Cemlyn Bay and Cemaes Bay from 2011 to 2013 (figure D13-12, Application Reference Number: 6.4.101).
- Site-specific land-based seal surveys.
- Incidental/casual sighting records maintained since April 2010.

13.3.145 The baseline information and assessment of potential effects on otters (*Lutra lutra*) are presented in chapter D9 (Application Reference Number: 6.4.9).

Cetaceans

13.3.146 All cetaceans are listed under Annex IV of the Habitats Directive as European Protected Species. A review of cetacean sightings in Welsh waters collated since 1990 [RD30] shows 18 species of cetacean in Welsh waters, with 14 having being sighted in north Wales within the last 10 years. Of these 14 species, most represent occasional sightings with only three species being frequently observed and identified in marine mammal observer data:

- harbour porpoise (*Phocoena phocoena*);
- bottlenose dolphin (*Tursiops truncatus*); and
- Risso's dolphin (*Grampus griseus*).

13.3.147 Baleen whales are more commonly found offshore and in the southern Celtic and Irish Sea (appendix D13-6, Application Reference Number: 6.4.88). Baseline surveys undertaken have reported two sightings of baleen whales (possibly minke) outside of the survey (appendix D13-6, Application Reference Number: 6.4.88).

13.3.148 Many cetacean species are known to have large home ranges, and evidence suggests that certain coastal populations might exploit food sources up to 200km from their residence [RD31] with a core area of 86km² in some instances for offshore species [RD32].

Harbour porpoise

13.3.149 The harbour porpoise is the most widely distributed cetacean found in the Irish Sea [RD30]. Harbour porpoise abundance within the Celtic and Irish Sea Management Unit has been estimated as 104,695 individuals (coefficient of variation (CV): 0.32; 95% Confidence Interval (CI): 56,774-193,065) using data sourced from Hammond *et al*., [RD33] and Macleod *et al*., [RD34]. Population estimate of the Irish Sea (SCANS II, survey block O) for harbour porpoise was 15,230 individuals (CV = 0.35) with a density equivalent of 0.34 individuals/km^2 [RD33].

13.3.150 Of key importance for harbour porpoise, is the fact that the Wylfa Newydd Development Area is located within the North Anglesey Marine cSAC. Harbour porpoise are present year round in waters around the north coast of Anglesey. Data sources from surveys local to the Wylfa Newydd Development Area, have all recorded harbour porpoise in the vicinity, specifically in and around both Cemlyn Bay (in the west) and Cemaes Bay (in the east) (appendix D13-6, Application Reference Number: 6.4.88). Surveys of 31 transect lines [RD35] at least once between May and September, between 2002 and 2004, reported a total of 213 sightings consisting of 347 individuals and estimated that the density was 1.261 individuals/km^2 using a g(0) estimate of 0.5 (assumes that 50% of animals on the trackline were missed). This produced an abundance of 618

individuals (CI 406-909) off north Anglesey, which represents 0.6% of the total Celtic and Irish Sea Management Unit population estimate [RD33].

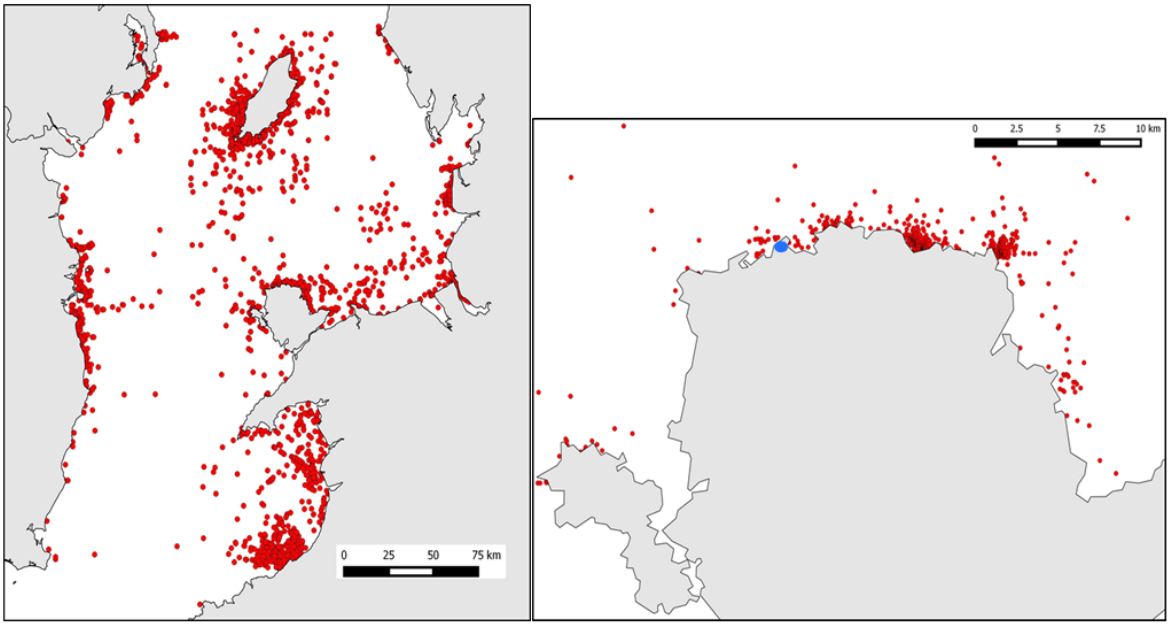
13.3.151 Across 12 transects, dedicated boat-based surveys have yielded 156 individuals from 110 sightings (appendix D13-6, Application Reference Number: 6.4.88) between May 2016 and January 2017. Density values have been calculated for September 2016 to January 2017 survey data, providing a density value using a g(0) = 0.5 of 0.680 individuals/km^2 without sea state correction and a corresponding abundance of 234 individuals (CI 145-380).

13.3.152 The C-POD monitoring indicates the importance of north Anglesey for harbour porpoise. The static C-POD surveys detected harbour porpoise presence every day (a survey period of 104 days) but also showed that levels of harbour porpoise activity varied between locations. The sites within Cemlyn Bay and Porth-y-pistyll had significantly fewer detections compared with Wylfa Head. The physical geography of the bays (Porth-y-pistyll and Cemlyn) is such that the harbour porpoise is likely to pass them en-route to other locations.

13.3.153 Land-based VP observations yielded 462 individuals of harbour porpoise, from 284 sightings, over 1,746 hours' survey effort across four years. During the five years of baseline surveys, a total of 250 individuals of harbour porpoise from 110 casual records were recorded; the average pod size was two animals. Other land-based surveys yielded 24 harbour porpoise individuals from 10 sightings. Higher numbers of harbour porpoise were sighted around Wylfa Head compared to in the shallow bays of Porth-y-pistyll and Cemaes.

13.3.154 The distribution of harbour porpoise sightings around the coast of Anglesey is shown in figure D13-13. The distribution shows hot spots along the north coast of Anglesey and extends north to the Isle of Man and off the west coast of the Lleyn Peninsula southwards into Cardigan Bay.

Figure D13-13 Distribution of harbour porpoise in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



Bottlenose dolphin

13.3.155 The bottlenose dolphin is one of the most common cetacean species to occur in the coastal waters throughout the UK and the second most frequently recorded (according to land-based effort) species [RD30]. Population estimates of the Irish Sea (SCANS II, survey block O) for bottlenose dolphin were reported to be in the region of 235 individuals (CV = 0.75) with a density equivalent of 0.0052 individuals/km^2 [RD33]. More specifically, Cardigan Bay is the largest population in the UK with annual estimates for the wider area varying between 254 and 330 animals (CV = 0.25 to 0.28) for the years 2011 and 2013 inclusive [RD36].

13.3.156 In Welsh waters, 33,174 individuals have been logged into the Sea Watch Foundation database, accounting for more than 50% of the total number of individual marine mammals recorded between 2004 and 2014 [RD30].

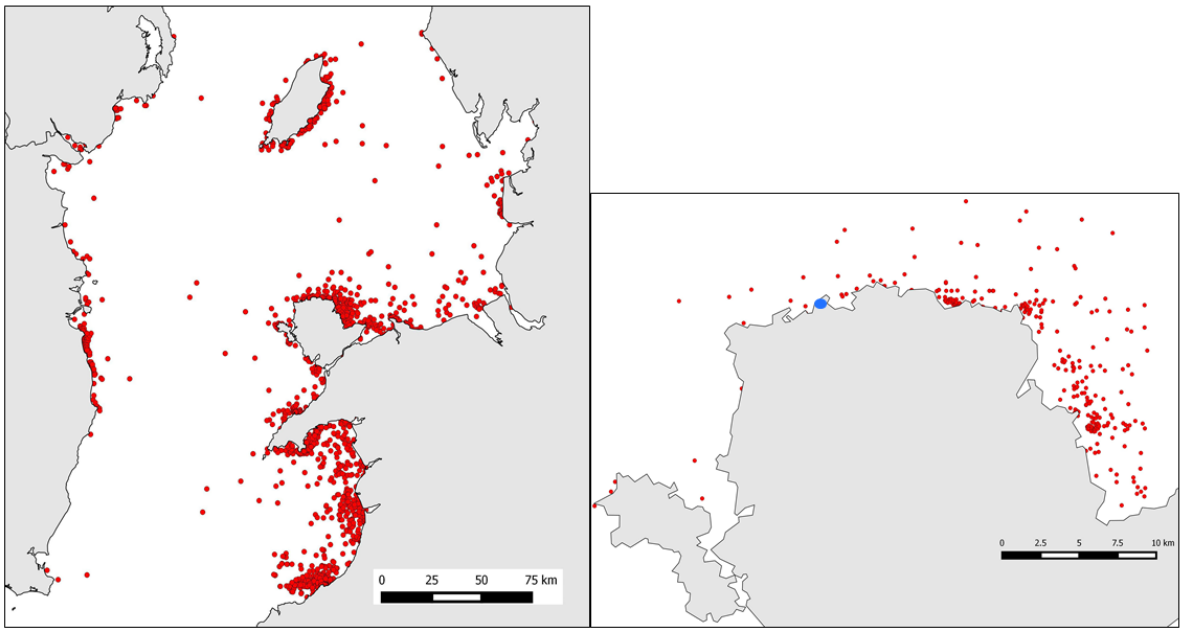
13.3.157 Across 12 transects, dedicated vessel transect surveys have yielded two sightings totalling 14 individuals of bottlenose dolphin (a pod of four and 10 individuals respectively) between May 2016 and January 2017 (appendix D13-6, Application Reference Number: 6.4.88).

13.3.158 Land-based VP surveys recorded 11 individuals, over 1,746 hours' survey effort across four years (appendix D13-6, Application Reference Number: 6.4.88). Since 2010, 202 individuals have been recorded from 10 casual records during baseline surveys; the average pod size was 20 animals. Other land-based surveys yielded 53 bottlenose dolphin individuals from two sightings.

13.3.159 Bottlenose dolphins are present throughout the year with most sightings occurring during the summer months. The average pod size in winter off Anglesey has been estimated to be 26.4 individuals.

13.3.160 Sea Watch Foundation records show the distribution of bottlenose dolphin is concentrated to the east of Anglesey along the coast between Bull Bay and Llandudno (figure D13-14). Baines and Evans [RD37] reported other hotspots located within Cardigan Bay SAC and around the Lleyn Peninsula and Sarnau SAC. Data from photo-ID studies [RD38] confirm that there is connectivity between the Cardigan Bay SAC and the waters surrounding north Anglesey, which means that any bottlenose dolphins sighted off Anglesey and in relation to the Wylfa Newydd Project should be considered to be part of the SAC population.

Figure D13-14 Distribution of bottlenose dolphin in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation (2004-2014) [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



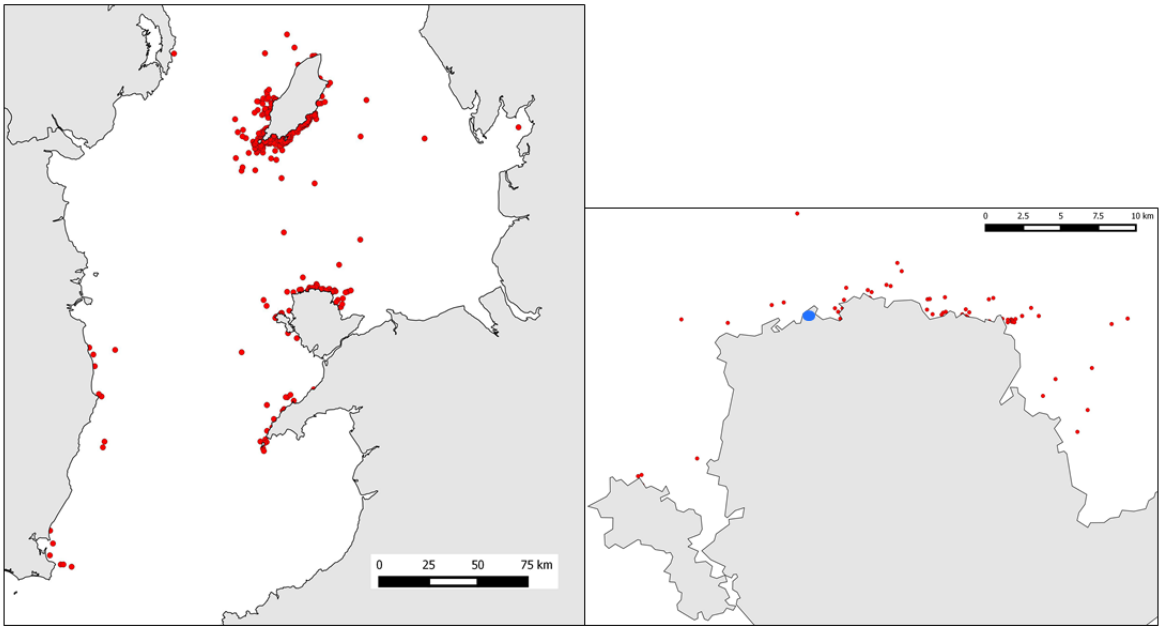
Risso's dolphin

13.3.161 Risso's dolphin has a relatively localised distribution in the Celtic and Irish Sea and is described as a wide band running from the south-west to the north-west, encompassing Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey [RD30]. There were no sightings of Risso's dolphin during the land-based surveys (2011 to 2014) and only one sighting of a single individual was recorded during transit for the dedicated vessel transect surveys. The dedicated vessel transect surveys have yielded three sightings of Risso's dolphin with an average pod size of two individuals.

13.3.162 The species is regularly sighted around the western and northern part of the Lleyn Peninsula, particularly around Bardsey Island [RD30] but it is rare in Cardigan Bay (figure D13-15).

13.3.163 The seasonal distribution of Risso's dolphin shows that there is a presence along the north coast of Anglesey throughout the year with an increased abundance during the summer (May to September) and a peak in June.

Figure D13-15 Distribution of Risso's dolphin in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation (2004-2014) [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



Pinnipeds

13.3.164 Two species of pinniped, the grey and harbour seal, frequent the Irish Sea and, of these, only the grey seal (*Halichoerus grypus)* has been recorded on a regular basis around north Anglesey [RD39]; [RD40]; [RD41] and [RD42]. Along the north coast of Anglesey, the estimated density of harbour seal at sea ranges between 0.00000976/km^2 to 0.0000304/km^2; with a slightly higher estimated density at The Skerries with 0.00004544/km^2 [RD43]. Since there is no documented evidence to suggest that harbour seals are present in Welsh waters or around Anglesey in any significant numbers, only grey seals are considered further.

Grey seal

13.3.165 Pinniped populations are generally estimated from a breeding census and, as such, pup counts as well as adult and juvenile grey seals are taken during the breeding season when pups and seals are hauled out. In the UK, the most recent grey seal population estimate was an estimated 56,988 pups (95% CI 56,317-57,683 (based on 2012 pupping surveys)) and 111,600 adults (95% CI 91,400–139,200) [RD44]. Wales is thought to have between 3% and 4% (1,650 individuals) of the total UK grey seal pup production [RD44]. Grey seals are present year round on both the Irish and Welsh coasts and are known to move between the two; the movement between the

Irish and Welsh coasts was at its greatest between the south-east coast of Ireland and the south-west coast of Wales [RD45].

13.3.166 There are a number of major haul-out sites identified in three districts of north Wales (Lleyn Peninsula, Anglesey, and West Hoyle Bank at the mouth of the Dee estuary), all of which have been surveyed between 2001 and 2003 for either pup production or site usage [RD39]; [RD40]; [RD41]. Grey seals spend most of their lives at sea, coming ashore to breed, rest or moult. In Wales, grey seals breed between August and December, with the peak month reported as September, and moult three to five months later during spring.

13.3.167 Telemetry tagging has allowed greater understanding of habitat usage and distances travelled by grey seal pups and adults. The results have shown that not only do grey seals move between SACs such as the Saltee Island (Ireland) SAC, Pembrokeshire Marine SAC and the Lleyn Peninsula and Sarnau SAC, but they also have the ability to travel great distances. The study by the Special Committee on Seals [RD44] showed grey seal pups cover an average maximum distance of 19.47km with the time between each haul-out location lasting 0.92 days (as a median). Grey seal adults covered an average maximum distance of 16.94km with the time between each haul-out location lasting 0.75 days (as a median) [RD44]. Overall, grey seals have large foraging ranges and they frequently travel over 100km between haul-out locations with foraging trips lasting anywhere between one and 30 days [RD46].

13.3.168 Within the study area, grey seals are present year round with peak sightings occurring between April and May. Sightings mostly occurred at VP1 (figure D13-12, Application Reference Number: 6.4.101) with a total of 61 individuals recorded between 2011 and 2014 out of a possible 199 individuals reported. Boat-based transect surveys yielded a total of 18 individuals across the four-month survey period (May 2016 to August 2016). The majority of these sightings occurred to the west of the Wylfa Newydd Development Area (particularly near The Skerries) and to the east of the Wylfa Newydd Development Area near to Ynys Dulas, Moelfre and Puffin Island. A total of two individuals were recorded near Cemaes Bay and Middle Mouse.

13.3.169 There are many suitable haul-out locations for grey seal across Anglesey, two of which (Carmel Head and The Skerries) are also known for grey seal breeding [RD39]; [RD41]. The dedicated land-based surveys (pupping and haul-out site investigations) of 2016 to 2017 (appendix D13-6, Application Reference Number: 6.4.88) indicates that the north Anglesey coastline between Hen Borth and Porth Padrig does not provide suitable habitat for breeding with no grey seal pups recorded. It is known that there are limited sites where grey seals are known to haul-out, these being Harry Furlough's Rocks (including Craig yr Iwrch) and occasionally on Cerrig Brith. Despite this, no seals were found to haul-out during the site-specific land-based seal surveys; five individuals were sighted in the water around Porth Wnal, Porth Padrig, Trwyn y Penrhyn and Cerrig Brith.

13.3.170 Across 12 transects, dedicated boat-based surveys have yielded 31 individuals from 30 sightings (appendix D13-6, Application Reference Number: 6.4.88) between May 2016 and January 2017. Site-specific land-based VP surveys yielded a total of 193 grey seal sightings and 201 individuals over 1,746 hours' survey effort across four years.

13.3.171 During the five years of baseline surveys, between 25 and 28 individuals of grey seal from 13 casual records were recorded. Other land-based surveys yielded eight casual records totalling 23 individuals. These casual records include two grey seal sightings (each on separate occasions) of between six and 15 individuals hauled out on Harry Furlough's Rocks (including the island, Craig yr Iwch). These are the intertidal rocks located to the west of Cemlyn Bay at a distance of approximately 1.3km for Porth-y-pistyll. There are no major haul-out sites within the Wylfa Newydd Development Area, but it is recognised that individual grey seals will haul-out intermittently wherever there is a suitable intertidal habitat.

13.3.172 Sea usage maps produced for grey seals show that they tend to be concentrated around The Skerries and Lleyn Peninsula and to the east of north Anglesey towards the mainland and West Hoyle Bank [RD43]. The density of grey seal at sea for north Anglesey reaches a maximum of 0.83/km^2 (95% CI 0-2.07) at The Skerries. Other areas such as the waters surrounding Middle Mouse and East Mouse have between five and 10 individuals/25km^2. Between Cemlyn and Cemaes Bay, the maximum number of grey seals in a given 25km^2 area has been calculated to be less than one individual.

Value of receptors

13.3.173 Each of the species of cetacean and pinniped discussed in the previous sections are considered to be of high value owing to their international and national importance. All cetacean and pinniped species are listed under the Habitats Directive (Annex II and/or IV, and/or V) and cetaceans are protected by the Wildlife and Countryside Act 1981, The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) and the Conservation of Habitats and Species Regulations 2017 (as amended). Table D13-4 (paragraph 13.3.239) sets out the receptors relevant to the marine environment and their assigned values.

Seabirds

13.3.174 To inform assessments of potential effects of the scheme on seabirds during the breeding and wintering season, a baseline data search and a range of land-based and boat-based surveys undertaken from 2010 to 2017 were carried out.

13.3.175 The key literature sources, scientific research and consultations used for the baseline assessment process comprised:

- Joint Nature Conservancy Council (JNCC) Seabird Monitoring Program Data;

- JNCC boat transect data from tern survey around Anglesey (2010/2011);
- JNCC and ECON Ecological Consultancy Ltd. Cemlyn Lagoon tern tracking data (2009);
- NWWT annual reports for Cemlyn; and
- Royal Society for Protection of Birds geolocator tracking data for The Skerries' Arctic terns (2016).

13.3.176 The survey methodologies used were:

- VP surveys within a study area out to a distance of approximately 1km from the coast (encompassing the area of sea between the westernmost edge of Cemlyn Bay, east to Cemaes);
- boat-based surveys, comprising tern tracking and European Seabirds at Sea transect surveys;
- intertidal surveys at Porth-y-pistyll and Cemlyn Bay;
- non-breeding season surveys of Cemlyn Lagoon;
- black-headed gull (*Chroicocephalus ridibundus*) surveys;
- gull colony counts; and
- disturbance monitoring surveys of terns and black-headed gulls at the Cemlyn colony.

13.3.177 Lists of target and secondary bird species were drawn up by Jacobs' ecologists in agreement with NRW (and their predecessor organisation), Royal Society for Protection of Birds and NWWT. The agreed aim was to focus surveys on target species, while recording secondary species when appropriate. Target species were defined as the qualifying species of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*) and Sandwich tern (*Sterna sandvicensis*).

13.3.178 Secondary species are defined as those species that are specially protected or are of conservation concern as identified within the following documents (and are not target species as defined above):

- Annex I of European Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive'), or regularly occurring migratory species;
- Schedule 1 of the Wildlife and Countryside Act 1981;
- Red-listed Birds of Conservation Concern [RD47];
- UK Biodiversity Action Plan priority bird species list (http://jncc.defra.gov.uk/page-5163); and
- Section 7 of The Environment (Wales) Act 2016.

JNCC Seabird Monitoring Program Data

13.3.179 Seabird colony count data were extracted from the JNCC Seabird Monitoring Program database, specifically the Seabird 2000 surveys [RD48] in order to estimate the regional breeding populations for species that have been recorded within the areas studied for the Project. Regional populations for each species are defined as the number of birds, as taken from Seabird Monitoring Programme data colony counts, occurring within the mean/max foraging range of that species, measured from the outer limit of the worst case zones of effect for the Wylfa Newydd Development Area and Disposal Site (figure D13-16, Application Reference Number: 6.4.101). Worst case zones of effect were considered as 5km buffers from the Wylfa Newydd Development Area and from the Disposal Site, which is a precautionary distance encompassing all the potential pathways to significant effects on seabirds.

13.3.180 The breeding colonies located within the zones of effect themselves were also identified and totalled for each species to give a percentage of the regional breeding population present within each zone of effect.

13.3.181 The methodology used and the detailed results of this assessment are given in appendix D13-7 (Application Reference Number: 6.4.89). Results relating to the Wylfa Newydd Development Area are summarised below whilst results relating to the Disposal Site are presented in section 13.4 (see paragraphs 13.4.78 to 13.4.80).

13.3.182 Colony count data were available for 21 of the seabird species that have been recorded within the Project study areas (see appendix D13-7, Application Reference Number: 6.4.89, for full results).

13.3.183 Regional breeding population sizes for target species (terns) ranged from two (roseate terns) to 1,705 (Arctic tern). Percentages of target species which breed within the Wylfa Newydd Development Area zone of effects ranged from 0.12% (Arctic tern) to 100% (Sandwich tern) of the regional breeding populations.

13.3.184 Regional breeding populations for secondary species within the study area for the Wylfa Newydd Development Area ranged from zero (great skua and common gull, which do not breed locally) to 173,445 (Manx shearwater). Notable regional populations were shown for gannet (70,260), fulmar (31,831), guillemot (26,016) and kittiwake (3,111).

13.3.185 Within the Wylfa Newydd Development Area zone of effects, there were colonies of nine secondary species, ranging in numbers from shag (three pairs) to guillemot (2,464 pairs). Black-headed gull (440 pairs) was the species with the largest proportion (52.38%) of birds in comparison to its regional breeding population.

Tern population sizes and breeding success at Cemlyn

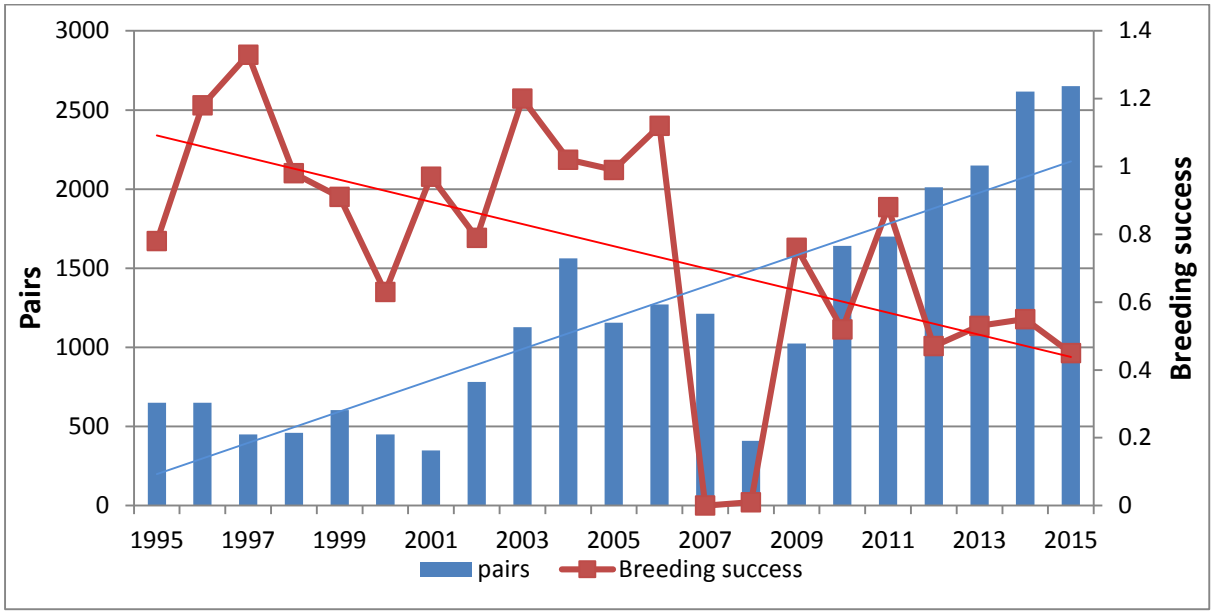
13.3.186 The population sizes and productivity (a measure of breeding success rate, defined by the average number of chicks successfully reared per adult pair) of the three tern species that are present at the Cemlyn Lagoon colony were extracted from the JNCC Seabird Monitoring Program database [RD48].

Data were available for most breeding seasons over a 30 year period from 1986 to 2015. All breeding records during this period are shown in appendix D13-7, (Application Reference Number: 6.4.89). Data from the period 1995 to 2015 for each tern species are also presented below.

13.3.187 Population sizes of Sandwich, Arctic and common tern at Cemlyn have all increased markedly over this period. Sandwich tern productivity has decreased, Arctic tern productivity has increased and common tern productivity shows no particular trend. The extent of available suitable nesting habitat at Cemlyn Lagoon is limited, suggesting the decrease in Sandwich tern productivity could be indicative of a population reaching its natural carrying capacity. It would be expected that productivity would decline as an increasing population approached carrying capacity. Data published by the British Trust for Ornithology on population dynamics of species with rapidly increasing populations often show dips in productivity towards the end of the study periods, despite continued population growth. Another possible contributing factor is that chicks are more difficult to count accurately in a large colony, leading potentially to an under-recording of chick numbers.

13.3.188 The fledge count (number of chicks successfully reared to fledging) for Sandwich tern at Cemlyn Lagoon has generally increased over the 30 year period, in line with the long-term increase in the number of breeding pairs. Productivity has however shown an overall decrease, particularly when taken from 1995 when fledge counts started to be recorded annually (figure D13-17). Productivity has ranged from 0.00 and 0.01 chicks fledged per pair (2007 and 2008, respectively, which were years of high predation levels) to a maximum of 1.33 chicks fledged per pair (1997).

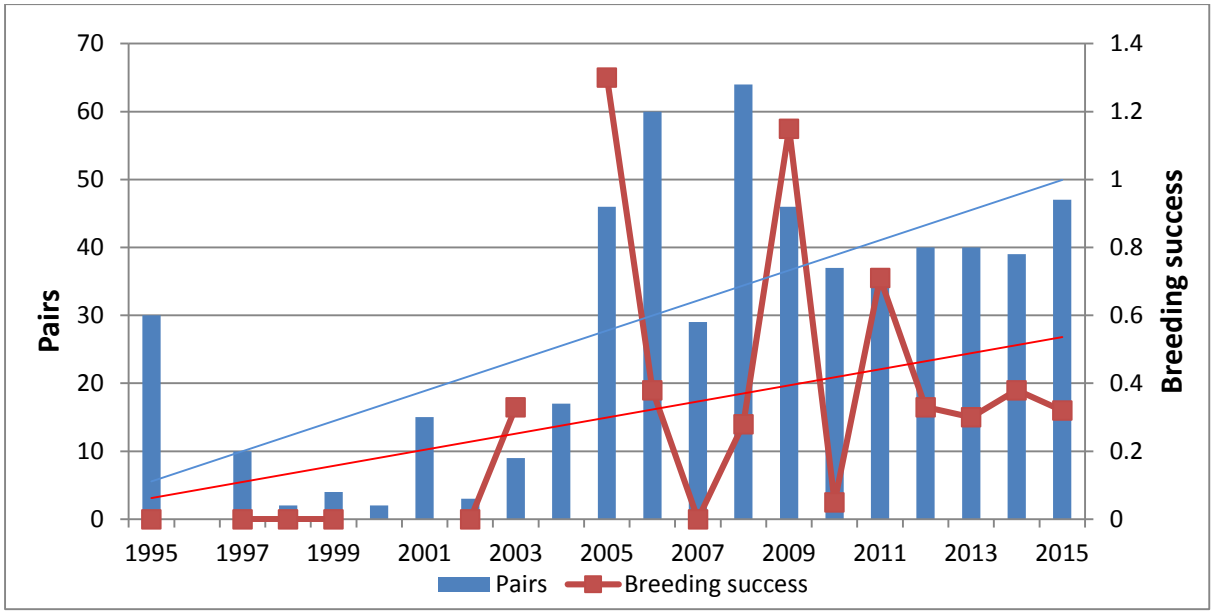
Figure D13-17 Sandwich tern productivity and number of pairs at Cemlyn Lagoon since 1995



13.3.189 Arctic tern numbers have been slightly increasing since 1986, although the number of breeding pairs and fledge count has decreased since the 30 year

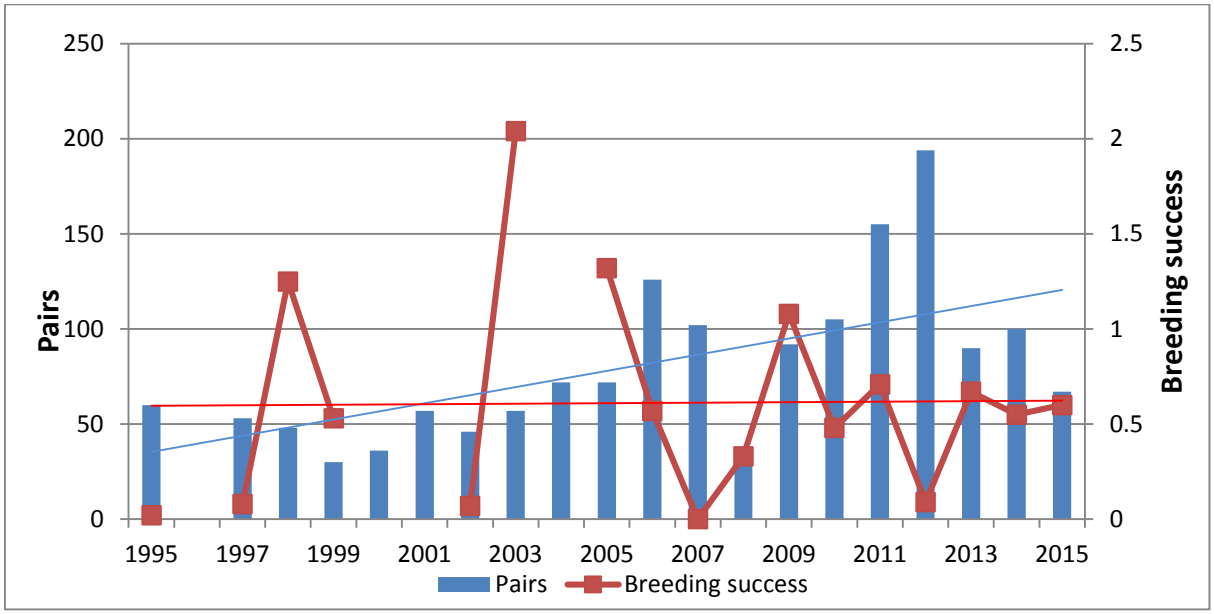
peak in 1992 (300 pairs). Productivity shows an increasing trend (see figure D13-18) and has ranged from zero chicks fledged per pair (1995, 1997 to 1999 and 2002) to maxima of 1.3 and 1.2 chicks fledged per pair (2005 and 2009), respectively (see figure D13-18).

Figure D13-18 Arctic tern productivity and number of pairs at Cemlyn Lagoon since 1995



13.3.190 The trend in number of breeding pairs of common terns is an overall increase since 1986, although it has been in decline since its peak in 2012 (194 pairs). There have been sharp fluctuations in productivity since 1986 (ranging from 0.00 chicks fledged per pair in 2007 (a predation year) to 2.04 fledged per pair in 2003). Productivity trends since 1995 have generally been stable (see figure D13-18).

Figure D13-19 Common tern productivity and number of pairs at Cemlyn Lagoon since 1995



JNCC boat transect data (2010/2011)

13.3.191 Transect-based surveys for terns were carried out in June 2010 and June/July 2011, within the period when breeding terns are at their busiest, provisioning chicks. These surveys formed part of a wider study on identifying important marine areas for tern species breeding in the UK. Methods and results are described in detail in Wilson *et al*., [RD49]. In summary, surveys followed modified European Seabirds at Sea approach, but with snapshot point counts taken at 2km intervals along each transect, counting all terns observed in any direction from the boat.

13.3.192 JNCC boat transect data (2010 and 2011) generally show that Sandwich terns were distributed to the north and east of Anglesey, while common and Arctic terns were distributed off the west and north-west Anglesey coast in both 2010 and 2011. Sandwich tern was recorded more frequently within the first couple of kilometres from the Anglesey north-east coast compared with further offshore. Low numbers of Sandwich tern were recorded near the inshore bays of the Wylfa area, including Cemaes Bay, Porth Wnal, Porth-y-pistyll and Cemlyn Bay.

13.3.193 The majority of common and Arctic tern records were recorded around The Skerries. Apart from a count of one common tern recorded near the inshore bay of Porth-y-pistyll in 2011, common and Arctic terns were not recorded within the inshore bays of the Wylfa Head area.

13.3.194 The distribution of common and Arctic tern remained the same between 2010 and 2011. However, the highest densities of Sandwich tern shifted to some extent along the coast between 2010 and 2011, with Sandwich tern numbers at their highest at Dulas Bay in 2010 and at Point Lynas in 2011.

JNCC and ECON tern tracking data (2009)

13.3.195 In 2009, JNCC and ECON tracked foraging terns at sea using methodology detailed in Perrow *et al*., [RD50]. Sandwich, common and Arctic terns were tracked by JNCC between 9 June and 6 July and by ECON from 28 May to 10 July.

13.3.196 All tracks show a high level of foraging activity within approximately 5km of the colony, with continued high foraging activity further north and east, especially Sandwich tern.

13.3.197 No common or Arctic tern diving activity was recorded in any of the databases from within the inshore bays, i.e. Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay. No tracked common or Arctic terns were seen feeding within Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay.

Royal Society for Protection of Birds geolocator tracking data for The Skerries' Arctic terns

13.3.198 The 2016 tracking data for breeding Arctic tern fitted with Global Positioning System (GPS) loggers on The Skerries shows the foraging range, primarily radiating westwards from The Skerries into the Irish Sea (appendix D13-7, Application Reference Number: 6.4.89). Half (50%) of the birds' utilisation of the area was within approximately 15km of the colony, with 95% of utilisation

extending out to approximately 35km from the colony (see appendix D13-7, Application Reference Number: 6.4.89).

North Wales environmental information service (Cofnod)

13.3.199 Historical data were obtained from consultation with the Cofnod detailing records of seabird species in and around Anglesey from 1995 to 2015 (see appendix D9-11, Breeding Bird Technical Summary Report, Application Reference Number: 6.4.44).

13.3.200 The Cofnod dataset provides a wide range of historic local records with varying level of detail. Due to the size of the dataset and available information relating to individual records it was not always possible to separate breeding and non-breeding records. The historic records do, however, reflect the common seabird activity, particular for target species (terns), surrounding Cemlyn Bay that have been recorded during more recent surveys for the purposes of the Project. Sandwich, common and Arctic tern were recorded in high numbers for all four time periods. Smaller numbers of roseate tern (13 records) were also recorded at Cemlyn during the most recent 2010 to 2012 period.

13.3.201 Manx shearwater is the most commonly recorded non-target (secondary) species (20,304 records). A number of species are under-recorded within this dataset due to their commonness. Rarer birds are more likely to be reported by the public and therefore appear within this dataset. This may contribute towards the inclusion of scarce species such as Balearic shearwater, black-necked grebe and red-necked grebe and the relatively low number of records of more common species such as guillemot and razorbill.

Land-based VP surveys

13.3.202 VP surveys were initially carried out over a 36-month period between September 2010 and August 2013, followed by a six-month validation programme in 2014 (April to September). The validation programme comprised a reduced survey effort undertaken to test whether there was any change to the baseline conditions observed in previous years, i.e. the behaviour of terns and other seabirds and of relative numbers of terns actively feeding in the bays. The locations of the VP survey areas are shown in figure D13-12 (Application Reference Number: 6.4.101). Full details on the methodology are given in appendix D13-7 (Application Reference Number: 6.4.89).

Target species (terns)

13.3.203 Four target species were recorded: Arctic tern, common tern, roseate tern and Sandwich tern in the VP survey area.

13.3.204 The recordings of Arctic and common terns were combined due to identification difficulties, and are subsequently referred to as ‘Arctic/common terns’. These species were observed during April to July each year, with numbers consistently highest in June. Over the four-year survey period, a peak count of 224 Arctic/common terns was recorded in VP4 during June

2014, with low numbers generally recorded in VP1, VP2 and VP3 (see appendix D13-7 Application Reference Number: 6.4.89).

13.3.205 Sandwich terns were observed during all months from April to August each year. High numbers were recorded between May and July and relatively low numbers recorded during April and August from 2011 to 2014. A peak count of 1,808 Sandwich terns was recorded from VP4 during July 2012 with high numbers recorded from VP1, VP2 and VP3 (see appendix D13-7, Application Reference Number: 6.4.89). Birds were counted in 15-minute count periods. The majority of terns were recorded in flight, passing through the VP study area, therefore double counting of birds during a 15-minute count period is likely, and numbers presented give an indication of rate of passage of birds rather than a study area population size estimate.

13.3.206 Roseate tern was only recorded on two occasions, both in June 2014, both of which were in flight within VP4.

13.3.207 The vast majority of both Arctic/common and Sandwich terns recorded were observed in flight within the VP areas, between the breeding colony and feeding areas. Peak counts of 40 Arctic/common and 64 Sandwich terns were recorded actively feeding in the VP survey area, representing approximately 2% of Arctic/common tern and 0.9% of Sandwich tern records were of those actively feeding within the VP areas.

Secondary species

13.3.208 Twenty-six secondary seabird species were recorded during the VP surveys from September 2010 to September 2014, of which 23 were recorded using (e.g. foraging, roosting or loafing for example) the VP survey area. The other three species were flying throughout the study area. The recordings of guillemot (*Uria aalge)* and razorbill (*Alca torda)* were combined due to identification difficulties and are subsequently referred to as ‘common auks’

13.3.209 The frequency and timing (i.e. seasonality) of observations of secondary species varied depending on the species, but was consistent over the survey years. The secondary species recorded using the VP survey area in greatest numbers were black-headed gull (peak count of 570 loafing during February 2013), common auks (peak count of 480 loafing and foraging during August 2011) and herring gull (*Larus argentatus*) (peak count of 210 recorded loafing and foraging during July 2013). Common gull (*Larus canus*) was also recorded in high numbers in the VP survey area.

13.3.210 Counts of birds sat on the water during VP surveys are likely to be an under-estimate of the actual number present within the study area. The detectability of birds sat on the water, particularly small species such as auks, decreases with distance from observer and with increasing sea state.

13.3.211 The black-headed gull colony at Cemlyn comprises a large proportion of the population in Wales (15% of the coastal population during the Seabird Colony Register and 52% during Seabird 2000 [RD51]).

Boat-based seabird surveys

13.3.212 Boat-based surveys were carried from May 2016 to June 2017. Two boat-based survey methods were adopted: monthly transect surveys based on the European Seabirds at Sea methodology, and tern tracking surveys following individual birds in flight (see appendix D13-7, Application Reference Number: 6.4.89, for full details).

Transect surveys

13.3.213 Transect surveys were carried out monthly between May 2016 and May 2017. These surveys employed modified European Seabirds at Sea (ESAS) methods to provide data on the abundance and distribution of birds within the study area, both in flight and on the water, at intervals of 500m along 23 transects orientated north to south off the north coast of Anglesey. Modifications from standard ESAS methods were used. These were using two observers simultaneously (one port side, one starboard), and taking 'snapshot' counts at specific waypoint locations rather than at set time intervals.

13.3.214 The primary study area for the transect surveys is defined as Block 1 shown in figure D13-12, (Application Reference Number: 6.4.101) and appendix D13-7 (Application Reference Number: 6.4.89), which has a boundary loosely described by a radius of approximately 12km centred on the Wylfa Newydd Development Area. The extent of the study area (Block 1) represents an area approximately six times that of the maximum predicted zone of influence, in keeping with guidance in Camphuysen *et al*., [RD52] (see figure D13-12, Application Reference Number: 6.4.101).

13.3.215 During the period May to September 2016 an additional survey area, Block 2, see figure D13-12 (Application Reference Number: 6.4.101) and appendix D13-7 (Application Reference Number: 6.4.89), was added to the study area. Block 2 was designed to incorporate the known foraging range of Sandwich terns from the Cemlyn Bay colony. The full results are given in appendix D13-7 (Application Reference Number: 6.4.89).

Target species (terns)

13.3.216 Sandwich terns were recorded in the study area from May to September 2016 and May 2017. The maximum estimated study area population size of Sandwich tern was 1,696 birds recorded in June 2016 (Block 1 and Block 2). The maximum relative density of Sandwich terns recorded in the study area was 7.21 birds/km² during June 2016.

13.3.217 The maximum estimated study area population size of Arctic/common tern was 988 birds in July, lower than the combined common tern and Arctic tern breeding populations recorded on The Skerries in 2015 (546 and 7,616 respectively), but higher than the breeding populations at Cemlyn Bay in 2015 (134 and 94 respectively). This indicates that birds from The Skerries as well as the Cemlyn Bay colonies were recorded within the study area. The maximum relative density of Arctic/common terns recorded in the study area was 3.87 birds/km² during July 2016.

Secondary species

13.3.218 A total of 22 species were recorded in the transect survey study area (Block 1 and Block 2) between May 2016 to May 2017. One great northern diver (April 2017) and one pomarine skua (May 2017) was recorded in the raw count data.

13.3.219 For the majority of species, study area population size estimates within both Block 1 and Block 2 were generally low. The highest peak population estimate was recorded for common scoter (15,174 birds) passing through Block 2 in September 2016, although population estimates recorded in other months for common scoter were generally much lower than this. The estimate of 15,174 common scoter is an over-estimate due to the unsuitability of the use of Distance Analysis for clumped data of this type. The raw count data show a flock of approximately 3,000 birds flying through Block 2, possibly disturbed by the presence of the survey vessel.

13.3.220 The second highest peak population estimate of 8,586 birds was recorded for guillemot in May 2016; moderate to high numbers of guillemots were recorded in every calendar month.

13.3.221 A peak population estimate of 1,503 Manx shearwaters was recorded in June 2016. Manx shearwater was recorded during the calendar months of April to September inclusive.

13.3.222 Kittiwake had the highest peak population estimate of any gull species recorded in the study area: 2,138 kittiwakes were estimated in August 2016 (Block 1 and Block 2). Low numbers of black-headed gull were recorded in the transect surveys; the highest raw count of 183 birds was recorded in November 2016, but only 94 of these black-headed gulls were in the sample area at the time of counting, the rest were outside of the transect survey area closer to the coast.

Tern tracking surveys

13.3.223 Tern tracking surveys were carried out in June and July 2016 (representing 19 days of survey effort) and again for five days in June 2017. These surveys followed the methodology described by Perrow *et al*., [RD53]; terns of all three species from the colony in Cemlyn Lagoon were tracked (visually during their foraging flights at sea) from a high-speed boat. Individual birds were typically followed to the full extent of their foraging range, including their return flights (normally carrying fish) back to the colony.

13.3.224 Tracking data for Sandwich tern showed a large foraging range in comparison to other tern species, primarily radiating eastwards from the Cemlyn Bay colony, along the north Anglesey coast and into the shallow sandy bays along the east of the island (see appendix D13-7, Application Reference Number: 6.4.89). Tracked Sandwich terns did not feed in Porth-y-pistyll or Cemaes Bay. Arctic and common terns were generally found to actively feed within 5km of the colony, with occasional tracks heading much further north and east with some notable feeding activity around 2km north of Cemlyn Lagoon (appendix D13-7, Application Reference Number: 6.4.89). Arctic/common terns were not recorded diving in Cemlyn Bay, Cemaes Bay or Porth-y-pistyll. The results of these surveys concur with findings of the VP

surveys which recorded very little feeding activity in Porth-y-pistyll and the adjacent bays for all three tern species (appendix D13-7, Application Reference Number: 6.4.89).

Intertidal surveys

13.3.225 Intertidal zone seabird surveys at Porth-y-pistyll (figure D13-12, Application Reference Number: 6.4.101) were carried out over 36 months between April 2012 and March 2015, during which time 80 visits were undertaken at low tide and 19 at high tide, to record target and secondary species. Intertidal zone surveys at Cemlyn Bay (figure D13-12, Application Reference Number: 6.4.101) were carried out over six months between October 2014 and March 2015.

13.3.226 The intertidal zone surveys in Porth-y-pistyll recorded seven species of seabirds loafing and/or foraging. Herring gull and black-headed gull were recorded in relatively high numbers with peak counts of 163 (August 2012) and 150 (February 2014), respectively. Herring gull was present in all but one of the visits.

13.3.227 In Cemlyn Bay, the intertidal zone surveys recorded a total of eight seabird species between October 2014 and March 2015. Herring gull was recorded in relatively high numbers with peak count of 37 in January 2015.

Cemlyn Lagoon surveys

13.3.228 Surveys of Cemlyn Lagoon (figure D13-12, Application Reference Number: 6.4.101) were carried out in order to record the abundance, distribution and behaviour of birds using the lagoon, adjacent water bodies and shorelines. The surveys were carried out from September 2012 to April 2013 (non-breeding and early breeding season) to complement the breeding season data gathered by the reserve wardens during May to August.

13.3.229 A total of seven seabird species were recorded loafing and/or foraging in Cemlyn Lagoon between September 2012 and April 2013. Black-headed gull was recorded in the greatest numbers with a peak count of 812 during April. Herring gull was also recorded in relatively high numbers with a peak count of 364 during December.

13.3.230 The black-headed gull is a secondary species of notable importance as the colony located on islands within Cemlyn Lagoon during the breeding season is the largest in Wales with 450 pairs recorded in 2015 [RD54]. This species also exhibits a commensal relationship with Sandwich terns (and occasionally other tern species) during the breeding season[2]. Black-headed gulls use a variety of habitats for foraging and roosting in flocks during the winter including strandline and intertidal areas in Porth-y-pistyll and Cemlyn

[2] Black-headed gulls and Sandwich terns (and occasionally other tern species) frequently nest in close association with each other [RD55]. Within these relationships there is a degree of piracy by gulls stealing fish from terns (kleptoparasitism) which is detrimental [RD56], but black-headed gulls also provide increased predator protection to terns [RD57].

Lagoon as well as grasslands (semi improved and improved) (see appendix D13-7, Application Reference Number: 6.4.89).

Black-headed gull breeding and wintering surveys

13.3.231 Transect surveys were undertaken in the vicinity of the Wylfa Newydd Development Area during all winter periods from 2009/2010 to 2014/2015 (October to March), and again in winter 2016/2017 (January to March 2017 only). Transect surveys were also carried out during all breeding seasons in years 2010 to 2014, and again in 2017. Transect surveys in all seasons from 2009 to 2015 were undertaken as part of the wintering and breeding bird surveys (for all bird species) carried out in relation to the scheme. The surveys conducted in 2017 were carried out specifically for black-headed gull.

13.3.232 Overall, it was found that the usage of the habitats by black-headed gull within the survey area was limited. The results show that during the winter and breeding surveys, almost most records of birds within fields were of single individuals or small flocks (mostly less than five individuals).

13.3.233 The winter season data revealed a preference for intensively-grazed improved grassland, short sward grassland and also for areas of rocky shoreline (e.g. Porth-y-pistyll and Cemlyn Lagoon). Overall, black-headed gull numbers recorded in the area were higher during the winter season (peak of 190 birds recorded in 2016/17) compared with the breeding season (peak count of 75 birds recorded from 2010 to 2014). The 2016/17 winter peak count was recorded during mid–February to late March, when relatively large numbers of black-headed gulls were using the fields to the south and south-east of Wylfa Head.

13.3.234 During the breeding season, records were restricted to the western half of the survey area and, away from Cemlyn Lagoon, fewer large flocks were recorded. In contrast with the winter period, birds did not show a preference for intensively-grazed improved grassland. Rather, usage of fields appeared to be opportunistic and linked to habitat operations, with black-headed gulls mostly observed in ploughed arable farmland and recently-cut grassland.

Gull colony counts

13.3.235 Surveys of the gull colony at Porth Wnal to the north of the Existing Power Station were carried out during 23 and 24 April 2013 to coincide with the early incubation period for gulls and hence the maximum likelihood of birds being present at their nests.

13.3.236 Three species of gulls were recorded using colonies on the rocks at Porth Wnal to the north of the Existing Power Station during April 2013: herring gull (peak count of 223), lesser black-backed gull (*Larus fuscus*) (peak count of 156) and great black-backed gull (*Larus marinus*) (peak count of two).

13.3.237 The minimum number of breeding pairs for each species assessed to be using the colony during 2013 was considered to be 111 for herring gull, 78 for lesser black-backed gull and one for great black-backed gull.

Value of receptors

13.3.238 The seabird species referred to as 'target species' are those which are qualifying features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern, common tern, roseate tern and Sandwich tern, and these are assigned a high value. All other seabirds (secondary species) are assigned a value of medium. This includes secondary species such as regularly occurring migratory species (listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) and some species which are listed on Annex I of the Wild Birds Directive, e.g. black-headed gull, or on Schedule 1 of the Wildlife and Countryside Act 1981 e.g. Mediterranean gull (*Ichthyaetus melanocephalus)*.

Summary of receptors

13.3.239 The receptors relevant to the marine environment assessment for the Wylfa Newydd Development Area and their values are presented in table D13-4.

Table D13-4 Summary of marine environment receptor value

Receptor	Value
All designated sites of nature conservation importance and supporting features (SACs, SPAs and SSSIs, including candidate SACs)	High
EU-designated WFD water bodies	High
EU-designated bathing water	High
Plankton (phytoplankton and zooplankton)	Low
Subtidal and intertidal habitats of conservation importance	Medium
Intertidal habitats and communities	Low
Subtidal habitats and communities	Low
Invertebrates (of conservation and/or commercial importance)	Medium
Ichthyoplankton (of conservation and/or commercial importance)	Medium
Ichthyoplankton (not of conservation and/or commercial importance)	Low
River lamprey	High
European eel	High
Atlantic salmon	High
Fish (of conservation and/or commercial importance)	Medium
General fish and fisheries (intertidal and subtidal)	Low
Marine mammals (pinnipeds and cetaceans)	High
Seabirds (target species)	High
Seabirds (secondary species)	Medium

Evolution of the baseline

13.3.240 The existing baseline conditions within the study area are considered to be relatively stable for many receptors as there have not been fundamental

changes to environmental conditions or in the use of the marine environment in the local area for many years.

13.3.241 In recent years, the baseline environment has been influenced by the operation of the Existing Power Station including the associated Cooling Water discharge and discharge of treated waste water. The effects of the existing Cooling Water discharge on benthic habitats and species are described in paragraphs 13.3.90 to 13.3.92. The Existing Power Station had been running at half-load (one reactor) since April 2012 and ceased power generation altogether in December 2015. The baseline will evolve in response to this change, in particular from the cessation of Cooling Water discharge and the removal of the thermal plume and biocide effects.

13.3.242 In the absence of the Wylfa Newydd Project it is anticipated that there would be a recovery in the habitats and species which are currently affected by the Cooling Water discharge of the Existing Power Station. Where there are currently acute effects (within 100m) it is likely that in the medium-term (10 years) there would be a recovery close to natural conditions. For the area where only subtle effects were recorded (from around 100m to 300m) it is likely that recovery will be faster, and that within five years, conditions would return to near natural conditions. The assessment of effects relating to the Cooling Water discharge at the Existing Power Station takes a precautionary approach, assuming full recovery (and therefore value) of the habitats in this location.

13.3.243 The baseline will evolve as a result of global trends which include an increasing human population, global warming (climate change) and sea-level rise. One particular concern is changes in the distribution of non-native species (linked to warming sea temperature and movement of non-natives around the UK coastline). The evolution of the baseline due to climate change is considered further below.

13.3.244 A full assessment of likely effects of global trends has not been undertaken here as it is considered unlikely that these trends will significantly alter the baseline presented (for 2010 to 2015) and the period during which consent for the Wylfa Newydd Project would be considered. It is acknowledged that these global trends may affect the baseline prior to the Environmental Impact Assessment for decommissioning and therefore additional monitoring may be required.

Evolution of the baseline due to climate change

13.3.245 There are a number of models covering the UK which simulate the possible change in climate. The UK Climate Impact Programme [RD58] indicates winters may become generally wetter and summers substantially drier for the whole of the UK. Data from Jenkins *et al*., [RD58] also suggest that there may be more variability year-to-year, and the number of extreme years may increase, e.g. more intense storms and severe droughts. It is expected that there will be a warming trend in sea surface temperatures.

13.3.246 The UK Climate Projections (UKCP09) and the latest UK and Welsh Government guidance indicate a rise in sea levels [RD59]; [RD60]. Modelling outputs for the Wylfa Newydd Development Area Development

AMEC modelling [RD61] shows a 'reasonably foreseeable' future sea level rise from 2008 to 2023, to 2087 and to 2187 of 0.05m, 0.67m and 2.12m, respectively (0.07m, 0.48m and 1.48m in the Further Wave Model Phase 2 study) with no additional allowance for surge. However, it is recognised that there is continuing uncertainty with respect to sea level rise.

13.3.247 In the medium-term and long-term these changes may affect the marine environment baseline in particular from increasing frequency of high intensity storms, sea level rise and warming sea temperatures which could negatively affect certain receptors.

13.3.248 The effects of climate change on marine environment receptors may include:

- increases in sea level rise resulting in the potential loss of coastal habitat for seabirds;
- effects on migratory fish which may suffer from increased frequency and severity of droughts reducing water levels or drying-out of watercourses;
- changes in species distribution as Lusitanian species (those with an affinity for warm water) move further north around the coast into the study area due to increasing sea temperatures;
- changes in species distribution as boreal species (those with an affinity for cold water) move out of the study area as their optimal habitat range is pushed northwards or into deeper waters; and
- changes in timing of spawning and other lifecycle characteristics due to increasing sea temperatures.

13.3.249 The significance of rising seawater temperature in terms of the potential for seasonal advancement or delay as a result of Power Station operations will be assessed. The thermal tolerances of relevant habitats and species is used together with the sea temperature predictions from the hydrodynamic model to determine any significant effects under a range of conditions (see paragraphs 13.6.609 to 13.6.718).

13.3.250 The Wales Coastal Group Forum (2011) Shoreline Management Plan 2 [RD62] provides a broad-scale assessment of the risks associated with coastal evolution resulting from future sea level rise. It also presents a policy framework to address risk both to people and to the environment in a sustainable manner.

13.4 Disposal Site baseline environment

13.4.1 This section provides a summary of the baseline conditions for the marine environment within the Disposal Site study area described in section 13.2. Where a wider study area has been defined to characterise the baseline for a particular receptor, further description is provided below.

13.4.2 The Disposal Site for the Wylfa Newydd Project is defined as the newly designated Holyhead North (IS043) disposal site (see figure D13-20, Application Reference Number: 6.4.101). A comprehensive report of the baseline is provided in the Disposal Site characterisation report [RD63] and

a summary of the environmental baseline for the Disposal Site is presented in the following sections. The following are key sources of information.

- Environmental characterisation surveys commissioned by Horizon in 2016 i.e. water quality, physico-chemical analyses of sediment and analysis of benthic communities.
- NRW-commissioned study encompassing the Disposal Site and surrounding area [RD64].
- The Environmental Statement and supporting technical appendices for the Minesto Deep Green Holyhead Deep Project [RD65].
- Predictive habitat mapping of the seabed from HABMAP project [RD66].
- Research thesis by Potter [RD67] investigating the historic Holyhead Deep disposal site.

13.4.3 This section is supported by the following appendices, which present environmental baseline data, and which are cross-referenced in the text where relevant:

- D13-1 Water quality and plankton surveys report (Application Reference Number: 6.4.83);
- D13-2 Benthic ecology report (Application Reference Number: 6.4.84);
- D13-4 Fish surveys report (Application Reference Number: 6.4.86);
- D13-6 Marine mammal baseline review (Application Reference Number: 6.4.88);
- D13-7 Seabird baseline review (Application Reference Number: 6.4.89);
- D13-8 Marine hydrodynamic modelling report – Wylfa Newydd Development Area (Application Reference Number: 6.4.90); and
- D13-12 Marine hydrodynamic modelling report – Disposal Site (Application Reference Number: 6.4.94).

Site description

13.4.4 The Disposal Site covers the northern half of the Holyhead Deep (IS040) disposal site which was closed in April 2017. Marine disposal has been taking place at Holyhead Deep since 1983 and it has received both capital and, more regularly, maintenance dredged material since this time. Historical environmental data for Holyhead Deep have therefore been utilised for the Disposal Site due to the geographical overlap in these two sites.

13.4.5 The closure of Holyhead Deep followed the granting of a Marine Licence to Minesto Limited to install tidal kites within the southern half of the Holyhead Deep disposal site. As such, baseline environmental data obtained by Minesto to support their Marine Licence application are particularly relevant to baseline information for the Disposal Site, providing recent data on the

marine environment within and adjacent to the Disposal Site, and also from the wider sea area (i.e. the Irish Sea).

13.4.6 The Disposal Site is a rectangular area off the north-west coast of Anglesey in the Irish Sea. The north-western corner of the Disposal Site is the furthest point from shore at approximately 15km from Holyhead harbour and, at its nearest point, approximately 18km from Porth-y-pistyll. The total area of the site is approximately 28.8km² [RD63].

13.4.7 Within the Disposal Site is a natural depression on the seafloor. High-resolution multibeam bathymetry data collected by Sustainable Expansion of the Applied Coastal and Marine Sectors (SEACAMS) between 2013 and 2014 shows that the majority of the Disposal Site is greater than 50m deep, although within the middle of the depression a maximum of 96m is reached. There is a small rock platform protrusion on the northern boundary of the site, where depths range between 35m and 40m [RD68].

Conservation designations

13.4.8 The designated sites of national/international importance for nature conservation in proximity to the Disposal Site include (figure D13-21, Application Reference Number: 6.4.101):

- Bae Cemlyn/Cemlyn Bay SAC and SSSI;
- Gogledd Môn Forol/North Anglesey Marine cSAC;
- Morwenoliaid Ynys Môn SPA /Anglesey Terns;
- Glannau Ynys Gybi/Holy Island Coast SAC, SPA and SSSI;
- Puffin Island SSSI; and
- The Skerries SSSI.

13.4.9 The Disposal Site is located within the North Anglesey Marine cSAC (proposed for harbour porpoise) and the Anglesey Terns/Morwenoliaid Ynys Môn 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.

13.4.10 A separate Shadow HRA Report (Application Reference Number: 5.2) has been undertaken which considers internationally designated sites on a wider geographic scale which are not listed above. The Shadow HRA Report (Application Reference Number: 5.2) is provided as a separate supporting report to the Marine Licence application.

13.4.11 In January 2017, a marine extension to the existing Ynys Feurig, Cemlyn Bay and The Skerries SPA was designated to include the marine area used by foraging terns during the breeding season. The site, now incorporating the nesting birds of Ynys Feurig, Cemlyn Bay and The Skerries SPA, and their foraging areas, was renamed the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA.'

13.4.12 This chapter will herein refer to the amalgamated SPA sites as the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA' although the current conservation

objectives for the Ynys Feurig, Cemlyn Bay and The Skerries SPA will continue to apply until Regulation 35 advice is formally issued by NRW.

Value of receptors

13.4.13 All nationally/internationally designated sites are assigned a high value.

Water quality

13.4.14 The Disposal Site is not located within a water body designated under the WFD. The nearest WFD water bodies are more than 12km from the Disposal Site; Caernarfon Bay North and The Skerries. Caernarfon Bay North is currently achieving good ecological status and The Skerries water body is at high ecological status [RD3]. In addition, there are no bathing waters in proximity of the Disposal Site, with the nearest being some 20km away.

13.4.15 A technical report on plankton ecology [RD11] classified areas of the Irish Sea with respect to hydrology, nutrient chemistry and ecology. The Disposal Site falls into 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 periods of fine weather.

13.4.16 Marine water quality was sampled at six sites within the Disposal Site itself, with two additional survey sites sampled within 1km to characterise marine water quality within the surrounding area (figure D13-20, Application Reference Number: 6.4.101). Marine water quality was sampled in October 2016, with physico-chemical and chemical results indicating a good chemical status, and many concentrations reported below the MRV (see paragraphs 13.4.22 to 13.4.26 and appendix D13-1, Application Reference Number: 6.4.83).

13.4.17 As the Disposal Site falls within the maximum tidal excursion south-west of the Wylfa Newydd Development Area, results of the 2010 to 2014 baseline water quality programme are also relevant to the understanding of water quality at the Disposal Site. Whilst the following sections summarise the dedicated survey carried out at the Disposal Site in 2016, it should be acknowledged that the Disposal Site study area for marine water quality encompasses the north coast of Anglesey and therefore survey data from the central study area for the Wylfa Newydd Development Area (see paragraphs 13.3.6 to 13.3.22 and appendix D13-1, Application Reference Number: 6.4.83).

Physico-chemical parameters

13.4.18 Temperature and salinity profiles sampled in the Disposal Site study area were very stable throughout the water column and across all sampling sites. This indicates a very well-mixed water body and the absence of permanent stratification within the area.

13.4.19 Dissolved oxygen values recorded within the vertical water column at all sites were high according to current WFD classification (>5.74mg/L).

13.4.20 The mean suspended solids (as total) reported in all samples was 5.5mg/L; based on this, the Disposal Site study area is classified as clear water under WFD criteria.

13.4.21 pH showed minimal variation, ranging between 8.18 and 8.23 across the survey sites.

Chemical and biochemical parameters

13.4.22 All results reported by the laboratory were compared with EQSs where applicable. No exceedance from AAs or MAC-EQS was reported for any of the determinands analysed, including metals. Moreover, all concentrations reported by the laboratory are in line with good chemical status, as defined by the WFD, and consistent with other coastal water with the absence of polluting substances.

13.4.23 Zinc concentration was reported above the relevant long-term EQS in one sample (HHD_18) at 34.5m. However, the AA concentration in all samples was 4.32µg/L, well below the EQS (6.8µg/L + 1.1µg/L background concentration). No MAC-EQS has been established for zinc.

13.4.24 Concentrations for boron, copper, zinc, arsenic and lead were all found within the expected values for coastal waters [RD4]. Nickel was reported marginally above the MRV in four samples, however, the mean value reported remained below the MRV. The following were all found below MRV in all samples

- vanadium;
- chromium;
- manganese;
- iron;
- cobalt;
- selenium;
- cadmium;
- tin; and
- mercury.

13.4.25 Most of the nitrogen and nutrient concentrations reported were found below the respective MRV, including total organic nitrogen (as N), inorganic nitrogen (as N), ammoniacal nitrogen (as N), nitrite (as N) and nitrate (as N). Total oxidised nitrogen (as N) was reported as below MRV (0.0040mg/L) in all samples except for one, reported marginally above (0.0056mg/L).

13.4.26 Total petroleum hydrocarbons and di-2-ethylhexyl phthalate were reported as below the MRV (0.2mg/L) in all samples collected.

Value of receptors

13.4.27 The Disposal Site is situated offshore in the Irish Sea. In relation to water quality, the Disposal Site's distance from the nearest EU-designated WFD water bodies (Caernarfon Bay North and The Skerries) and EU-designated

bathing waters mean these are outside the zone of influence from disposal activity.

13.4.28 The water quality has a role in supporting the wider ecosystem but has limited economic value, is considered representative of the wider Irish Sea and is therefore not considered as a receptor for the Disposal Site. However, the potential effects of changes to water quality from the disposal activity are considered in relation to other marine receptors.

Seabed characteristics

13.4.29 The seabed off the north-west coast of Anglesey is largely defined by the presence of an extensive subsea platform of hard pre-Cambrian rock, which extends north-westerly to around 25km offshore [RD69]. The seabed therefore tends to be characterised by patches of either exposed bedrock or bedrock thinly overlain by boulders and lag gravel. There are also intermittent ribbons of sand where the remnants of glacial moraines or other protruding features baffle currents. Overall, it is an area of coarse tide-scoured rough ground [RD69].

13.4.30 Multibeam bathymetry collected by SEACAMS in 2013 and 2014 has indicated that the Disposal Site varies in depth from approximately 35m to 95m, though the majority of the site is deeper than 50m, with the seabed predominantly comprised of coarse sediments, boulder and bedrock [RD70].

13.4.31 Work by the British Geological Survey (BGS DigSBS250) and SEACAMS indicated that the majority of bedrock is found along the eastern and south-eastern boundary of the site, with estimates giving an area of 274ha (~10% of the whole Disposal Site) for bedrock. Adjacent to the bedrock, covering approximately 959ha is an area described as ‘rock and sediment’ with grab samples by SEACAMS recording ‘sandy coarse gravel’ to ‘very coarse gravel’ [RD70]. 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.

13.4.32 Due to the depths of the Disposal Site, bed shear stress is dominated by tidal processes rather than wave climate, with values predicted to range between $6Nm^{-2}$ and $10Nm^{-2}$, with the bed shear stress threshold for bed transport of fine sediments at $0.18Nm^{-2}$ [RD67].

Sediment quality

13.4.33 Marine sediments were sampled at five sites within the Disposal Site itself, with an additional survey site sampled within 2km to characterise sediment quality within the surrounding area (figure D13-20, Application Reference Number: 6.4.101). Collectively, these sites represent the Disposal Site study area for sediment quality. Details of this work, including a map of the sampling locations, are contained within appendix D13-2 (Application Reference Number: 6.4.84), with a summary of the results presented below.

13.4.34 Grab samples were taken at depths ranging from 59m to 82m with all sites recording similar gravelly substrata. All metal concentrations were well below the relevant Cefas Action Level 1 threshold value with several metals

below MRV. No metals exceeded the relevant Interim Sediment Quality Guidelines (ISQG) or Probable Effects Level (PEL) [RD9] with the exception of arsenic which just exceeded the ISQG at all sites.

13.4.35 All organic compounds monitored PAHs, PCBs, tributyltin (TBT) and other volatiles were below the relevant ISQG and Action Level 1 with many concentrations below MRV or only marginally above this value.

Value of receptors

13.4.36 Sediment quality is not a receptor in itself; however, it supports a number of marine receptors including subtidal communities, invertebrates, fish and seabirds. It is not therefore assigned a value but is considered within the receptor subtidal benthic communities, as it supports the communities present.

Phytoplankton and zooplankton

13.4.37 Considering the similarities in water quality characteristics and the mobility of plankton within currents, results of the phytoplankton and zooplankton monitoring programme, which was carried out in the central study area (within 5km of the Wylfa Newydd Development Area) between May 2010 and September 2014 (see paragraphs 13.3.40 to 13.3.53 and appendix D13-1, Application Reference Number: 6.4.83), are considered applicable to the Disposal Site.

Value of receptors

13.4.38 Phytoplankton and zooplankton are not considered to be of specific conservation value themselves, even though larval stages of species of conservation importance found around the coast of north Anglesey are expected to be found within the zooplankton community. 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. Plankton is of local importance and is relatively common in the coastal waters of north Anglesey, and therefore, the value assigned to this receptor is low.

Marine benthic habitats and species

Subtidal habitats and species

13.4.39 To characterise the subtidal benthic habitats and species within the Disposal Site, faunal grab samples were collected in 2016 from eight sites. At three of these, drop-down camera recordings were also taken in addition to 14 other sites. Survey effort was concentrated within the Disposal Site itself (17 of the 19 separate sites were located here), with the remaining located approximately 2km to the east to further characterise benthic habitats in this area (figure D13-20, Application Reference Number: 6.4.101). Collectively, these sites represent the Disposal Site study area for subtidal habitats and species

13.4.40 The recorded communities were as expected and align well with previous studies of the region (e.g. [RD69]; [RD71]) which found epifaunal benthic communities indicative of scoured environments.

13.4.41 Analyses of drop-down camera and, specifically, faunal grab samples revealed generally impoverished communities across the study area, likely a result of the mobile nature of some of the substrata and consequent scouring action. However, at several locations comparatively high faunal densities and numbers of taxa were recorded, with the richest site (HHD_20) recording 86 taxa, in contrast to the four taxa recorded at the most impoverished site (HHD_19) (figure D13-20, Application Reference Number: 6.4.101).

13.4.42 Annex I rocky reef feature was identified at 10 of the 19 sampling stations, predominantly as a result of 'stony reef' [RD72] with the exception of HHD_01 which was a 'bedrock reef'. Assessment of 'reefiness' was carried out (appendix D13-2, Application Reference Number: 6.4.84) resulting in four considered as medium reefiness and six as low [RD72].

13.4.43 The potential presence of the Annex I Ross worm (*S.spinulosa*) biogenic reef feature was noted at a number of sites. Similarly, these aggregations were assessed for reefiness [RD14]. This resulted in two sites, HHD_17 and HHD_20, considered as containing biogenic reef habitat of 'medium' and 'low' reefiness respectively. During analyses it was noted that the congeneric *S.alveolata* was often in high numbers and hence referred to as Sabellariidae biogenic formations from hereon.

13.4.44 No other Annex I habitats were recorded from the Disposal Site benthic surveys. A benthic study by NRW [RD64] covered three sampling locations in the Disposal Site; at three of these sites Sabellariidae reef was recorded. However, based on reef elevations recorded at these sites it is thought that these would represent low and medium reefiness.

13.4.45 Further afield, to the south of the Disposal Site, work by CMACS [RD71] recorded the presence of Sabellariidae reef at three locations, two sites of low reefiness and one of low to medium reefiness. A comprehensive benthic study in this region by Rees [RD69] recorded many sites with biogenic Sabellariidae crusts, but with an apparent reef structure recorded at only a single site. A recent study by NRW [RD64] recorded well developed Sabellariidae reef at a number of sites; however, these were far to the east of the Disposal Site, specifically around Church Bay, north-west Anglesey.

13.4.46 No species listed in accordance with Section 7 of The Environment (Wales) Act 2016 were recorded within the Disposal Site from the benthic surveys or work by NRW [RD64]. Nor did CMACS [RD71] record any from the area adjacent to the Disposal Site. However, several biotopes were recorded from these surveys that sit within the broad Section 7 habitat, 'subtidal sands and gravels'. Subtidal sands and gravel sediments are the most commonly found habitats below the level of the lowest low tide around the coast of the United Kingdom and are widely occurring in this region of the Irish Sea.

13.4.47 The HABMAP project [RD66] predicted that the muddy mixed biotope '*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment' to be present and wide ranging within the Disposal Site boundary. However,

benthic surveys by Horizon have not recorded the presence of the *Mysella bidenta* and *Thyasira* spp. biotope within the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84).

Non-native species

13.4.48 Neither the Disposal Site benthic surveys (appendix D13-2, Application Reference Number: 6.4.84) nor work commissioned by NRW, with one of the key objectives to record any benthic INNS, recorded the presence of non-native species within or adjacent to the Disposal Site. However, a number of non-native species have been recorded from marine ecology surveys covering the north Anglesey coastline and within Holyhead Harbour. These are considered in detail in paragraphs 13.3.80 to 13.3.89.

13.4.49 Non-native species are not considered receptors in themselves; however, the potential effects associated with non-native species has been discussed, and the potential effects on other receptors considered, as part of the Disposal Site assessment.

Value of receptors

13.4.50 The Habitats Directive Annex I reef is present within the Disposal Site as stony reefs, rocky reefs and biogenic reefs; the latter being represented by Sabellariidae reef (see paragraph 13.4.43). There are no designated sites of national/international importance within, or adjacent to, the boundary of the Disposal Site that have reefs as a qualifying feature. However, recognition is given to reefs being an Annex I habitat and the aim of the Habitats Directive to achieve 'favourable conservation status' to the entire occurrence of a habitat type within its natural range.

13.4.51 Assessments of reefiness (appendix D13-2, Application Reference Number: 6.4.84) found two examples which qualified as reef features; one assigned a medium reefiness score whilst the second was of low reefiness. The reef features, in particular Sabellariidae reef, add to the local biodiversity and support the wider ecosystem. Based on the above the Annex I 'reef' features are assigned a medium value under the receptor group 'subtidal habitats of conservation importance'.

13.4.52 Several biotopes are present within the Disposal Site that fall within the broad habitat 'subtidal sands and gravels' which is listed in accordance with Section 7 of The Environment (Wales) Act 2016. These are commonly found throughout the area. These subtidal habitats are assigned medium value under the receptor group 'subtidal habitats of conservation importance.'

13.4.53 Other subtidal habitats identified throughout the surveys are common in the local area, have some biodiversity characteristics (e.g. naturalness, contribution to diversity) and are of local importance. All invertebrate taxa recorded are considered characteristic and common to this region. Habitats and species that are common and do not have any particular conservation importance are considered as part of the subtidal habitats and communities' receptor group, which is assigned a low value.

Marine fish

13.4.54 Considering the similarities in water quality characteristics, and mobility of fish, the wider study area delineated for the Wylfa Newydd Development Area (see paragraphs 13.3.99 to 13.3.101) which encompasses the eastern Irish Sea and coastal waters around Anglesey, is considered relevant to the Disposal Site.

Ichthyoplankton

13.4.55 The species complement at the Disposal Site will be similar to that recorded around the Wylfa Newydd Development Area. Abundances of some species (e.g. plaice, herring, Dover sole and whiting) may be slightly higher than that observed within the Wylfa Newydd Development Area, although abundances are likely to remain much lower than those recorded in the eastern Irish Sea. Furthermore, 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.

13.4.56 High intensity spawning grounds for a number of fish taxa have been identified in the eastern Irish Sea (e.g. [RD24]); however, like the Wylfa Newydd Development Area, the Disposal Site is to the south-west and hence outside of the areas characterised by high intensity spawning in the Irish Sea.

13.4.57 Demersal species such as cod, plaice, sandeel, Dover sole, anglerfish (*Lophius piscatorius*) and whiting are all known to have low intensity spawning grounds that encompass the Disposal Site [RD24]. While pelagic species, such as mackerel, also have spawning grounds within the Disposal Site, the intensity of spawning within this area is considered to be low [RD24]. There are no known high intensity spawning or nursery grounds within the Disposal Site.

Subtidal fish and shellfish

13.4.58 Of the demersal species listed above, only whiting and anglerfish are known to utilise the Disposal Site as nursery grounds although this is considered to be a low intensity area [RD24]. Nursery grounds are assumed active for much of the year.

13.4.59 Considering the water depth at the Disposal Site, lesser-spotted dogfish, sprat, herring, grey gurnard (*Eutrigla gurnardus*), common dragonet, poor cod and other elasmobranchs are all expected to be present in this area, although in much lower abundances than that observed inshore within coastal waters around the north coast of Anglesey and wider Irish Sea. Although [RD24] classified inshore coastal waters around the north coast of Anglesey as a high intensity nursery ground for Dover sole, subtidal trawl surveys for the Wylfa Newydd Development Area (appendix D13-4, Application Reference Number: 6.4.86) along with evidence from other fish data (e.g. average fish landings into Holyhead, Cemaes Bay and Amlwch, from 2010 to 2014 by all vessels [RD25]; suggest Dover Sole is not a key characterising species of the Wylfa Newydd Development Area and Disposal Site.

13.4.60 Whilst sandeel is undoubtedly a key taxa characterising wider fish communities along the north coast of Anglesey (particularly inshore within sandy bay and inlets), owing to the presence of coarse rocky substrata, it is not considered to represent a key taxa characterising subtidal fish communities within the Disposal Site. Similarly, the dominance of coarse substrata at the Disposal Site would preclude any significant abundance of dab and plaice.

13.4.61 Elasmobranchs such as the basking shark (*Cetorhinus maximus*), nursehound, lesser-spotted dogfish, spotted ray (*Raja montagui*) and tope shark (*Galeorhinus galeus*) are all likely to be present at the Disposal Site [RD73]. There have been ten sightings of basking sharks near the Disposal Site between 1987 and 2006 and therefore, this species could to be present, albeit in low abundance and considered transitory rather than resident. Data from Ellis *et al*., [RD24] indicate that no elasmobranch species spawn near the Disposal Site. Tope shark and spotted ray are known to use the area for nursery but the intensity of use is low [RD24].

13.4.62 Diadromous species may transit the Disposal Site on an occasional basis to reach freshwater habitats on the west coasts of England and Wales. Sea lamprey (*Petromyzon marinus*), allis (*Alosa alosa*) and twaite shad (*Alosa fallax*) have not been encountered in any baseline surveys for the Wylfa Newydd Project, historic monitoring of the Existing Power Station, nor in biological records supplied by NRW and Cofnod. It is therefore unlikely that any of these species would be present at the Disposal Site in any significant numbers. Diadromous species such as river lamprey and sea trout, which are known to be present along the north coast of Anglesey, are also unlikely to be present in any significant numbers at the Disposal Site, as these species prefer inshore coastal waters.

13.4.63 Although European eel and Atlantic salmon has not been recorded in any of the recent marine surveys (since 2010), their presence along the north coast of Anglesey has been recorded historically. European eel is also known to be present in freshwater environments within the Wylfa Newydd Development Area (see appendix D9-16, Application Reference Number: 6.4.49). 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.

13.4.64 Commercial shellfish species such as edible crab, queen scallop and king scallop are likely to be present at the Disposal Site. There is no commercial fishing for scallops operating in or around the Disposal Site. Commercial potting for whelks, lobster and crab is known to occur at the Disposal Site although the intensity is considered to be low (less than two pots lifted and dropped per hectare per day) [RD28]. However, the recent Disposal Site benthic survey did not record the presence of any of these commercial shellfish (appendix D13-4, Application Reference Number: 6.4.86) nor were they recorded from this area in reports by NRW [RD64] and CMACS [RD71].

13.4.65 Of the Section 7 species recorded during the Wylfa Newydd Development Area subtidal trawl surveys, the following species are likely to occur at the Disposal Site: 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 the whiting and herring represent key characterising species of the fish communities at the Disposal Site.

13.4.66 No Annex II fish species were recorded from the subtidal trawls (appendix D13-4, Application Reference Number: 6.4.86); however, as noted above, species such as Atlantic salmon and European eel may transit through the Disposal Site.

Value of receptors

13.4.67 A number of individual fish species have no specific conservation value themselves but need to be considered as a community owing to the importance they play in the wider environment. Fish communities are therefore considered as 'ichthyoplankton not of commercial or conservation value' and 'general fish and fisheries (subtidal)', both of which are considered to be of low value.

13.4.68 Given that a similar complement of fish species will be present in the ichthyoplankton from those collected as part of the Wylfa Newydd Development Area ichthyoplankton surveys, it is considered that those species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) will be present (see table D13-3).

13.4.69 Any Section 7 fish species likely to be present in the Disposal Site are considered to be important on a regional level and have therefore been assigned a medium value. Similarly, any fish species of commercial importance are also assigned a medium value.

13.4.70 There are two fish species of national/international importance which are likely to be present at the Disposal Site. Atlantic salmon, which is listed on Annex II of the Habitats Directive, and European eel, which is protected by the Eels (England and Wales) Regulations 2009, are both considered high-value receptors. These species are considered as separate receptors and assigned a high value.

Marine mammals

13.4.71 Considering the mobility and home ranges of marine mammals, the baseline for the Wylfa Newydd Development Area is considered to be representative of the Disposal Site. 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 information relevant to the Wylfa Newydd Development Area is presented in appendix D13-6 (Application Reference Number: 6.4.88). A desk-based study was also undertaken by Minesto, which assessed the density of marine mammals and sensitivity to potential effects near Holyhead Deep [RD74]. This information is considered applicable to the wider area around the Disposal Site. Baseline information directly relevant to the Disposal Site is summarised in paragraphs 13.4.72 to 13.4.76 below.

13.4.72 Bottlenose dolphin is one of the most common cetacean species recorded in the Irish Sea, accounting for over 50% of individuals sighted between 2004 and 2014 [RD30]. However, during dedicated surveys carried out within the area of the Disposal Site, no bottlenose dolphins were recorded from the entire survey area (375km survey effort) [RD65]. Considering this, it seems unlikely that the Disposal Site represents an area of particular importance to bottlenose dolphins although individuals are known to be present.

13.4.73 Harbour porpoise is the most widely distributed cetacean within the Irish Sea, and the distribution of sightings shows a localised hotspot of abundance around the area of the Disposal Site [RD37]. Harbour porpoise are known to be present year round with seasonal peaks in abundance during the summer months (particularly July and August).

13.4.74 Risso's dolphin has a relatively localised distribution in the Celtic and Irish Sea, covering Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey [RD30]. Although Risso's dolphin are known to be present in the area, neither the Sustainable Expansion of the Applied Coastal and Marione Sectors [RD74] nor Gordon *et al*., [RD75] 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 carried out in 2016. It is therefore unlikely that the Disposal Site is of particular importance to this species, although it is possible that they could use the area on occasion. 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 summer (May to September) and a peak in June.

13.4.75 Grey seals are present in Welsh waters year round with peak sightings occurring between April and May. 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 [RD39]; [RD41]. 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.

13.4.76 The north Wales coast is described as a high-density area for grey seals. [RD76]. Two grey seal sightings in the west Anglesey area, corresponded to a rate of 0.10 sightings per hour [RD74]. Dedicated marine mammal surveys of the sea area surrounding the Disposal Site recorded equally low numbers of grey seals [RD74]. Hence, there is evidence to suggest that both adult and juvenile grey seal use the Disposal Site, although it is considered that the Disposal Site does not represent a particularly important area in the context of the wider Irish Sea.

Value of receptors

13.4.77 As detailed in paragraph 13.3.173, all species of marine mammal discussed above are assigned a high value.

Seabirds

13.4.78 JNCC Seabird Monitoring Program data (see paragraph 13.3.179) has shown that regional breeding population sizes (as defined in 13.3.176) ranged from zero for species known to occur but do not breed in the region (e.g. great skua) up to 173,445 (Manx shearwater). For the Disposal Site zone of effects, notable regional populations were shown for gannet (70,260), guillemot (90,559), fulmar (32,370) and kittiwake (2,738).

13.4.79 Within the Disposal Site zone of effects, there were colonies of four species ranging in numbers from shag (four pairs) to guillemot (196 pairs), with shag being the species with the largest proportion (14.81%) of birds in comparison to the regional population.

13.4.80 A desk-based ornithology study was undertaken by Minesto in 2016, which assessed the density of certain species of diving seabirds (mainly auks and gannet) and their sensitivity to potential effects in their study area near Holyhead Deep [RD65]. This was supported by an offshore ornithology baseline study [RD77] and work by Natural Research (Projects) Ltd on seabird populations and collision risks to diving seabirds [RD78]. This was a broad search, with the inclusion of bird populations of target species across the Irish Sea. Existing boat-based (JNCC ESAS data) and WWT aerial survey data identified relatively low densities of seabirds in the vicinity of Holyhead Deep with many species' presence being limited to the breeding season, especially auks. The desk study data used by Minesto was suitable for the purpose of their sensitivity study, but too old for use in EIA. Consequently, ESAS transect surveys were carried out in the Minesto study area in late 2016 and part of 2017, the results of which are summarised in appendix D13-7, (Application Reference Number: 6.4.89). Auks and Manx shearwater were the species present in highest numbers.

Value of receptors

13.4.81 The seabird species referred to as 'target species' are those which are qualifying features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern, common tern, roseate tern and Sandwich tern, and these are assigned a high value. All other seabirds (secondary species) are assigned a value of medium, as this includes secondary species such as regularly occurring migratory species (listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016) and some species which are listed on Annex I of the Wild Birds Directive, e.g. black-headed gull, or on Schedule 1 of the Wildlife and Countryside Act 1981, e.g. Mediterranean gull.

Summary of receptors

13.4.82 The receptors relevant to the assessment and their values are presented in table D13-5.

Table D13-5 Summary of marine environment receptor value for Disposal Site

Receptor	Value
All designated sites of nature conservation importance and supporting features (SACs, SPAs and SSSIs, including candidate SACs)	High
Plankton (phytoplankton and zooplankton)	Low
Subtidal habitats and communities of conservation importance	Medium
Subtidal habitats and communities	Low
Ichthyoplankton (not of conservation and/or commercial importance)	Low
Ichthyoplankton (of commercial and/or conservation importance)	Medium
General fish and fisheries (subtidal)	Low
Fish (of conservation and/or commercial importance)	Medium
European eel	High
Atlantic salmon	High
Marine mammals (pinnipeds and cetaceans)	High
Seabirds (target species)	High
Seabirds (secondary species)	Medium

Evolution of the baseline

13.4.83 Acknowledging connectivity between marine receptors, the baseline environment at the Disposal Site and that characterised for the Wylfa Newydd Development Area are considered to be very similar with differences primarily relating to subtidal benthic habitat and species receptors. The evolution of baseline conditions at the Disposal Site is therefore likely to closely resemble that outlined in paragraphs 13.3.240 to 13.3.250 for the Wylfa Newydd Development Area baseline environment, although the effect of climate change will be less.

13.5 Design basis and activities

13.5.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that will be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

13.5.2 As described in chapter D1 (proposed development) (Application Reference Number: 6.4.1), the application for development consent and Licensable Marine Activities is based on a parameter approach. The assessment described within this chapter has taken into consideration the flexibility afforded by the parameters. Modelling has included sensitivity testing of the tolerances within the Parameter Plans and Works Plans (Application Reference Number: 2.3), such as changes in positioning of the breakwater

and in dredged depth. A worst case scenario has therefore been assessed from a marine environment perspective within the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction

13.5.3 During construction the following activities are of particular relevance to the assessment of effects on the marine environment (either directly or through effects to surface water and groundwater, and freshwater environments); listed in order of occurrence:

- tree felling, vegetation clearance and dry stone wall dismantling and storage;
- topsoil clearance and storage;
- installation of drainage;
- removal of rock outcrop(s);
- watercourse diversion;
- construction of haul roads, plant compounds, car parks and offices (described as part of Main Construction);
- bulk earthworks including site levelling and grading to form required building platform levels for Unit 1 and Unit 2, including building platforms and construction and laydown areas;
- construction of haul roads and bridges;
- deep excavation (of Unit 1 and Unit 2);
- excavation of other features such as culverts and building foundations;
- progressive mound creation (through Enabling Works and Main Construction);
- construction and commissioning of concrete batching plant;
- temporary use of a beach landing facility;
- construction of the Cooling Water Systems (CWSs), breakwaters and Marine Off-Loading Facility (MOLF) (bulk material and Roll-on Roll-off (Ro-Ro));
- dry marine excavation, including blasting;
- wet marine excavation, including dredging;
- installation (and removal) of cofferdams for Cooling Water intake and outfall construction;
- excavation and construction of Cooling Water intake and outfall including tunnelling;
- construction of internal roads, car parking, security fencing and permanent lighting;
- operation of the MOLF;
- operation of concrete batching plant;

- Main Plant construction (Unit 1 and Unit 2);
- discharge of sewage; and
- disposal of material (rock and sediment) from marine excavation.

13.5.4 The term 'inner harbour' has been used to describe activities inside the temporary cofferdam whilst the term 'outer harbour' has been used to refer to activities within the remaining area in Porth-y-pistyll.

13.5.5 The Power Station construction programme is anticipated to commence following grant of development consent. The Main Construction is anticipated to take approximately seven years with the first Unit operational following Main Construction and the second Unit operational approximately two years later.

13.5.6 Activities such as bulk earthworks, deep excavations, rock excavation and MOLF construction would commence in the first year following grant of development consent. Details on the phasing of construction of the Marine Works are provided in appendix D1-1 (Construction Method Statement) (Application Reference Number: 6.4.17).

Drainage network

13.5.7 The drainage within the Wylfa Newydd Development Area would be modified during construction to manage the change in runoff from land drainage. The preliminary design for construction surface water drainage is contained in appendix D8-8 (summary of preliminary design for construction surface water drainage) (Application Reference Number: 6.4.33). The surface water drainage system would be installed prior to any major earthworks (including topsoil stripping) and would remain in place throughout the construction works. To control suspended solid concentrations during the construction of mounds and when they are unvegetated an active treatment system would be installed which, when required, would use a polyelectrolyte to aid settlement. Following construction of the mounds and once they are vegetated the drainage system would remain as a passive system (i.e. the ditches and swales and settlement ponds would remain but the active polyelectrolyte treatment equipment and any additional temporary measures such as silt fences, would be removed).

13.5.8 No process water from the concrete batching plant would enter the marine environment. Runoff from the concrete batching plant would drain into the main site surface water drainage. It would be intercepted within the batching plant site and monitored for pH levels. If the pH is above eight, then it would be treated prior to discharge.

13.5.9 Drainage of the MOLF quay would occur via longitudinal slot drains that would run along the back of the paved areas to collect surface water via an oil separator (to remove oily contaminants) and sediment catch-pit (to removed settled solid materials) before discharge to the sea via the main site drainage outfall. It is anticipated that this outfall would comprise a pipe outlet concrete headwall with a flap valve. The main site drainage outfall would be located within the MOLF's footprint; for example, in the revetment between

the two bulk berths (see figure D8-8, Application Reference Number: 6.4.101).

Dewatering

13.5.10 Dewatering comprises both groundwater (from excavations, and tunnelling) and seawater (from the temporary cofferdams).

13.5.11 Groundwater abstracted for dewatering of the basements and platform area during construction would be discharged to the sea via a system of transverse and perimeter ditches that discharge through two sedimentation ponds. Further treatment will be provided by a polyelectrolyte coagulant dosing system when required. Three discharge points (PA, PB, PC) in Porth-y-pistyll would be used depending on the phase of construction as shown in appendix D8-8 (Application Reference Number: 6.4.33).

13.5.12 Dewatering in the marine environment would be required at the outfall and intake cofferdams and for the inner harbour cofferdam in Porth-y-pistyll. Water would be pumped over the side of the cofferdams into the sea.

13.5.13 Suspended solids concentrations of the groundwater and marine dewatering components (with the exception of the initial dewatering of the inner harbour and outfall area) would be managed to not exceed the permitted level at the discharge points (see paragraphs 13.5.78 and 13.5.78).

Sewage discharge

13.5.14 Construction derived sewage would be treated in a dedicated construction sewage package plant. Following treatment, effluent would be discharged in the north of Porth-y-pistyll, at a location that would become the northern end of the western breakwater. The maximum daily rate of discharge is approximately 1,598m^3 per day.

13.5.15 An extension to the existing Cemaes Welsh Water Treatment Plant, operated by Dŵr Cymru Welsh Water (DCWW), and located to the west of the Site Campus, would treat sewage derived from the Site Campus. This would discharge through the current DCWW outfall or otherwise through the new Cooling Water outfall constructed for the Wylfa Newydd Project. The maximum daily rate of discharge from the Site Campus is approximately 1,598m^3 per day.

Construction, commissioning and operation of the concrete batching plant

13.5.16 The construction of the concrete batching plant and associated infrastructure (e.g. hardstanding, haul roads, conveyor system) is integrated with the construction of the MOLF. Reclamation of land behind of the MOLF would be required for construction of the concrete batching plant. The concrete batching plant would have a total footprint of up to 3.6ha, covering approximately 2ha of the intertidal zone.

Temporary access ramp construction

13.5.17 As one of the initial marine construction activities, a temporary access ramp would be constructed at the southern end of Porth-y-pistyll (see figure D1-9, Application Reference Number: 6.4.101). The ramp would take the form of a slipway and would be constructed from crushed rock either won from the Power Station construction site or imported by road if site-won rock was not available. The ramp would be graded to the required slope by a bulldozer working within the tidal window. The toe of the ramp would be at around Low Water Springs level. For each barge-unloading operation a ramp formed from crushed rock or similar would be reshaped to enable the construction plant to drive off the barge.

13.5.18 Once built, it is anticipated that the ramp would remain in place for a limited period of time (up to one year). It would then be dismantled and removed having served its purpose. The resulting materials would be re-used on-site or off-site (e.g. as aggregate), or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Temporary barge berth

13.5.19 A temporary berthing and unloading facility would be required to accommodate barges importing construction materials for subsequent Marine Works (e.g. quay wall materials for the MOLF).

13.5.20 The berth would be located to the south of (and adjacent to) the planned site of the eastern breakwater within the area of reclaimed land (see figure D1-9, Application Reference Number: 6.4.101). Its structure would 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 area behind the retaining wall would be backfilled to create a working platform for a mobile tracked/crawler crane behind the retaining wall. An area in front of the retaining wall would be filled and levelled with rock to create a platform onto which barges could be grounded as the tidal level falls. An access ramp would be provided from the quay level down to the beach in front of the quay to facilitate plant access for maintenance of the platform.

13.5.21 Once the MOLF is part-constructed and the temporary barge berth is not required, it would be removed. Materials arising from removal of the temporary barge berth would be re-used on-site, off-site or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Construction of the temporary cofferdam and southern causeway

13.5.22 The temporary cofferdam, approximately 350m long, and a causeway approximately 400m long, would be required to create a watertight seal inside which the inner harbour would be dewatered and excavated in the dry (see figure D1-9, Application Reference Number: 6.4.101). The temporary cofferdams would be constructed by depositing rubble stone and rock armour won from the Power Station Site over the foreshore and seabed to

form rubble mound structures. The materials would be transported to the cofferdam using dump trucks or by sea using barges, and would be shaped by tracked excavators either working from land or working from sea on jack-up platforms or barges.

13.5.23 The rubble mound structures would need to be made watertight by integrating a steel pile wall into the centre of the structure. The wall could be constructed by installing steel sheet piles through the middle of the structures and grouting them into a pre-cut trench in the seabed (i.e. trench cut from the seabed prior to the placement of the rubble mound structure) to create an effective seal. Under this option, the piles would be installed using a vibratory piling hammer and, potentially, a hydraulic drop hammer (e.g. Dawson's hydraulic impact hammer) should the piles not reach the required depth through the use of the vibratory piling hammer alone.

13.5.24 Alternatively, the wall could be constructed by installing interlocking steel tubular piles through the middle of the structures and grouting them into the rock below the rubble mound. Under this option, the piles would be installed into holes pre-drilled through the middle of the rubble mound structures and into the bedrock using a vibratory piling hammer and, potentially, a hydraulic drop hammer should the piles not reach the required depth through the use of the vibratory piling hammer alone. Under both options the piles would be installed by construction plant working from the top of the rubble mound structures.

13.5.25 Construction of the temporary cofferdam and temporary causeway (including sheet piling) is expected to take approximately eight months. Once sealed the main dewatering of the inner harbour would take approximately ten days.

13.5.26 To maintain dry conditions within the cofferdam there would be 24-hour use of four dewatering pumps to compensate for water inflow into the basin, for example, through or under the cofferdams, through the ground or by precipitation.

13.5.27 The cofferdam would initially be dewatered using pipes within the cofferdam structure to allow water to flow out at low water. The remaining seawater would subsequently be pumped from the landward to the seaward side. With the exception of the initial dewatering of the inner harbour, the suspended solids of the pumped seawater would be monitored to check that it does not exceed the permitted level and if required, management procedures such as settlement would be provided to meet this limit.

Removal of the Temporary Marine Works (temporary cofferdam and temporary southern causeway)

13.5.28 On completion of the works within the inner harbour, the temporary cofferdam between the temporary causeway and MOLF and the southern causeway would need to be removed. This is expected to extend over a period of 12 months. The temporary structures would be removed in reverse of the installation method. All materials would be re-used on-site, off-site, or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Dredging and excavation

13.5.29 Superficial soft sediments will be dredged from the outer harbour to provide a solid foundation for the breakwaters and MOLF, and to ready the area for dredging of rock which is required to create sufficient depth for the intake and navigation channel.

13.5.30 The target dredge depth is -10 metres Above Ordnance Datum (mAOD) with a tolerance of a maximum parameter of -11mAOD at the intake channel and -13mAOD at the Berthing Pockets.

Dredging of the outer harbour

Soft sediments

13.5.31 The superficial soft sediment (mainly sands and gravels) would be removed by conventional dredging plant such as a backhoe dredger, cutter suction dredger or trailing suction hopper. For the purpose of the assessment and modelling the worst case upper limit of soft sediment that would be dredged is a bulked volume of 242,000m^3 (equating to a saturated density of approximately 352,000 wet tonnes, based on a specific gravity of 1.6), although the values are likely to be considerably less; see chapter D1 (Application Reference Number: 6.4.1).

Rock

13.5.32 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. The duration of this activity would be about 16 months. For the purposes of the assessment and modelling the worst case upper limit of rock that would be removed from the outer harbour by dredging is a bulked volume of 368,000m^3 (equating to an *in situ* density of 709,714 tonnes, based on a specific gravity of 2.7) (see chapter D1 (Application Reference Number: 6.4.1) for more detail). Dredged bedrock would be re-used for the construction of the cores of the western and eastern breakwaters where appropriate (i.e. geotechnically suitable) and practical (i.e. available when the breakwater construction requires it), or exported off-site for re-use. The remaining dredged bedrock that cannot be re-used would be disposed of at the Disposal Site. Waste material characterisation is outlined in [RD79].

Excavation of the inner harbour

13.5.33 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 in the dry) and then excavated using tracked excavators and dump trucks.

13.5.34 Excavation of the inner harbour would be carried out in the dry and is expected to take around 14 months in total. Preliminary excavation would begin onshore up to 0mAOD and would take around six months. Once the cofferdam around the inner harbour is in place, rock fracturing by blasting in the dry behind the cofferdam would be carried out for approximately seven

months. There is likely to be three blasts per day, with operations limited to within 10:00 and 16:00 Monday to Friday, and 10:00 and 13:00 on Saturdays (see appendix B6-2, Application Reference Number: 6.2.21). Drilling activities prior to blasting would be limited to 07:00 to 19:00.

13.5.35 Approximately 500,000m^3 bedrock would be excavated in the dry, including the excavation directly in front of the Cooling Water intake structure.

Re-use and disposal of dredged material

13.5.36 Material arising from works in the inner harbour would be re-used on-site (e.g. for core material in the Cooling Water intake breakwaters).

13.5.37 Disposal of dredged rock and soft sediments from the outer harbour would be carried out at the Disposal Site. The site is located approximately 18km west of the Wylfa Newydd Development Area (see figure D13-21, Application Reference Number: 6.4.101).

13.5.38 For the purposes of this assessment and modelling the worst case volume for material that could require disposal at sea is approximately 610,000m^3. This would comprise approximately 368,000m^3 of bulked rock material and 242,000m^3 of bulked soft sediment.

13.5.39 Assuming a barge with approximate capacity of 3,500m^3, it would take 35 days to dispose of the sediment. However, this assumes a continual series of disposal events without break and is therefore a worst case (see appendix D13-12, Application Reference Number: 6.4.94).

13.5.40 Rock would be disposed of over the duration of the wet excavation works, taking approximately 16 months (chapter D1, Application Reference Number: 6.4.1).

Construction of the breakwaters

13.5.41 There would be two breakwaters extending out into Porth-y-pistyll that would provide protection and create acceptable wave conditions for operation of the CWS; referred to as the western breakwater and the eastern breakwater (see figures D1-2, Application Reference Number: 6.4.101 and D1-9, Application Reference Number: 6.4.101). The breakwaters would also provide sheltered conditions for vessels accessing and berthing at the MOLF.

13.5.42 The western and eastern breakwaters would be approximately 400m and 150m in length, respectively. Both breakwaters would have rock-filled cores covered with pre-cast concrete armour units and, where practical, rock armour. The largest concrete armour units to be used on the ends of the breakwaters are expected to be approximately 38 tonnes in weight, with smaller units being used in less exposed areas. A change to natural rock armour would occur once the block weights are sufficiently reduced to allow economical use of natural rock and where there is sufficient space to accommodate the gentler gradient when using rock armour.

13.5.43 Access for the construction of both breakwaters would be facilitated by the construction of haul roads. A temporary causeway would be constructed to

create a haul road (wide enough for two vehicles to pass) between the land and the southern end of the western breakwater.

13.5.44 The western breakwater's core would be constructed by depositing dredged material (i.e. fractured bedrock) and stone and/or rock won from the Power Station Site, with a rock size varying from approximately one kilogramme to one tonne, on top of the prepared seabed to form a mound.

13.5.45 Depending on whether the construction is taking place from the land or the sea, the core material would be transported to site by road using dump trucks or by sea using split hopper barges and/or side stone dumping vessels, and would be trimmed by long-reach tracked excavators working on the breakwaters or from jack-up platforms or barges in the sea.

13.5.46 A rock underlayer with rock size varying from one tonne to six tonnes, depending upon the location along the breakwater, would be placed on top of the core material. Pre-cast concrete armour units (or rock armour, if used; see below) would be placed over the mound. The armour units could vary in size depending upon the location along the breakwater. The further out to sea, the larger the armour unit size. The armour units would be placed in a precise grid pattern to ensure they are interlocked. The rock underlayer and armour units would be transported to site by sea using barges and/or via the haul road using dump trucks, and would be unloaded directly onto the breakwaters using cranes working from the breakwaters.

13.5.47 The eastern breakwater would be constructed from land working seawards using similar methods, materials and plant as described for the western breakwater.

13.5.48 During Power Station operation the breakwaters would be subject to routine visual inspection to check that they were structurally intact, particularly after major storm events. No routine maintenance of breakwaters should be required, but it is possible that the breakwaters could require some occasional maintenance, which is most likely to take the form of the re-positioning and/or replacement of dislodged and/or damaged armour units. In the case of the western breakwater, this would require the use of floating plant; there would be no vehicular access to the breakwater.

Construction of the MOLF

13.5.49 The MOLF is required to facilitate the construction of the Power Station and would therefore be constructed early in the programme and be operational throughout the Power Station construction phase (see figure D1-2, Application Reference Number: 6.4.101). It would provide two quays and a layby berth. The bulk quay (with two berths) for the offloading of bulk materials such as sand, gravel, cement and reinforcement and a Ro-Ro quay. The layby berth is provided as a safe place for ships to berth if the other berths are occupied.

13.5.50 The bulk quay would lie south of the eastern breakwater. It would comprise two berthing platforms providing berthing facilities for bulk vessels and unloading facilities for bulk materials, each with four mooring dolphins (i.e. eight in total). The area between the two platforms would either be a

continuous quay wall and for the purposes of modelling and assessment a revetment has been assumed. The bulk quay would provide berthing facilities for bulk materials. The area behind the berthing platforms, dolphins and quay would be reclaimed to form a new land area up to the required platform level of between +5mAOD or +6mAOD, and would be protected by a rock armour revetment.

13.5.51 The Ro-Ro quay would extend eastwards from the southern end of the bulk quay (i.e. towards the shoreline) and comprise a quayside used primarily for Ro-Ro vessels and Lift-on Lift-off vessels, incorporating a ramp for ship to shore transfer of Abnormal Indivisible Loads, and Lift-on Lift-off of equipment and materials by cranes. Its quay wall would be approximately 100m in length and its quay surface would be set at a platform level of between +5mAOD or +6mAOD. The quay wall for the Ro-Ro ramp would be set at the same level as the bulk berth quay surface level with the toe of the sloping ramp used to receive Abnormal Indivisible Loads being at approximately +3.5mAOD, thereby providing a shallow gradient up to the general quay level. The quay wall would continue towards the CWS intake and the base of the wall would match the level required for the CWS intake.

13.5.52 The layby berth would be located at the southern end of the western breakwater and constructed in the dry behind the cofferdam. The berth would consist of a series of berthing and mooring dolphin structures adjacent to a dredged pocket. The berth would be remote from the land and would be accessed by small boats.

13.5.53 The temporary layby berth would be removed once Power Station construction is complete. Removal would involve the use of a floating crane barge or a jack-up crane barge for lifting off the walkways between the dolphins; and demolition of the dolphins. If mass concrete blocks were used for the dolphins, they would be cut into manageable sections using a wire saw or similar and lifted onto a barge for removal and crushing off-site. If steel piles were used to construct the dolphins, these piles would be cut off at seabed level and lifted onto a barge for removal from site and either reuse elsewhere or scrapping. The power cable would be removed from the seabed.

13.5.54 In addition to the various cargo vessel berths, a pontoon would be required for mooring tugboats, pilot vessels, safety boats and other small workboats during the construction of the Power Station. It would be a floating structure located between the Ro-Ro berth and the Cooling Water intake structure.

13.5.55 It is anticipated that the walls of the bulk berthing platforms and the Ro-Ro quay wall would use pre-cast mass concrete blockwork structures built up from the bedrock which would be prepared by rock dredging to the required formation level. The mooring dolphins would either be similarly constructed in pre-cast mass concrete blocks or using large diameter steel mono-piles socketed onto the seabed or multi-pile dolphins similarly socketed into the seabed.

13.5.56 Berthing pockets would be dredged alongside the bulk quay and the layby berth. The proposed depth of the berthing pockets would allow bulk cargo vessels to remain berthed across most states of the tide, but may not be

sufficient to allow fully laden vessels to manoeuvre onto the berths across all states of the tide. The berthing pockets would extend approximately 30m from the quay. An indicative bulk berth pocket depth would be approximately -11.9mAOD plus dredging tolerance of approximately 1m.

13.5.57 The berthing platforms, mooring dolphins (if constructed using concrete blockwork) and the Ro-Ro quay wall would be constructed on top of the prepared bed using pre-cast concrete blocks. To facilitate the placing of the blocks, the area immediately behind the quay wall would be partially filled with suitable rock fill material. The pre-cast concrete blocks would be transported to site by barges and would be placed into position by cranes working from the land or from jack-up platforms or barges in the sea. A concrete capping beam would be cast *in situ* along the top of the blockwork to complete the structures.

13.5.58 Aids to navigation would be installed to provide safe navigation for vessels during both construction and operation. During the MOLF construction phase, up to three special marks with yellow lights would be placed at intervals along the north-west of the bay such that they create a safety zone but do not present a navigational hazard for approaching construction vessels. Subject to agreement with the Maritime and Coastguard Agency and Trinity House Lighthouse Service, the aids to navigation for the operational phase would include a set of leading marks with lights to guide vessels between the breakwaters, and marks and lights for breakwaters, the bulk and Ro-Ro berths and the CWS intake. The aids to navigation would be in accordance with the International Association of Lighthouse Authorities' buoyage system.

Operation of the MOLF

13.5.59 It is expected that the MOLF would operate on a 24-hour basis all days of the year, used by bulk Lift-on Lift-off and Ro-Ro vessels. Typically, the bulk vessels would take the form of approximately 8,000 dead weight tonnage aggregate bulk carriers, plus up to approximately 4,000 dead weight tonnage cement bulk carriers, and approximately 1,500 dead weight tonnage general cargo/Lift-on Lift-off ships (for plant, equipment, rebar and cement in tanktainers). Typically, the Ro-Ro vessels would take the form of barges, sized to suit the dimensions of the individual Abnormal Indivisible Loads.

13.5.60 At the bulk quay a range of bulk materials handling and conveyance equipment would be installed including a mobile harbour crane on each berth, height-adjustable receiving hoppers, mechanical conveyors for aggregate transport, and pneumatic pumps and pipelines for cement transport.

Shore protection

13.5.61 Adequate shore protection would be provided where dredging or excavation could lead to shore erosion and/or unacceptable wave overtopping discharges. Locations for shore protection would include:

- between the eastern breakwater and the shoreline (approximately 80m in length); and

- between the two bulk MOLF.

13.5.62 Shore protection would take the form of rock revetments or seawalls and would be tied-in with the adjacent structures (e.g. breakwaters, quay walls and Cooling Water intake channel). The toe of the shore protection would be below Mean Low Water Springs at the dredged seabed depth, which would be approximately -10mAOD. Where there is no requirement to dredge in front of the area of shore protection, the revetment/sea wall would tie in with the existing seabed level.

Cooling Water intake and outfall works

13.5.63 The CWS comprises three individual systems, all of which share a common intake. The CWS requires the construction of the following elements below Mean High Water Springs:

- an intake channel and forebay structure with screening, acoustic deterrents and a skimmer wall within Porth-y-pistyll;
- breakwater structures to offer necessary weather protection to the intakes, including calming the water during stormy conditions (see paragraph 13.5.41);
- outfall structure within Porth Wnal; and
- fish recovery and return discharge structure (see paragraph 13.5.70).

13.5.64 Construction of the intake and outfall would require significant rock excavation which would be completed in the dry behind cofferdams. The Cooling Water intake channel would be excavated to create a –10mAOD formation level. An additional cofferdam is required in front of the intake as the tunnelling works and installation of associated infrastructure are longer in duration than the marine excavation and construction works.

13.5.65 The cofferdams at both the Cooling Water intake and outfall would be constructed using one of three options:

- twin sheet piled wall gravity structures;
- twin tubular pile wall gravity structure; or
- rock bund type cofferdams similar to the semi-dry cofferdam (not considered for the Cooling Water intake structure)

13.5.66 For the two piled options, trenches on the line of the two tubular pile/sheet pile walls would either be blasted into the rock (intake cofferdam constructed in the dry), or cut into the rock where the work is undertaken underwater. The tubes/sheet piles would be stood up in place and concreted into position. In the case of the Cooling Water intake cofferdam this operation would be undertaken in the dry, behind the semi-dry cofferdam. In the case of the Cooling Water outfall cofferdam the operation would be carried out underwater. In both cases, tie rods and steel waling beams would be installed between the two parallel walls and fill material placed inside the cofferdam.

13.5.67 The rock bund type cofferdam being considered as an option for the Cooling Water outfall would be a similar form of construction to the semi-dry

cofferdam with a steel sheet pile concreted into a trench cut into the rock, supported on both sides by a rock fill bund, protected on the outer face by rock armour.

13.5.68 The cofferdam structures would remain in place until completion of all of the intake, outfall and tunnel works. The cofferdam removal works would be a reversal of the construction works. The resulting materials would be re-used on-site, off-site, or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

13.5.69 The Cooling Water tunnels are to be primarily excavated by controlled drilling and blasting. The discharge channels at the Cooling Water outfall would be constructed using a cut-and-cover methodology.

Fish protection measures

13.5.70 Fish protection measures including an Acoustic Fish Deterrent (AFD) and fish recovery and return (FRR) system would be installed at the Cooling Water intake structure. The discharge point for the FRR system would be below lowest astronomical tide (LAT) and located to the north of the eastern breakwater in the region of the -6.0mAOD contour. The design of the FRR outfall structure and type of conduit is currently being examined but would follow best practice (e.g. [RD80]). It is likely to involve installation of a conduit below ground level, of sufficient diameter, flow and gradient to reduce risk of blockage, following a route north from the Cooling Water intake screen structure to meet the coastline level with the eastern breakwater and rock armour. The discharge point would be fixed to the northern face of the eastern breakwater and the height and positioning of this structure have been considered in order to permit the best chance of fish survival and reduce the risk of re-impingement (as determined by modelling), respectively.

13.5.71 The AFD would involve mounting an array of underwater sound projectors on the dividing walls of the coarse screens at the face of the Cooling Water intake. This array would provide an adequate sound field to deflect fish hearing specialists and generalists (when coupled with low approach velocities), whilst not spreading beyond the intake embayment (which could cause a disturbance to passing marine mammals).

Marine plant

13.5.72 To excavate and construct the marine elements the following plant are required in addition to conventional site plant:

- jack-up platforms;
- a variety of cranes;
- barges for the transportation of material;
- drilling rigs;
- dredgers;
- rock breaker;
- rock cutter; and

- work boats and safety boats.

13.5.73 There would be a number of small vessels required to transfer workers from land onto marine plant during the two-year period of construction and during operation of the MOLF. These vessels would primarily operate within Porth-y-pistyll and would be subject to strict controls including appropriate speed restrictions. Journeys to and from other ports would not normally be required.

Lighting

13.5.74 Lighting levels would be required to be as uniform as possible, thereby offering an even field of view and the elimination of unnecessary bright spots. The effect of glare is of particular importance for the moving of vehicular and trailer-mounted cargo within the area together with the effect on the approach to the MOLF from the Power Station Site. Lighting levels would vary based on the construction activity with maximum levels of 200Lux associated with dredging operations. Land based operations would have light levels between 2Lux and 120Lux.

13.5.75 Dolphin walkway lighting would typically consist of low-level luminaires mounted in walkway hand-railing. The mobile harbour cranes located on each platform would feature on-board lighting for the purpose of providing specific supplementary lighting, task lighting, and for operational purposes to supplement the berth platform vulnerable areas (i.e. remove shadows created when the crane moves on the platform).

Embedded mitigation

13.5.76 As set out in the Phasing Strategy (Application Reference Number: 8.29), Horizon will install appropriate drainage on-site prior to main construction. This would include sediment settlement ponds, appropriate treatment to manage flows and meet agreed water quality thresholds. An application would be made for an Environmental Permit which would set limits on the concentrations of substances which could be discharged to protect the receiving surface water.

13.5.77 As set out in the Wylfa Newydd Code of Construction Practice (CoCP) (Application Reference Number: 8.6), surface water runoff from exposed topsoil during construction and later from the newly formed landscape mounds would be managed by a treatment train of sustainable drainage system (SuDS) features, as detailed in appendix D8-8 (Application Reference Number: 6.4.33). Sediment settlement ponds would be used in conjunction with other measures including silt traps, silt curtains, silt fences and vegetated channels. Ditches would be constructed around the base of the landscape mounds to allow flows to be captured and discharged to the drainage system. The discharge limit for suspended solids for each discharge point would be set in the construction Environmental Permit with the limit set based on baseline conditions so that there would be no significant effect on the receiving water. The design has been prepared to meet a minimum treatment standard of between 40mg/l and 70mg/l total suspended solids (depending upon the background concentration in the receiving watercourse) during normal rainfall conditions. Chemical dosing

may be required during the construction stage of the mounds and when they are unvegetated if there is insufficient settlement of solids in the settlement ponds (e.g. due to high flow rates). Details are provided in appendix D8-8 (Application Reference Number: 6.4.33).

13.5.78 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) dredging of soft sediments in Porth-y-pistyll will be restricted to the area identified in the dredging plan and the duration will be shortened as far as practicable, in order to reduce suspended solids concentrations and the release of sediment-bound contaminants.

13.5.79 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) where possible excavated rock material would be used in the construction of marine structures to reduce the volume of material imported to site and the amount requiring marine disposal. This would reduce the possibility of transmitting INNS via excavated materials.

13.5.80 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) and the Marine Licence application, where practicable, disposal of sediment would take place within the central area of the Disposal Site to mitigate any effects beyond the Disposal Site boundary. Rock material would also be deposited within a micro-sited area of the Disposal Site.

13.5.81 As set out in volume 2 of the Design and Access Statement (Power Station Site, Application Reference Number: 8.2.2) the design and positon of the western breakwater would ensure that a sufficient gap exists at the landward end, post construction of the Marine Works. This would be designed to maintain appropriate hydrodynamic flows and allow mixing within Porth-y-pistyll and prevent long-term physical disturbance to habitats located to the west of the breakwater structures around Cerrig Brith during the remainder of the construction phase of the Wylfa Newydd Project. The design would also consider wave refraction to reduce changes to hydrodynamics (bed shear stress and scour) and wave climate from the presence of the breakwaters and MOLF.

13.5.82 As set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) the footprint of the breakwaters, Cooling Water intake and outfall structures, temporary causeway, including dredging activities would be designed to be as small as practicable (whilst meeting operational requirements). This would ensure migratory fish species such as European eel and sea trout are not prevented from entering and leaving freshwater habitat in the Afon Cafnan during the construction phase.

13.5.83 As set out in the Phasing Strategy (Application Reference Number: 8.29) the design of the breakwater structures will introduce new hard surfaces which could potentially have the capacity to function as an artificial rocky reef, providing new colonisation opportunities for species dependent on hard substrate [RD81].

13.5.84 As set out in the Phasing Strategy (Application Reference Number: 8.29) the design of the permanent breakwaters will provide intertidal areas for grey seals to haul out. The development of habitats and species on the

breakwater structures could also potentially provide habitat, food and refuge resources for seabirds.

13.5.85 As stated in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) the sediment control design element of the construction drainage system would reduce mobilisation and transport of fine suspended sediment. Methods would be applied to manage the discharge of sediment (as outlined in the Main Power Station Site sub-CoCP, Application Reference Number: 8.7). At the Nant Cemlyn (which drains to the Cemlyn Lagoon) specific measures would be undertaken during construction of Mound E. Flow would be diverted into the Afon Cafnan until vegetation becomes established and risk of high sediment solid discharge is reduced.

13.5.86 In accordance with the strategy set out in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), methods would be applied to manage the discharge of suspended sediments to Cemlyn Lagoon. These include:

- No polyelectrolyte dosing would be employed for discharge E1.
- From the point of commencement of earthworks on the west of Mound E onwards, no water would be discharged into Nant Cemlyn via discharge E1 until vegetation has re-established and risk of increased sediment run off is low.
- After establishment of vegetation, if there are any additional bulk earthworks on the west of Mound E resulting in a risk of sediment discharge, no water would be discharged into Nant Cemlyn via discharge E1 until re-establishment has again occurred.
- During the above period(s) all water would be diverted and discharged into the Afon Cafnan via discharge E2 or further down the catchment. This discharge would require an Environmental Permit from NRW.

Good practice mitigation

13.5.87 An overarching Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8) set out environmental management requirements to mitigate construction activities. These documents include best practice, where practicable, such as environmental emergency management as well as dust and sediment management strategies. Pollution prevention strategies are also set out to reduce the potential for, and the scale of, any accidental leaks and spills during the proposed activities. All bulk fuel storage would be within engineered containment facilities including suitably bunded tanks.

13.5.88 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) a suitably qualified and experienced person would be employed during the construction phase to monitor the environmental aspects of the Wylfa Newydd Project. For example, where activities necessitate an Ecological Clerk of Works/environmental liaison officer will be present to ensure the

works proceed in accordance with best practice guidance and adhere to the mitigation measures as outlined here. This person would work with the appointed construction contractors with regard to implementation of the environmental mitigation measures.

13.5.89 As set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) marine and land-based plant would be used in line with best practice construction methods, for example machinery would be switched off when not in use and drip trays would be placed under plant and appropriate bunding will be in place where necessary.

13.5.90 In accordance with the management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8), methods would be applied to all works to control noise and vibration.

13.5.91 The management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8), will include monitoring locations within the Wylfa Newydd Development Area including locations close to Cemlyn Bay. The scope of the monitoring, including the locations, would be discussed and agreed with NRW.

13.5.92 In accordance with the Marine Works sub-CoCP (Application Reference Number: 8.8) Horizon will produce and adhere to a Biosecurity Risk Assessment and Method Statement based on industry standards.

Operation

13.5.93 The operation of the Power Station includes the following components which are relevant to the marine environment and assessed within this chapter:

- abstraction and discharge of cooling and service water;
- control of biofouling;
- emissions of nitrogen and sulphur dioxide from operational combustion plant;
- the presence of the breakwater throughout operation;
- vessel movements associated with the MOLF;
- maintenance dredging; and
- general operational activities including alarm testing, intake and exhaust fans, steam venting, use of generators and pumps.

13.5.94 The activities that would be carried out during operation are described in chapter D1 (Application Reference Number: 6.4.1). At this stage of the Wylfa Newydd Project it has been necessary to make a number of assumptions to facilitate assessment; the assumed scenario for operations relevant to the marine environment is provided below and the worst case is provided where applicable.

Abstraction and discharge of Cooling Water

13.5.95 The Cooling Water intake would be located in the south-east corner of Porth-y-pistyll (see figure D1-2 (Application Reference Number: 6.4.101) and D1-9 (Application Reference Number: 6.4.101). The Cooling Water outfall would be located adjacent to the outfall of the Existing Power Station (chapter D1, Application Reference Number: 6.4.1).

13.5.96 The Cooling Water System would be designed to limit the entrapment of marine organisms and includes the following measures:

- A maximum intake velocity of 0.3m/s in front of the intake opening at LAT.
- Screening in the form of coarse raked bars located in front of fine mesh drum screens (for the main Cooling Water intake) and band screens (for the service water intake). The proposed fine mesh screen size is 5mm. There are likely to be a minimum of four main screens at the Cooling Water intake and two service water (reactor service water and turbine service water) intake screens per unit; this would incorporate redundancy to allow maintenance and biocide treatment of screens and adequate and effective fish handling capacity.
- An AFD in front of the Cooling Water intake, designed in line with Best Available Technique [RD80]. The sound field would be located in the most appropriate location within the intake entrance; it would be specified to allow redundancy in the system and would be supported by modelling to demonstrate a uniform sound field. It would also be designed to avoid effects on marine mammals.
- An effective FRR system, discharge point located below LAT, designed in line with the Best Available Technique that would remove fish impinged on all screens and return them to sea.
- To control biofouling, treatment of the CWS is required. Sodium hypochlorite or appropriate alternatives would be used for this purpose. Management of the biocide dosing regime, while preventing harm to fish impinged on screens, will be in line with best practise. Continuous dosing will be applied during a higher fouling risk period. The biocide dosing regime would be designed to reduce biofouling risk, normally between April and December, when sea temperatures are above 10°C. Typically, biocide dosing would be applied to all areas of the CWS except around the fine mesh screens to prevent harm to fish impinged upon them. It is assumed that the water source for any on-site generation of hypochlorite does not change water balance and if seawater is used, then the abstraction point will be downstream of the fine mesh screens.

13.5.97 Circulating and service water flows would vary according to the state of the tide. At highest astronomical tide the flow would increase by approximately 12% compared with the flow at LAT as a result of a reduced pumping head. The flows at LAT and highest astronomical tide are shown in table D13-6. It

is acknowledged that there may be marginal differences between predicted and actual pump efficiencies; furthermore, over the operational lifetime of the Power Station, there could be variations in the performance of the different pumps constituting the CWS and inefficiencies due to biofouling. A precautionary approach has therefore been taken with an additional 5% contingency added to the tidal average of 119.6m^3/s, equating to 125.5m^3/s. For modelling purposes this was rounded up to 126m^3/s.

Table D13-6 CWS abstraction rates

	Maximum at LAT		Maximum at highest astronomical tide		Tidal average (two reactors)		Tidal average plus 5% contingency	
	Vol.	Units	Vol.	Units	Vol.	Units	Vol.	Units
Cooling Water	184,800	m^3/hr	206,976	m^3/hr				
Turbine service water	7,400	m^3/hr	8,288	m^3/hr				
Reactor service water	10,800	m^3/hr	12,096	m^3/hr				
Subtotal per reactor (m^3/hr)	203,000	m^3/hr	227,360	m^3/hr				
Subtotal per reactor (m^3/s)	56.39	m^3/s	63.16	m^3/s				
Total for two reactors	112.78	m^3/s	126.31	m^3/s	119.55	m^3/s	125.52	m^3/s

13.5.98 The temperature of the Cooling Water discharge water will also vary with the tide; the larger the volume of abstracted water the lower the temperature will be at the point of discharge. At LAT, the temperature increase at the point of discharge will be:

- 12°C (98 percentile) above ambient for the Cooling Water discharge;
- 5°C above ambient for the turbine service water; and
- 5.4°C above ambient for the reactor service water.

13.5.99 The service water intakes are independent from the main Cooling Water intake but they have a common discharge.

13.5.100 The ultimate heat sink is the Irish Sea using this once-through cooling system. Should this system become impaired, a reserve ultimate heat sink facility, based on forced draft wet cell cooling towers, would be called into service as described in chapter D1 (Application Reference Number: 6.4.1).

There is no additional discharge from the reserve ultimate heat sink into the marine environment.

13.5.101 The Cooling Water abstraction and associated discharge could vary during the lifetime of the Power Station as a result of different operational modes, resulting in variation of the discharge flow and temperature. These modes include commissioning, routine operation, outages, turbine trips and start-up/shut-down. In addition, there are two modes which are governed by National Grid in relation to balancing demand and total generation; these are known as 'frequency responsive' and 'island mode' operation. Many of these modes are either unplanned, infrequent and/or regarded as abnormal or emergency modes.

13.5.102 The assessment is based on the routine operation mode and assumes 100% reactor load with no steam bypass, which is the most representative scenario during operation. During commissioning, outages, turbine trips and start-up/shut-down modes there would be no increase in abstraction or thermal discharge above routine operation. If an abnormal or emergency mode is entered there may be an increase in the temperature of the Cooling Water discharge for a very short duration, but this would not exceed 12°C as a 98 percentile.

Commissioning and maintenance

13.5.103 There are three phases of commissioning; construction testing, pre-operational testing and start-up testing. Construction testing involves testing the components of the Power Station and would not have any effects on the marine environment.

13.5.104 During pre-operational testing (also known as cold commissioning) it may be necessary to discharge some water to the environment to support required plant testing. The amount of water abstracted would be increased in stages but would not exceed the maximum volumes for the Cooling Water and service water intakes. During this period the discharge water would be approximately the same temperature as the abstracted water, i.e. ambient temperature.

13.5.105 Start-up testing (also known as hot commissioning) is the final phase of commissioning. Water would be abstracted up to the maximum permitted volumes for the Cooling Water and service water systems. During this period, warm water would be discharged from the outfall at temperatures up to 12°C above ambient.

13.5.106 The chemicals discharged during commissioning would be similar or less than those used during the operational phase.

13.5.107 The Power Station is planned to operate on an 18-month fuel cycle; 17 months at high power operation and one month shutdown.

Drainage and other discharges

13.5.108 During operation, all sewage would be treated at a Welsh Water sewage treatment works (under Dwr Cymru Welsh Water operations) and would be

discharged to the sea in the same (or similar) location as the Cooling Water outfall as occurred at the Existing Power Station.

MOLF and breakwater during operation

13.5.109 All or part of the MOLF may be retained for use during Power Station operation. Whilst the bulk quay is expected not to be required, the Ro-Ro quay may be used for delivery of replacement parts which are Abnormal Indivisible Loads (to avoid road transport). It is currently assumed that only one vessel per year would use the MOLF during operation.

13.5.110 Dredging is likely to be required to maintain sufficient depth in front of the intake and to allow continued access to the MOLF. The dredged material would be deposited at the Disposal Site. The volume of dredged material (sediment) would be significantly smaller than that for the capital dredging programme and consist largely of dispersive material. Any material requiring disposal through maintenance will be subject to a separate Marine Licence application.

13.5.111 During operation the western breakwater would be a standalone structure with no connection between the breakwater and the land to allow through flow of water.

Embedded mitigation

13.5.112 Measures to prevent the entrapment of marine organisms are set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) and have been described in paragraph 13.5.96. The control of biofouling through the use of biocide is set out in the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13). The majority of these measures are intended to reduce the risk of impingement and increase the return and survival of marine organisms that would be impinged. However, the reduced mesh size (5mm) and biocide dosing regime are also intended to reduce the risk of entrainment and increase survival through the CWS of entrained marine organisms.

13.5.113 As set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) the Cooling Water outfall would be designed to increase the momentum of the discharge, to help propel the thermal plume, and promote mixing and dispersal of associated biocide products to the north of Wylfa Head where the offshore currents will aid dispersion and decay, and reduce the risk of recirculation.

Good practice mitigation

13.5.114 The Wylfa Newydd CoOP (Application Reference Number: 8.13) sets out mitigation measures for operational activities with the potential to cause significant effects (for example, in relation to air, noise, traffic, water quality etc.).

Decommissioning

13.5.115 Activities associated with decommissioning are outlined in chapter D1 (Application Reference Number: 6.4.1). The activities of particular relevance to the marine environment are:

- the shutdown of reactors and the reduction and eventual cessation of abstraction and discharge of Cooling Water;
- changes in the quantity and quality of liquid effluent discharge; and
- the removal of structures including the intake, outfall and MOLF, but not the breakwaters.

13.5.116 The details of decommissioning are not known at this time and to facilitate the assessment a number of assumptions have been made:

- the Power Station would operate for 60 years;
- both reactors would be decommissioned simultaneously;
- the pumps required to abstract Cooling Water would continue for a period of 100 days after cessation of generation;
- there would be some residual abstraction and discharges during the decommissioning period;
- all plant and equipment would be removed prior to demolition and all structures down to 1m below ground level would be removed;
- civil structures greater than 1m depth would be left *in situ* and backfilled or grout-filled, including the discharge water channel and the discharge water tunnels; and
- the removal of structures would be carried out using similar equipment as for construction.

Embedded mitigation

13.5.117 No embedded mitigation in relation to decommissioning has been identified at this stage.

Good practice mitigation

13.5.118 No good practice mitigation in relation to decommissioning has been identified at this stage.

13.6 Assessment of effects for Wylfa Newydd Development Area

13.6.1 This section presents the findings of the assessment of effects associated with the construction, operation and decommissioning of the Wylfa Newydd Development Area. Assessments of cumulative effects are provided in chapter I4 (intra-project cumulative effects) (Application Reference Number: 6.9.4) and chapter I5 (inter-project cumulative effects) (Application Reference Number: 6.9.5).

Table D13-7 Signposting table to receptors

Receptor	Changes to marine water quality from land drainage, dewatering and sewage discharge	Changes to water quality from dredging (suspended sediment and release of contaminants)	Direct footprint of the works leading to mortality and habitat loss	Physical disturbance of habitats	Introduction of non-native species	Underwater noise	Airborne noise	Changes in visual stimuli	Physical injury of marine mammals from vessel strikes	Impingement of marine organisms	Entrainment of marine organisms	Thermal effects	Thermal effects on spread of non-native species	Thermal effects on dissolved oxygen	Thermal effects on pH pm the ratio of ionised to unionised ammonia	Total Residual Oxidant (TRO)	Chemical changes in discharge water	Airborne noise
All designated sites of nature conservation importance and supporting features	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓		
EU-designated WFD water bodies	✓	✓										✓		✓	✓	✓	✓	
EU-designated bathing water	✓	✓																
Plankton	✓	✓			✓						✓	✓	✓	✓	✓	✓	✓	
Subtidal and intertidal habitats of conservation importance	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	
Intertidal habitats and communities	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	
Subtidal habitats and communities	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	
Invertebrates (of conservation and commercial importance)	✓	✓	✓	✓	✓					✓	✓	✓		✓	✓	✓	✓	
Ichthyoplankton (of conservation and commercial importance)	✓	✓									✓	✓		✓	✓	✓	✓	
Ichthyoplankton	✓	✓									✓	✓		✓	✓	✓	✓	
River lamprey	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
European eel	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
Fish (of conservation and/or commercial importance)	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
General fish and fisheries	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
Marine mammals	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓			
Seabirds (target species)	✓	✓	✓	✓			✓	✓		✓	✓	✓		✓	✓			✓
Seabirds (secondary species)	✓	✓	✓	✓			✓	✓		✓	✓	✓		✓	✓			✓

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Construction

Impact pathway: changes to marine water quality from land drainage, dewatering and sewage discharge

13.6.2 This pathway covers the potential changes in water quality relating to physico-chemical, biological and chemical parameters during construction from all discharges including land drainage, dewatering and sewage. The deposition of sediment from these sources and associated effects is considered in paragraph 13.6.181.

13.6.3 The drainage design for construction, which is a key embedded mitigation measure (see paragraph 13.5.76) has identified seven discharge points into the marine environment in the following locations (from west to east):

- Cemlyn Lagoon via the Nant Cemlyn;
- Cemlyn Bay;
- Porth-y-pistyll via the Afon Cafnan and directly at points PA, PB and PC;
- Porth Wnal;
- Porth y Wylfa; and
- Cemaes Bay via a location east of Porth y Wylfa, and the Nant Cemaes (see appendix D8-8, Application Reference Number: 6.4.33 for the location of these areas).

13.6.4 The construction drainage system will alter the flows in terms of the volume and timing of discharges from fluvial catchments into the marine environment. The discharge quality could also be modified in terms of the chemical and physico-chemical parameters (e.g. water chemistry and suspended solids).

Basis of modelling and a worst case

13.6.5 Horizon's marine hydrodynamic model was used to assess the effects of all sources of suspended solids (drainage, dewatering, and sewage). The modelling methodology, details of the input parameters and results are described in appendix D13-8 (Application Reference Number: 6.4.90). A worst case has been modelled where water discharges incorporate a storm event and includes all land drainage, sewage (from both main construction and Site Campus), and dewatering from the deep excavations, tunnelling and from cofferdams. The model has also taken into consideration the particle size distribution to take account of fine clay particles as these have a lower settling velocity and could therefore travel further.

13.6.6 To assess the effects on specific pollutants and priority substances an assessment was carried out using the Environment Agency's H1 software tool to calculate the chemical composition of discharges from all sources and to compare the predicted quality of the discharges to EQSs. The modelling methodology, details of the input parameters and results are described in appendix D13-14 (marine modelling of the construction discharge)

(Application Reference Number: 6.4.96). The H1 assessment represents a worst case scenario as the screening phase uses raw data from leaching tests and it assumes that the surfaces of mounds are bare soil.

Effects on marine water quality

Changes to freshwater flows

13.6.7 Surface water modelling has predicted that there would be changes to freshwater flows into marine waters over the duration of the construction phase (see appendix D8-7 (surface water and groundwater modelling results) (Application Reference Number: 6.4.32). The changes to flows relating to the construction drainage design are outlined in chapter D8 (Application Reference Number: 6.4.8). The predicted rates of discharge from land drainage are set out in appendix D8-7 (Application Reference Number: 6.4.32) and are all within +/- 10% of the Q_{95}.

13.6.8 There will also be a change in the delivery of freshwater flows into coastal waters (excluding Cemlyn Lagoon) from dewatering. The dewatering component of deep excavations would comprise rainfall and groundwater seepage with a predicted upper estimate of 9,500m^3/day in a 1 in 30 year rainfall event. Discharge would be a phased at three different locations within Porth-y-pistyll during construction (at PA, PB and PC – see appendix D8-8, Application Reference Number: 6.4.33), with PC being the final dewatering discharge location.

13.6.9 During construction sewage would be discharged in the north of Porth-y-pistyll at a rate of approximately 1,598m^3/day. This discharge water would be buoyant and would be quickly dispersed and diluted by the strong tidal currents.

13.6.10 Hydrological modelling (excluding the temporary diversion of flow from the western side of Mound E to the Afon Cafnan) has quantified the change in water availability to the Cemlyn catchment (appendix D8-7, Application Reference Number: 6.4.32). Results show that the mean change in flow duration at the downstream point of the catchment is an increase of 51m^3/day, representing a temporary change equivalent to +/- 10% of the Q_{95}. The mean change in flow duration at the discharge point from Nant Cemlyn into Cemlyn Lagoon is an increase of 20m^3/day representing a small change (chapter D8, Application Reference Number: 6.4.8). The magnitude of this effect would be reduced by operation of the pumping infrastructure during construction to convey runoff from Mound E to discharge point E2 to the Afon Cafnan. Freshwater flows being discharged into Cemlyn Lagoon from Nant Cemlyn would only be 10% different to the existing regime. The lagoon already has wide fluctuations in salinity with low salinity values (as low as 10) in the winter (corresponding with increased precipitation and freshwater inflow), and high values (30) in the summer when the lagoon is managed. The small change in freshwater flow is not likely to result in changes that would be detectable above background variation in salinities.

13.6.11 Although there is a predicted change in the rate of freshwater flows being discharged into the marine environment, the volumes are small in comparison to the size of the WFD coastal water bodies. The coastal waters

are characterised by strong tidal flows which provide rapid dispersion. The changes in freshwater flows would not lead to any change in the physico-chemical or chemical characteristics of marine waters. The change in freshwater input into Cemlyn Lagoon is very small and given that baseline salinities are so variable within the lagoon; this change is not likely to be detectable above the naturally variable baseline conditions.

13.6.12 The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to freshwater flows are predicted to be negligible.

Changes to suspended solids

13.6.13 The discharge of suspended solids from the drainage system at all discharge points would be limited to the concentrations proposed in the construction Environmental Permit (i.e. 40mg/L to 70mg/L during normal rainfall events, and higher levels during storm events). Worst case assessments on the marine environment have been based on modelling suspended solid concentrations predicted during a spring – neap tidal cycle for a 1 in 2 year flow with a 1 in 30 year storm event, with no wind or waves as presented in appendix D13-8 (Application Reference Number: 6.4.90). The modelling of drainage discharges to the marine environment includes all surface water runoff with landscaping mounds un-vegetated, including runoff from the platform and the concrete batching plant. There would be no other discharges relating to the concrete batching plant other than drainage of surface water as any excess process water would be tankered off site.

13.6.14 The discharge of suspended solids from dewatering (from deep excavations and from cofferdams) would be limited to 70mg/L suspended solids under normal rainfall conditions, whilst sewage discharge would be limited to 30mg/L suspended solids.

13.6.15 One other potential source of suspended solids is the channel realignment works on the Caerdegog Isaf, however as these are 2km upstream any sediment would fall out of suspension over this distance before reaching the marine environment. Geomorphological assessments are made in chapter D13-8 (Application Reference Number: 6.4.8).

13.6.16 The dispersion of suspended sediment in The Skerries and Anglesey North WFD water bodies has been modelled and the concentrations at the seabed resulting from fugitive spill from dredging activities are shown in figure D13-22 (Application Reference Number: 6.4.101). During the dredging operation there is an area of approximately 18ha to 25ha, varying with the depth in the water column, which has an increment in concentration of 6.1mg/L (equal to the low end of observed ambient concentrations). Between the dredge events this area reduces as the material is flushed out of the bays.

13.6.17 The suspended solid concentrations from the surface water drainage system, dewatering and sewage discharge with the absence of dredging are shown in figure D13-23 (Application Reference Number: 6.4.101). The modelling undertaken assumes no wind and wave in the receiving environment and concentrations reach levels similar to background (less than 6mg/L) within 4.16ha from the discharge point in Port-y-pistyll.

Following a 1 in 30 year storm event there is an increase in the extent and concentration of suspended solids. The maximum concentration (115mg/l) following the storm event falls within the lower end of the turbid waters classification for WFD of 100 – 300mg/L and is restricted to within 0.05ha of the discharge point in Porth-y-pistyll (see appendix D13-8, Application Reference Number: 6.4.90). The highest concentration occurs at the discharge point of the Afon Cafnan as shown in figure D13-23 (Application Reference Number: 6.4.101).

13.6.18 For the majority of time it is likely that the suspended solids concentrations will be broadly similar to baseline conditions, with peaks occurring during rainfall events in line with the existing regime.

13.6.19 The Skerries and Anglesey North WFD water bodies are characterised by strong tidal flows and the receiving coastal waters have a high capacity for mixing and dilution. Upon entering the coastal water bodies suspended solids would be rapidly dispersed.

13.6.20 There will be no effects of suspended solids in the Nant Cemlyn and therefore Cemlyn lagoon as a result of the operation of the pumping infrastructure to the Afon Cafnan during construction of mound E and while it is un-vegetated.

13.6.21 The magnitude of change in suspended solids in coastal waters is predicted to be negligible and there would be no effect on coastal WFD water bodies from changes to suspended solid concentrations.

Changes in water chemistry

13.6.22 During construction there is potential for changes to water chemistry from discharges into the marine environment including land drainage, dewatering and sewage. As rain falls onto exposed bare earth surfaces this could result in the leaching of substances from soil strip and topsoil mounds, resulting in elevated concentrations of substances in receiving water bodies (both fluvial and marine).

13.6.23 An assessment using the Environment Agency's H1 software tool and associated guidance has been carried out to calculate the chemical composition of the discharges from all sources and compare the predicted quality of the discharges to EQSs (see appendix D13-14, Application Reference Number: 6.4.96). The modelling methodology, details of the input parameters and results are described in appendix D13-14 (Application Reference Number: 6.4.96). The H1 assessment represents a worst case scenario as the screening phase uses raw data from leaching tests and it assumes that the surfaces of mounds are bare soil. This is considered worst case as the mounds will be seeded.

13.6.24 The substances discharged during construction have been determined as part of an H1 screening assessment. The results indicate that three substances (dissolved copper, dissolved zinc and dissolved lead) would be discharged at levels above their respective relevant EQS from land drainage discharge. The relevant EQSs and predicted discharge concentrations are presented in table D13-8.

Table D13-8 Predicted concentrations at point of discharge from land drainage (surface water and groundwater)

Marine discharge point and receiving water	Outfall number and pathway to discharge point	Copper (dissolved) (µg/L)	Lead (dissolved) (µg/L)	Zinc (dissolved) (µg/L)	Nickel (dissolved) (µg/L)
EQS (AA)	-	3.76	1.3	7.9	8.6
EQS (Maximum Allowable Concentration)	-	n/a	14	n/a	34
Surface water discharges					
Cemaes Bay (1S)	A3 via Nant Cemaes	4.54	1.98	Not exceeded	Not exceeded
Cemaes Bay (A2)	A2 direct to sea	9.3	6.45	11.4	Not exceeded
Porth y Wylfa (2S)	A1 and B1 via Tre'r Gof outfall channel	9.26	6.45	11.4	Not exceeded
Porth-y-pistyll (direct to sea) (PA, PB and PC)	PA, PB and PC locations direct to sea	9.3	6.45	11.4	Not exceeded
Porth-y-pistyll (3S)	C1, D1, D2 and E1 via Afon Cafnan	8.57	5.91	11.09	Not exceeded
Groundwater discharge					
Porth-y-pistyll (direct to sea) (PA, PB and PC)	PA, PB and PC locations direct to sea	Not exceeded	Not exceeded	37.8	16.5

13.6.25 For the land drainage discharge the substance requiring the greatest dilution to achieve the EQS is dissolved lead, where the maximum concentration in the predicted discharge is 6.45µg/L compared to the AA EQS of 1.3µg/L, therefore requiring a dilution factor of 10.

13.6.26 For the groundwater dewatering discharge the substance requiring the greatest dilution to achieve the EQS is dissolved zinc, and the dilution factor is calculated to be 4.78.

13.6.27 Modelling was carried out using Delft3D to understand how both the surface water and groundwater discharges would disperse and dilute upon entering the marine environment at the marine discharge points within the Wylfa Newydd Development Area. Model runs emulated one complete spring-neap tidal cycle and as worst case, assumed the temporary cofferdam and causeway were in place. To represent the discharge locations PA, PB and PC within the model one location was modelled at discharge point PC.

13.6.28 The predicted discharge concentrations in surface water and groundwater from table D13-8 were combined, taking into account the flows from each discharge point to derive a maximum concentration once the discharge entered the marine environment. Once the flows from each discharge point were taken into account the maximum concentrations within the marine environment predicted by the Delft3D model differed from the original concentration in the predicted discharge. These results were processed for each substance in turn and the model indicated that for all substances, the mixing zones would occur within close proximity to the discharge points.

13.6.29 For dissolved zinc the predicted maximum concentration within the marine environment occurred in proximity to discharge point 2S, downstream of the Afon Cafnan, and the zinc AA EQS exceedance would be limited to within an overall area of 2ha in the model (figure D13-24, Application Reference Number: 6.4.101).

13.6.30 For dissolved lead the predicted maximum concentration within the marine environment occurred in proximity to discharge point 2S and the dissolved lead AA EQS exceedance would be limited to within an overall area of 31ha in the model (figure D13-25, Application Reference Number: 6.4.101).

13.6.31 For dissolved copper the predicted maximum concentration in the marine environment occurred in proximity to discharge point 2S and the dissolved copper AA EQS exceedance would be limited to within an overall area of 11.95ha in the model (figure D13-26, Application Reference Number: 6.4.101).

13.6.32 For dissolved nickel the predicted maximum concentration within the marine environment would be well below the AA EQS of 8.6µg/L and the dispersion occurs in very close proximity (within a few metres) of the discharge.

13.6.33 Given the predicted small extent of mixing zones, there would be no effect on the water chemistry within The Skerries or Anglesey North water bodies. If the discharge at PC were to be located at PA or PB during different phases of construction (chapter D1, Application Reference Number: 6.4.1, for locations) this could result in a slight increase in the extents of the mixing zones in Porth-y-pistyll. However, the relevant EQS for each substance would still be reached within close proximity to the discharge points and there would be no effect on the water chemistry within The Skerries or Anglesey North water bodies.

13.6.34 There would be no discharge from Mound E to the Nant Cemlyn until all topsoil movement and placement is complete and the mound is vegetated therefore no risk of EQS exceedance. Also there would be no treated water

discharged to Nant Cemlyn so there is no potential for carry over of polyelectrolytes into Nant Cemlyn or Cemlyn Lagoon.

13.6.35 The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to water chemistry are predicted to be negligible.

13.6.36 No process water would be discharged from the concrete batching into the marine environment. Surface water drainage from the concrete batching plant would be monitored to assess pH levels and if necessary it would be treated prior to discharge to neutralise the water. Therefore, no effects on coastal WFD water bodies are predicted relating to discharge from the concrete batching plant.

Changes to nutrient conditions

13.6.37 Sewage with conventional treatment would be discharged in the north of Porth-y-pistyll. The wastewater treatment works maximum flow will be 900m^3/d with a 10% allowance for nitrification. It is assumed that the plant will be operational for 12 hours a day, and that balancing tanks are included, therefore the maximum daily flow over 24 hours would be 11.5L/s. Modelling has been undertaken assuming a worst case flow of 18.5L/s.

13.6.38 Unionised ammonia concentrations depend on the equilibrium between the ammonium ion (NH_{4+}) and unionised ammonia (NH_3). The position of the equilibrium is affected by temperature, pH and salinity. The value for ammoniacal nitrogen would always be greater than the unionised ammonia fraction. The ammoniacal nitrogen concentrations following conventional treatment and after initial dilution are 0.016mg/L (as N) as an AA and represent worst case. This falls well below the long-term (mean) EQS for coastal waters (21µg/L), meets the required standards and therefore would not affect water quality in coastal WFD water bodies. Assuming a worst case temperature (maximum from baseline was 16.7ºC), maximum pH (8.25) and salinity (34) the combined total ammonia concentration (baseline of <0.021mg/L plus the process contribution of 0.016mg/L as worst case) would result in a non-ionised ammonia concentration after initial dilution of <1.57µg/L which is well inside the EQS for coastal waters (21µg/L).

13.6.39 The key nutrients in soils which could contribute to enrichment of freshwaters, and subsequently marine waters, are nitrates and phosphates which are present in the topsoil that would be removed during construction. Dissolved inorganic nitrogen is the key growth-limiting nutrient in marine waters and is therefore a key indicator for which standards are set in coastal waters.

13.6.40 The Wylfa Newydd Development Area is predominantly used as pastureland for grazing (chapter D7, soils and geology, Application Reference Number: 6.4.7) with only a small fraction of the land used for crop agriculture, which is assumed to be on the Best and Most Versatile land (Agricultural Land Classification Grade 2 and 3a), of which 23ha would be removed. Fertilisers or manures would not have been intensively applied to the majority of the land in the last few years as the land is mainly used as pasture for low-density grazing, therefore the levels of nitrates in soils are likely to be low. It is

anticipated that there would be no change to the nutrient concentrations in the runoff reaching the marine environment. The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on water quality in coastal WFD water bodies as a result of increased nutrient levels.

Changes to oxygenation conditions

13.6.41 Depletion of dissolved oxygen can occur in surface waters, due to an increase in biological productivity (e.g. from respiration of plankton), as a result of elevated nutrient concentrations. However nutrient concentrations are not predicted to increase as a result of a discharge and stratification owing to the high dilution in the receiving waters. The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on water quality in coastal WFD water bodies from a change in oxygenation conditions.

Changes to bacteriological water quality

13.6.42 Changes to bacteriological water quality could result from the mobilisation of soil during topsoil clearance and storage. In addition, sewage would be discharged in the north of Porth-y-pistyll. The estimates of worst case 95th percentile contributions of faecal coliforms would be a mean of $3x10^6$CFU/100ml at a continuous discharge of 18.5L/s from conventional treatment process (without disinfection).

13.6.43 The sensitive receptor in terms of bacteriological water quality is the EU-designated bathing water at Cemaes. Cemaes bathing water receives discharge from Nant Cemaes which meets the sea at the west of Cemaes Bay. The Cemaes catchment drains an area of 300ha that is mostly situated to the east and south-east of the Wylfa Newydd Development Area.

13.6.44 Only a small part of the Wylfa Newydd Development Area extends into the Cemaes catchment, approximately 15ha (5% of the total Cemaes catchment). The land within the catchment is currently used for pastureland for grazing (chapter D7, Application Reference Number: 6.4.7). During construction the vegetation would be cleared and topsoil removed from this area. Where practicable, a 15m buffer would be retained around Nant Cemaes and any runoff would be directed towards a sediment settlement pond.

13.6.45 A source of bathing water pollution is water draining from farmland and in particular from manure, livestock or poorly stored slurry that can wash into rivers and result in faecal material (*E. coli* and intestinal enterococci) entering the sea [RD7]. Fertilisers or manures would not have been intensively applied to the majority of the land in the last few years as the land is mainly used as pasture for low-density grazing. Prior to the start of works, grazing would be excluded from this area for four weeks which would allow sufficient time for animal faeces to biodegrade naturally, and reduce the risk of runoff containing *E.coli* and intestinal enterococci.

13.6.46 Modelling has been carried out to predict how sewage effluent will disperse within the marine environment. Modelling showed that the sewage

discharged in the north of Porth-y-pistyll would be quickly dispersed. Under the Bathing Water Directive, to achieve good classification the intestinal enterococci concentration must not exceed 200CFU/100ml in 80% of samples. In a worst case scenario, the modelled concentration of faecal coliforms reaching the bathing water at Cemaes would result in an increase in 29.3CFU/100ml (11.8CFU/100ml from the Breakwater north outfall and 17.5CFU/100ml from the Site Campus outfall). This contribution is likely to occur infrequently as it is based on a modelled continuous discharge of 18.5L/s, when in reality the discharge would be batched and would occur only over a 12- or 15-hour period. Furthermore, the small addition is well below the maximum concentration required to achieve good classification.

Changes to marine water quality from the use of polyelectrolyte coagulants in water treatment

13.6.47 Polyelectrolytes, which are commonly used in water treatment to control and enhance the coagulation and flocculation of suspended particulate matter, would be used infrequently to respond to anticipated and rapid responses to increased suspended solid concentrations resulting from storm events (see paragraph 13.5.11).

13.6.48 Flow proportional dosing is proposed and, therefore, it is very unlikely that there will be any notable concentrations of polyelectrolytes being discharged from the drainage system. Dosing is expected to be in the range of 0.1mg/L to 1mg/L, thus any accidental releases or over-dosing of the polyelectrolyte would be in concentrations less than 1mg/L [RD82].

13.6.49 A review of polyelectrolytes undertaken for the Environment Agency [RD83] found that the impact of polyelectrolytes on the aquatic environment (including brackish waters) is low due to the following:

- the strong and irreversible sorption (or binding) to suspended and dissolved organic matter;
- losses due to hydrolysis and biodegradation; and
- a low potential to bioaccumulate.

13.6.50 Jar testing of various ionic strengths has shown polyelectrolytes to have no effect on the following parameters:

- alkalinity;
- biological oxygen demand;
- chloride;
- nitrate;
- potassium;
- sulphate;
- electrical conductivity; and
- pH.

Slight effects to calcium, magnesium, dissolved organic carbon and total organic carbon were identified but these were minimal [RD82].

13.6.51 Considering this, there is considered to be a negligible effect to marine water quality (and subsequent ecological receptors) from the discharge of polyelectrolytes during the construction phase.

Summary on effects on EU-designated water bodies and EU-designated bathing waters

13.6.52 Considering the embedded and good practice mitigation proposed (see paragraphs 13.5.76, 13.5.87 and 13.5.88), changes to water quality from land drainage, dewatering and sewage discharge is not considered to result in detectable changes in the marine environment. Changes to freshwater flows, suspended solids, nutrient concentrations and oxygenation conditions are not considered to vary outside of baseline conditions and therefore the magnitude of change is predicted to be negligible. Therefore, the effect on EU-designated water bodies through changes in water quality from drainage, dewatering and sewage is predicted to be negligible.

13.6.53 Modelling of the sewage effluent has indicated that it will quickly disperse to background levels within the marine environment. Given the embedded and good practice mitigation proposed (see paragraphs 13.5.76, 13.5.87 and 13.5.88), the magnitude of change is therefore predicted to be negligible as the works would not result in a significant increase in E. coli and intestinal enterococci reaching Cemaes bathing water. Therefore, it is considered that there would be a negligible effect on EU-designated bathing waters through changes in water quality from drainage, dewatering and sewage.

Effects on phytoplankton and zooplankton

13.6.54 In coastal waters phytoplankton and zooplankton could be affected by freshwater flows through changes in salinity, changes to suspended solids and changes to water chemistry; principally nutrients (see paragraphs 13.6.37 to 13.6.40). These effects would be restricted to the immediate areas around the discharge points. Within these very small areas there could be some inhibition of phytoplankton and zooplankton growth. However, this would not have any effect on the abundance and diversity of phytoplankton or zooplankton within the water bodies as a whole. Any effects would be very small scale and are unlikely to be detectable above the ranges of natural variability.

13.6.55 Within Cemlyn Lagoon the changes in salinity, suspended solids concentrations and water chemistry are not likely to be detectable and there would be no change to the conditions that phytoplankton or zooplankton are exposed to.

13.6.56 The magnitude of change in phytoplankton and zooplankton communities is predicted to be negligible and the effect from land drainage, dewatering and sewage discharge on this receptor is considered to be negligible.

Effects on intertidal and subtidal habitats and communities

Changes to freshwater flows

13.6.57 There are a number of discharge points to the marine environment (see table D13-8 and appendix D8-8, Application Reference Number: 6.4.33).

Freshwater would be quickly dispersed by the strong tidal currents in the adjacent coastal waters and as it is more buoyant than seawater, any effects to subtidal habitats would be limited to the immediate vicinity of the outfall. In Cemlyn Lagoon there is predicted to be a negligible change in freshwater flows and the benthic lagoon habitats already experience large fluctuations in salinity and therefore there would be no detectable change.

13.6.58 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on intertidal and subtidal habitats, species and communities (including those of conservation importance) as a result of changes to freshwater flows.

Changes to suspended solids

13.6.59 Intertidal and subtidal habitats and species could be affected by an increase in suspended solids concentrations which may reduce feeding efficiency and subsequently growth rates of filter feeders if suspended solids result in the clogging of feeding structures. The effects relating to smothering are discussed in paragraphs 13.6.216 to 13.6.228.

13.6.60 In coastal water bodies the maximum area that would be affected by suspended solids concentrations above background is approximately 25ha at mid-depth, spread over the discharge points. The extent of a plume that would occur in a 1 in 30 rainfall event is within the immediate vicinity of the discharge locations. As noted in paragraph 13.6.17 for the majority of the time suspended solids concentrations would be within the existing variability of the baseline.

13.6.61 The habitats and species present are already adapted to fluctuating suspended solids from the existing catchments, and there may be effects on some more sensitive species although they are already habituated to fluctuations in suspended solids.

13.6.62 There would be rapid dispersion of suspended solids in coastal waters therefore any impact on benthic species would be localised to the discharge. The magnitude of change is therefore to be negligible and the effects on intertidal and subtidal habitats from an increase in suspended sediment are considered to be negligible.

Changes in water chemistry

13.6.63 The change in water quality due to the discharge of dissolved metal concentrations above the EQS is not predicted to have any detectable effect on intertidal or subtidal habitats or species. The mixing zones are very small, particularly on the seabed as the discharged water would be buoyant and would rise to the surface.

13.6.64 The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on intertidal and subtidal habitats as a result of changes to water chemistry.

Summary of effects on subtidal and intertidal habitats and communities

13.6.65 Based on the assessments provided in the previous sections (paragraphs 13.6.57 to 13.6.64) the changes to freshwater flows, introduction of suspended solids and changes to water chemistry are considered to result in a negligible magnitude of change. It is therefore considered there would be a negligible effect for subtidal and intertidal habitats of conservation importance, 'intertidal habitats and communities', subtidal habitats and communities, and invertebrates (of conservation and commercial importance).

Effects on fish

Changes to freshwater flows

13.6.66 The predicted change in delivery of freshwater flows into coastal waters is unlikely to affect marine fish as firstly the majority of the discharge locations into coastal waters are existing watercourses and secondly marine fish can avoid these locations if required. The areas which would be affected are very small compared to the available habitat for fish and these areas do not represent key refuge or foraging habitat.

13.6.67 An increase in freshwater flows would mean that during high rainfall events there would be a stronger cue for fish seeking to migrate upstream. The changes to flow rates in the watercourses would not affect fish migration from the sea into watercourses and for the majority of time would be similar to the existing baseline.

13.6.68 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on fish as a result of changes to freshwater flows.

Changes to suspended solids

13.6.69 High turbidity or suspended solids levels can diminish visibility, affect feeding behaviours as well as migration, and potentially cause physical harm to fish. Fish that rely on sight and speed to catch their prey are especially affected by high turbidity levels and may choose to avoid these areas. For the fish that remain in the turbid environment, suspended sediment can begin to physically affect the fish, for example by clogging of gills. In general, fish are more likely to undergo sub-lethal stress from suspended sediments rather than lethality because of their ability to move away from or out of an area of higher concentrations [RD89].

13.6.70 Suspended solids levels are above background concentrations over an area of approximately 18ha at the surface. As noted in paragraph 13.6.66 this area is small compared to the available habitat for fish and these areas do not represent key refuge or foraging habitat. It is possible that during heavy rain events when suspended solids concentrations are highest, some migratory fish species that are more sensitive to suspended sediments (e.g. sea trout) may choose to wait until levels have reduced prior to entering freshwater catchments. This may already occur however as suspended solids concentrations in catchments across the Wylfa Newydd Development

Area are very variable. For example, the range of suspended sediment concentration (SSC) recorded in the Afon Cafnan was between 2.5mg/L and 2,580mg/L (mean of 129mg/L) (see appendix D8-1, Application Reference Number: 6.4.26). Other species (e.g. European eel and river lamprey) which are accustomed to living on the river bed in silty environments are not likely to be affected.

13.6.71 The magnitude of change is predicted to be negligible and the effect on fish from an increase in suspended sediment is considered to be negligible.

Changes in water chemistry

13.6.72 Any exceedance of the EQSs would be restricted to the confines of small mixing zones. Any discharge of dissolved metals above the EQSs would be intermittent and driven by rainfall, and would readily dissipate once in the marine environment.

13.6.73 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on fish and ichthyoplankton (including commercial fisheries and spawning grounds) from changes in marine water quality.

Summary of effects on fish

13.6.74 The changes to freshwater flows, introduction of suspended solids and changes to water chemistry are considered to result in a negligible magnitude of change and therefore a negligible effect for all fish receptors (including those of conservation and/or commercial importance).

Effects on marine mammals

13.6.75 There are predicted to be no significant effects on marine water quality from changes relating to freshwater flows, suspended sediment and water chemistry. It is considered very unlikely that an individual marine mammal would enter a mixing zone due to the very small area affected and the shallow depth of water where the discharges are located. Water depth at the discharge points ranges from zero (water running across the foreshore in two locations) to a few metres at high water. There are no effects from changes in marine water quality on their prey sources (fish and invertebrates).

13.6.76 Owing to there being no effect on marine water quality or to prey source the magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on marine mammals (pinnipeds and cetaceans) from changes in marine water quality.

Effects on seabirds

13.6.77 The potential changes to suspended solids are discussed in paragraphs 13.6.13 to 13.6.21. The magnitude of change in suspended solids in coastal waters is predicted to be negligible, and there would be no effect on marine water quality from changes to suspended solids. Therefore, it is predicted that there would be negligible effects on the prey sources (fish and invertebrates) and ultimately on seabirds, from changes to suspended solids.

Effects on designated sites

13.6.78 As described in the preceding sections on seabirds and marine mammals, the magnitude of change on the features of the sites are predicted to be negligible and therefore there are predicted to be negligible effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA, the Bae Cemlyn/Cemlyn Bay SAC/SSSI and the North Anglesey Marine cSAC.

Impact pathway: changes to water quality from dredging (suspended sediment and release of contaminants)

General context

13.6.79 Dredging in Porth-y-pistyll will result in an increase in suspended solids concentrations as soft sediment is removed from the seabed. Mobilisation of sediment may release sediment-bound contaminants into the water column with potential indirect effects on marine organisms. The deposition of sediment from these sources and associated effects is considered in paragraph 13.6.181.

13.6.80 The maximum soft sediment to be dredged is 242,000m^3 (bulked volume) and will take approximately 35 days to complete. This activity would take place at the same time as land drainage, dewatering and sewage discharge. Embedded and good practice mitigation proposed to reduce any effects to water quality from dredging is outlined in paragraphs 13.5.78, 13.5.87 and 13.5.88.

Modelling and partition coefficient analysis

13.6.81 Dredging has been modelled using the marine hydrodynamic model to predict the dispersion of sediment within the water column and to provide estimates of concentrations of suspended sediments around the dredged area. The modelling methodology is described in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.82 In order to determine the potential for contamination of the water column as a result of sediment disturbance, an assessment was undertaken based on the metal concentrations reported from the water and sediment quality monitoring in and around the Wylfa Newydd Development Area. The assessment involved the following steps:

- estimating the maximum incremental suspended solids concentration in the dredge area;
- multiplying the maximum concentration of metal contaminants in sediments with the maximum incremental suspended solids concentration to derive the maximum concentrations of sediment-bound contaminants suspended in the water column;
- dividing the maximum suspended concentrations of sediment-bound contaminants by individual partition coefficients to derive the maximum concentration of each contaminant likely to enter the dissolved phase;

- adding the maximum dissolved concentration for each contaminant to the ambient levels recorded in the area to derive the total dissolved concentration; and
- comparing the estimated maximum concentrations of dissolved contaminants as a result of dredging activities with marine EQSs.

Effects on marine water quality

Changes to suspended solids

13.6.83 The dispersion of suspended sediment in coastal waters within The Skerries coastal WFD water body has been modelled and the concentrations at the seabed are shown in figure D13-22 (Application Reference Number: 6.4.101). The extent of the suspended sediment plume at the surface is localised to dredging operations. Suspended solids concentrations within the plume are predicted to be above background levels (approximately 6.1mg/L) over 24.5ha (mid-depth).

13.6.84 The marine environment is characterised by strong tidal flows and the receiving marine waters have a high capacity for mixing and dilution. Upon entering the marine environment suspended solids would be rapidly dispersed.

13.6.85 Dredging of soft-sediments would last for approximately 35 days and given the temporary nature of the effect, and the limited extent of the effect, the magnitude of change in suspended solids in coastal waters is predicted to be negligible and there would be no effect on marine water quality from changes to suspended solids.

Changes in water chemistry

13.6.86 Metal concentrations from water and sediment quality baseline monitoring in the Wylfa Newydd Development Area are described in paragraph 13.3.17. Overall the quality of sediment is not considered to be contaminated.

13.6.87 As a worst case scenario for the modelling, the maximum incremental SSC in the dredge area was assumed to be 1,000mg/L. The maximum concentrations of metal contaminants in sediments from the Wylfa Newydd Development Area (collected in 2016) are shown in table D13-9.

13.6.88 Due to the variability in environmental conditions, a wide range of partition coefficients are reported in the literature. The partition coefficient values used here for metals have been taken from documents used to derive the EQS for priority (hazardous) substances and specific pollutants (arsenic and chromium, [RD90]; [RD91]), as well as Crommentuijn *et al*., [RD92]. It should be noted that environmental conditions (such as salinity) can influence the desorption rates of contaminants from suspended sediments into the water column and thus use of such partition coefficients is indicative only.

13.6.89 As a conservative approach the lowest sediment-water partition coefficient value reported from the literature was used for each contaminant, i.e. the value resulting in the highest proportion of contaminant released into the water column.

13.6.90 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 D13-9.

Table D13-9 Estimated maximum concentrations of metals entering the water column and the dissolved phase as a result of sediment dredging activities at 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] [RD90]; [RD91]

[b] [RD92] – monitoring

[c] [RD92] – estimated

13.6.91 The maximum dissolved concentration for each contaminant resulting from dredging is several orders of magnitude below the available EQS, suggesting that the potential for dredging activity within the Wylfa Newydd Development Area to affect water quality from contaminants in sediments is minimal. Both the AA-EQS and MAC-EQS are relevant as the proposed dredging and disposal activities will occur over an extended period (more than one year).

13.6.92 While the potential change in the dissolved concentration of contaminants due to dredging activities within the Wylfa Newydd Development Area suggests very small increases may occur in isolation, it is necessary to consider the resultant concentration in addition to ambient levels. Table D13-10 presents maximum dissolved concentrations (for individual samples and AA) for metals measured in water samples collected from the Wylfa Newydd Development Area between May 2010 and November 2014, along with the maximum dissolved concentration attributed to dredging activity.

13.6.93 The maximum ambient water quality measurements collected between 2010 and 2014 indicate a few samples for chromium and mercury which exceeded the MAC-EQS (i.e. individual samples). Therefore, as sediment resuspended during dredging activities contains small quantities of contaminants, and assuming a proportion of this material should transfer into the dissolved phase, then it is possible to result in a further small temporary

uplift in concentration if the dredging activity occurred at the same time as these elevated ambient concentrations. However, this short-term (localised) increase in concentration is less than 0.1% compared to maximum ambient levels for all metals, with the exception of nickel (1.2%). By using the maximum annual ambient metal concentration, it can be seen that the AA-EQS thresholds are not exceeded for all metals (table D13-10).

13.6.94 Similar short-term, small-scale increases in concentration could be expected for other contaminants found within sediments at the Wylfa Newydd Development Area, including organotins, PCBs and PAHs, with any small uplift in concentration returning to ambient levels very quickly.

13.6.95 While the SSC will be extremely high immediately after release from the dredger hopper, sediment will naturally disperse and subsequently deposit on the seabed. It is anticipated that incremental concentrations calculated for dredging activity as described above provide a worst case scenario (based on 1,000mg/L). Therefore, it is unlikely that significant increases in metal concentrations will occur at the disposal site which would lead to EQS values being exceeded.

Table D13-10 Combined dredging and ambient metal concentrations

Contaminant	Maximum dissolved concentration for individual samples (maximum AA)				EQS[a]
	Ambient (µg/L)	Dredging (µg/L)	Ambient plus dredging (µg/L)	Percentage increase Ambient (%)	
Arsenic	1.9 (1.530)	1.8×10^{-3}	1.90 (1.532)	0.09 (0.12)	25 (AA)
Cadmium	0.128 (0.045)	2.1×10^{-5}	0.128 (0.045)	0.02 (0.05)	0.2 (AA)
Chromium	43.6 (0.865)	2.8×10^{-4}	43.6 (0.865)	- 0.001 - (0.03)	0.6 (AA); 32 (MAC)
Copper	20.9 (0.862)	4.5×10^{-3}	20.9 (0.867)	0.02 (0.52)	3.76 (AA)*
Lead	1.57 (0.350)	1.1×10^{-3}	1.571 (0.351)	0.07 (0.32)	1.3 (AA), 14 (MAC)
Mercury	0.086 (0.011)	4.0×10^{-6}	0.086 (0.011)	0.005 (0.04)	0.07 (MAC)
Nickel	1.29 (0.446)	1.5×10^{-2}	1.305 (0.461)	1.17 (3.37)	8.6 (AA), 34 (MAC)
Zinc	26.3 (7.129)	2.3×10^{-3}	26.3 (7.131)	0.01 (0.03)	7.9 (AA)**

[a] As described under the WFD (Standards and Classification) Directions (England and Wales) 2015. EQS values refer to dissolved concentrations. *Copper EQS based on dissolved organic carbon

concentration of <1mg/L. **Zinc EQS includes ambient background concentration for saltwater (1.1µg/L).

13.6.96 It is considered that any potential increase in dissolved concentrations of metals in the water column as a result of dredging activities will be minimal. The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to water chemistry are predicted to be negligible.

Effects on phytoplankton and zooplankton

13.6.97 The effects of suspended solids are temporary and are restricted to the vicinity of the dredging. The magnitude of change in phytoplankton and zooplankton is therefore predicted to be negligible and the effect from changes to water quality from dredging are considered to be negligible.

Effects on intertidal and subtidal habitats

13.6.98 Intertidal and subtidal habitats could potentially be affected by an increase in suspended solids concentrations which reduce light levels and may inhibit feeding for some species (as discussed in paragraphs 13.6.59 to 13.6.62). However, the effects on suspended solids are temporary and are restricted to the vicinity of the dredging. Therefore, the magnitude of change in intertidal and subtidal habitats and communities (including those of conservation importance and invertebrates of conservation and/or commercial importance) is predicted to be negligible and the effect from changes to water quality is considered to be negligible.

Effects on fish

13.6.99 The potential effects on fish are described in paragraph 13.6.69. The effects from suspended solids from dredging would be temporary (approximately 35 days) and the area affected is small in relation to the available refuge and foraging habitat. The magnitude of change is predicted to be negligible and the effect on all fish receptors from an increase in suspended sediment is considered to be negligible.

Effects on marine mammals

13.6.100 As stated in paragraph 13.6.75, it is unlikely that marine mammals would enter the area where suspended solids concentrations are above background and there is no predicted change to prey sources. The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on marine mammals from changes in marine water quality.

Effects on seabirds

13.6.101 The potential changes to suspended solids are discussed in paragraphs 13.6.13 to 13.6.21. The magnitude of change in suspended solids in coastal waters is predicted to be negligible, and there would be no effect on marine water quality from changes to suspended solids. Therefore, it is predicted

that there would be negligible effects on the prey sources (fish and invertebrates) and ultimately on seabirds, from changes to suspended solids.

13.6.102 The potential changes in marine water chemistry are discussed in paragraphs 13.6.22 to 13.6.31. This would not affect seabirds directly, and negligible effects are predicted from changes in marine water chemistry on their prey sources (fish and invertebrates). Therefore, it is predicted that there would be negligible effects on seabirds from changes in water chemistry.

Effects on designated sites

13.6.103 As described in the preceding sections on seabirds and marine mammals, the magnitude of change is predicted to be negligible and the effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA and the North Anglesey Marine cSAC, are considered to be negligible.

Impact pathway: changes to hydrodynamics from construction of Marine Works

General context

13.6.104 The temporary causeway to the western breakwater would restrict water circulation within the area inside of the breakwaters by blocking off water moving into this area from the west. The temporary causeway would be constructed first and would remain in place for a total of approximately five years. Following completion of the causeway the construction of the breakwaters and temporary cofferdam would commence. The temporary cofferdam would be in place for approximately two years during which the dewatering and excavation of the inner harbour will take place. The area inside the breakwaters would be approximately 30ha with 18ha comprising the inner harbour. For the two years during which the temporary cofferdam would be in place, seawater would only be present in the outer harbour (approximately 12ha). After excavation of the inner harbour the temporary cofferdam would be removed; this will allow seawater to flood back into the dewatered area.

Effects on marine water quality

Changes to water circulation

13.6.105 It is unlikely that water circulation within the outer harbour would be significantly affected while the temporary causeway is present, as water exchange through tidal movements between the eastern and western breakwater would still take place.

13.6.106 Whilst the tidal and wave driven flows around the southern tip of the western breakwater will be absent during construction due to the temporary causeway there will still be an exchange of water from within the harbour and the sea because of tidal forcing. On the ebb tide as levels fall water will leave the harbour whilst on the flood the rising water level will be associated with a flow south into the harbour. The tidal range at the Wylfa site varies between 2m and over 6m and hence a large volume of water will enter on the flood

and exit on the ebb with more exchange on a spring compared to a neap tide. The flow field outside the harbour set up by the east to west tidal flow north of Wylfa Head should ensure mixing of the water flushed out of the harbour with the wider sea. Within the harbour itself there can be expected to be vertical and transverse mixing of water due to the tidal forcing and from wind and wave action (the latter depending on the wave direction offshore).

13.6.107 The inner harbour will be dry for two years and therefore not subject to changes in hydrodynamics during this time. For the remaining three years, water circulation within the inner harbour would be restricted. It is likely that water exchange through tidal movements and mixing of the water column would be reduced compared to the outer harbour. Ongoing construction activities, however, such as dredging and piling would continually cause disturbance to the water column.

13.6.108 After the temporary causeway is removed water circulation in the area inside the breakwaters would be restored.

13.6.109 Construction of the temporary causeway would result in changes to water circulation particularly within the inner harbour for approximately three years. Given the limited extent and the temporary nature of the effect, the magnitude of change in water circulation of coastal waters is considered to be negligible and there would be no effect on marine water quality from changes to water circulation within the inner harbour.

Changes to temperature, underwater light regime and nutrient conditions

13.6.110 Reduced water circulation within the inner harbour could result in increased stratification of the water column. Particularly during the summer months increased solar radiation would increase the temperature of surface waters, promoting further thermal stratification.

13.6.111 Increased stratification of the water column within the inner harbour is likely to increase light availability in the surface waters. Ongoing construction activities, however, such as dredging and piling would continually cause disturbance to the water column with suspended material countering some of the effects of increased stratification on light availability.

13.6.112 Nutrient concentrations in the Wylfa Newydd Development Area are low (see paragraph 13.3.19) and nutrient conditions in Porth-y-pistyll are not predicted to change during construction (see paragraphs 13.6.9 to 13.6.41). Reduced water circulation within the inner harbour is therefore not expected to have an effect on nutrient conditions.

13.6.113 Reduced water circulation within the inner harbour could result in increased stratification and increased temperature and light availability in the surface waters; no effect is expected on nutrient conditions. Given the limited extent and the temporary nature of the effect, the magnitude of change in temperature, underwater light regime and nutrient conditions in coastal waters is considered to be negligible and there would be no effect on marine water quality from changes in these variables within the inner harbour.

Effects on phytoplankton

13.6.114 The increased temperature and light availability within the inner harbour as a result of reduced water circulation could promote phytoplankton growth and particularly that of harmful and/or toxic algae. A number of harmful/toxic algae are present within the Wylfa Newydd Development Area but their densities are considered to be very low compared to the number at which an individual taxon is considered to reach bloom densities (see paragraph 13.3.44). Overall phytoplankton densities are also considered to be low in the area (see paragraphs 13.3.41 and 13.3.42).

13.6.115 Increased light and nutrient availability as well as increased temperature are all considered to promote phytoplankton growth. While anthropogenic nutrient enrichment has been proposed as a principal causative factor of harmful algal blooms it is often the hydrodynamic processes that determine whether the blooms occur [RD93]. Porth-y-pistyll and the rest of the Wylfa Newydd Development Area are not subject to anthropogenic nutrient enrichment, though the temporary reduced water circulation in the inner harbour could promote algal growth including harmful algal blooms. The naturally low nutrient concentrations in the area, however, are not expected to change during construction and are unlikely to support extensive algal blooms in the inner harbour, if any.

13.6.116 Reduced water circulation could promote phytoplankton growth including harmful algal blooms within the inner harbour; however, extensive blooms, if any, are unlikely to be supported considering the low nutrient concentrations in the area. Given the limited extent and the temporary nature of the effect, the magnitude of change in phytoplankton densities including harmful algal blooms in coastal waters is considered to be negligible and there would be no effect on phytoplankton from changes to hydrodynamics within the inner harbour.

Impact pathway: direct footprint of the Marine Works leading to mortality of species and loss of habitats and the resource provided by these habitats

General context

13.6.117 Direct loss of intertidal and subtidal habitats and species would occur from construction activities such as excavation, dredging, dewatering and land reclamation; and from the construction of temporary and permanent marine structures as described in section 13.5. Embedded mitigation measures proposed to reduce direct loss of habitats and species are outlined in paragraphs 13.5.82, 13.5.83 and 13.5.113.

13.6.118 The MOLF would be constructed within the intertidal area south-west of the Existing Power Station (see chapter D1, Application Reference Number: 6.4.1). This structure (including any reclaimed land below Mean High Water Springs) would result in a loss of approximately 5ha. The Cooling Water intake would be constructed on the shore in Porth-y-pistyll bay, adjacent to the Ro-Ro MOLF. The main part of this structure would be positioned on land above Mean High Water Springs, but would extend vertically down

through the tidal range, resulting in a loss of approximately 5ha of intertidal habitats. Two permanent breakwaters would also be built, and the combined footprint of these permanent structures would result in the loss of approximately 4ha of intertidal and subtidal habitats. Temporary marine structures, including a causeway and temporary cofferdam, would result in the loss of intertidal and subtidal habitats (chapter D1, Application Reference Number: 6.4.1).

13.6.119 Excavation and dredging activities would be required to form the inlet navigation channel along with the Cooling Water channel and intake facility. This would result in the direct loss of approximately 17ha of intertidal and subtidal habitats and species. Total habitat loss due to the Marine Works in Porth-y-pistyll is estimated to be 30.5ha (figure D13-27, Application Reference Number: 6.4.101).

13.6.120 The Cooling Water outfall represents an additional permanent structure that would result in the loss of both intertidal and subtidal habitats. A temporary cofferdam would be required in front of the Cooling Water outfall to enable construction in dry conditions, resulting in further losses within the subtidal zone. The footprint of the Marine Works in the vicinity of the Cooling Water outfall represents an approximate area of 0.6ha.

13.6.121 Once constructed, the area inside the temporary cofferdams would be dewatered to permit dry marine excavation (see paragraph 13.5.10). Any fish drawn into the dewatering pumps would be vulnerable to direct mortality. The effect of dewatering on other marine organisms is considered to be negligible and has not been considered further in the assessment.

13.6.122 Following cessation of Cooling Water discharge at the Existing Power Station and prior to the construction phase commencing, baseline conditions within the vicinity of the Cooling Water outfall are likely to have changed. As it is not possible to reliably predict what these changes might be, a precautionary approach has been taken which assumes that habitats and communities at this location would have fully recovered and would therefore be of a value consistent with baseline conditions found elsewhere along the north coast of Anglesey.

13.6.123 The building of permanent and temporary structures will lead to the direct loss of habitats and mortality of associated communities within the construction footprint. Fragmentation of habitats and isolation of species and communities within the remaining areas would also occur. Core and beneficial ecosystem processes provided by intertidal and subtidal habitats, including nutrient cycling, primary production and regulation of water quality, would be lost within the footprint, with possible disruption to the functioning of adjacent habitats. Species which rely on these habitats for food or refuge would also be affected, leading to potential indirect effects on survival, growth, reproduction or displacement of individuals.

Effects on habitats and communities from direct loss

13.6.124 A total of 30.5ha of habitat would be lost under the footprint of the Marine Works in Porth-y-pistyll (figure D13-27, Application Reference Number: 6.4.101). Of this, 22ha has been classified into biotopes according to the

JNCC habitat classification system [RD12]. Effects to these specific habitats and communities have been considered in further detail below.

13.6.125 The remaining 8ha which falls under the footprint of the Marine Works in Porth-y-pistyll and a further 0.6ha under the construction footprint of the Cooling Water outfall (including temporary cofferdam) has not been assigned a biotope. Data from drop-down camera, dive and grabbing surveys (see appendix D13-3, Application Reference Number: 6.4.85) suggests that the remaining area under the western breakwater and to the north represents sublittoral sediments (see paragraph 13.3.68), whilst the area to the east of the eastern breakwater and around the Cooling Water outfall is comprised of predominately high and moderate energy littoral rock habitats (LR.HLR and LR.MLR).

13.6.126 For the purpose of this assessment, areas which have not been assigned a formal biotope but which are considered to represent littoral or sublittoral rock, have been considered under the receptor 'subtidal and intertidal habitats of conservation importance', as examples of Annex I 'rocky reef' (see figure D13-27, Application Reference Number: 6.4.101). Littoral and sublittoral sediments, are not considered to be of conservation importance (see paragraph 13.6.142 for further justification) and have been considered under the receptors intertidal habitats and communities or subtidal habitats and communities, respectively.

Intertidal habitats and communities

13.6.127 A total 7.6ha of intertidal habitats falls under the footprint of the Marine Works, of this 6.9ha have been assigned a biotope and would be lost in Porth-y-pistyll. These primarily represent littoral rock (LR) (5.9ha) with some littoral sediment (LS) (0.9ha) habitats (figure D13-27, Application Reference Number: 6.4.101). Approximately 55% of intertidal habitats within the footprint fall into two biotope complexes; 'Fucoids on sheltered marine shores' (LR.LLR.F) and 'Barnacles and fucoids on moderately exposed shores' (LR.MLR.BF) (table D13-11).

13.6.128 Habitats within the biotope complexes 'Lichens or small green algae on supralittoral and littoral fringe rock' (LR.FLR.Lic) and 'Mussel and/or barnacle communities' (LR.HLR.MusB) comprise a further 29% of the intertidal area that would be lost in Porth-y-pistyll whilst littoral sediment (LS) biotope complexes contribute 14%. The remaining area is characterised by 'ephemeral green or red seaweed communities' (LR.FLR.Eph) and 'robust fucoid and/or red seaweed communities' (LR.HLR.FR), contributing 2% and 1%, respectively.

Table D13-11 The approximate area (ha) of intertidal biotope complexes present within the footprint of the Marine Works (excludes the Cooling Water outfall construction footprint)

Biotope complex code	Biotope description	Approximate area of habitat in the footprint of the works (ha)
LR.LLR.F	Fucoids on sheltered marine shores	1.95
LR.MLR.BF	Barnacles and fucoids on moderately exposed shores	1.81
LR.FLR.Lic	Lichens or small green algae on supralittoral and littoral fringe rock	1.00
LR.HLR.MusB	Mussel and/or barnacle communities	0.97
LS.LCS.Sh	Shingle (pebble) and gravel shores	0.54
LS.LSa.FiSa	Polychaete/amphipod-dominated fine sand shores	0.18
LR.FLR.Eph	Ephemeral green or red seaweed communities (freshwater or sand-influenced)	0.13
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores	0.12
LS.LSa.St	Strandline	0.08
LR.HLR.FR	Robust fucoid and/or red seaweed communities	0.08
LS.LSa.MuSa	Polychaete/bivalve-dominated muddy sand shores	0.01

13.6.129 Intertidal habitats present within the construction footprint are typically characterised by dense fucoid seaweed species and invertebrates including molluscs and crustaceans. No species considered to be of conservation importance were recorded within the footprint of the Marine Works during intertidal benthic surveys.

13.6.130 Construction within the intertidal zone in Porth-y-pistyll would result in the loss of approximately 20 rock pools greater than 1m^2 that are characterised by a number of biotopes. 'Seaweed and sediment-floored rock pools' (LR.FLR.Rkp.SwSed) are the most common, representing 11 of the total number of rock pools present within the footprint of the Marine Works (see appendix D13-3, Application Reference Number: 6.4.85).

13.6.131 Several intertidal biotopes within the footprint of the Marine Works in Porth-y-pistyll are considered to be examples of rocky reef habitat (see paragraph 13.3.60) and in accordance with Section 7 of The Environment (Wales) Act 2016, although they are not qualifying features of any nearby designated site (see appendix D13-3, Application Reference Number: 6.4.85). Of these, the localised extents of four fall entirely within the footprint of the Marine Works in Porth-y-pistyll. These include:

- *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock (LR.FLR.Eph.EntPor);
- *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Mas);
- *Fucus serratus* on full salinity sheltered lower eulittoral rock (LR.LLR.F.Fserr.FS); and
- *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser).

13.6.132 Of the total 7.6ha of intertidal habitats that falls under the footprint of the marine works, approximately 6.7ha are considered to be rocky reef Annex I habitat. The remaining intertidal habitats (0.9ha) represent littoral sediments and are not considered to be of conservation importance (figure D13-27, Application Reference Number: 6.4.101).

13.6.133 Although the intertidal habitat within the footprint of the Marine Works is common round the north coast of Anglesey, the permanent loss of 7.6ha would result in fragmentation of intertidal habitat around the coastline. Recovery would not be possible in the long-term as conditions within Porth-y-pistyll and around the Cooling Water outfall will be permanently altered. It is recognised however, that the structures would introduce permanent hard surfaces providing new colonisation surface for species dependent on hard substrate [RD81].

Subtidal habitats and communities

13.6.134 A total of 23.5ha of subtidal habitats falls under the footprint of the Marine Works, of this 15.6ha have been assigned a biotope and would be lost in Porth-y-pistyll. These primarily represent infralittoral rock (IR) (11.1ha) with some sublittoral sediment (SS) (4.1ha) and circalittoral rock (CR) (0.4ha) habitats (figure D13-27, Application Reference Number: 6.4.101).

13.6.135 Approximately 60% of this area is characterised by habitats within the biotope complex Kelp and red seaweeds (moderate energy infralittoral rock) (IR.MIR.KR). Circalittoral muddy sand (SS.SSa.CMuSa), which includes the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNUC), contributes a further 18% (table D13-12). Of the remaining area, 14% represents the biotope complexes Silted kelp communities (sheltered infralittoral rock) (IR.LIR.K), Kelp with cushion fauna and/or foliose red seaweeds (IR.HIR.KFaR) and Mixed faunal turf communities (CR.HCR.XFa), whilst 9% represents sublittoral sediments (SS.SCS and SS.SSa).

Table D13-12 The approximate area (ha) of subtidal biotope complexes present within the footprint of the Marine Works (excludes the Cooling Water outfall construction footprint)

Biotope complex code	Biotope description	Approximate area of habitat in the footprint of the works (ha)
IR.MIR.KR	Kelp and red seaweeds (moderate energy infralittoral rock)	9.33
SS.SSa.CMuSa	Circalittoral muddy sand	2.76
SS.SSa.IMuSa	Infralittoral muddy sand	1.34
IR.LIR.K	Silted kelp communities (sheltered infralittoral rock)	1.06
IR.HIR.KFaR	Kelp with cushion fauna and/or foliose red seaweeds	0.70
CR.HCR.XFa	Mixed faunal turf communities	0.35
SS.SCS.ICS	Infralittoral coarse sediment	0.02
SS.SMu.ISaMu	Infralittoral sandy mud	0.02

13.6.136 The biotope complex IR.MIR.KR, one of the largest biotopes present within the footprint, is characterised by a variety of red, brown and green algal species which support epilithic seaweeds, encrusting sponges and epifaunal colonial organisms such as the bryozoan *Alcyonidium diaphanum* and *Flustra foliacea*, the cnidarian *Alcyonium digitatum*, the hydroid *Tubularia indivisa*, and the polychaete *S.spinulosa*.

13.6.137 No significant biogenic reef structures, classified as low to high reefiness according to Gubbay [RD14], have been recorded within the Wylfa Newydd Development Area during baseline surveys (see appendix D13-2, Application Reference Number: 6.4.84). Within the footprint of the Marine Works, sparse individuals and thin/sparse crusts of tube structures have been recorded although Sabellaridae does not represent a classifying feature of any of the biotopes present.

13.6.138 The biotope complex Bryozoan turf and erect sponges on tideswept circalittoral rock (CR.HCR.XFa.ByErSp) is present in Porth-y-pistyll. This is recognised as part of the broader Section 7 habitat 'Fragile Sponge and Anthozoan Communities on Rocky Habitats' of The Environment (Wales) Act 2016 as well as being an Annex I habitat under rocky reefs. This biotope covers an approximate area of 0.6ha, with 0.4ha falling within the footprint of the Marine Works. The extent of this habitat in Porth-y-pistyll is considered to represent a relatively small area compared to its wider distribution along the north Anglesey coastline, with better examples in terms of species richness observed to the east of Porth-y-pistyll (see appendix D13-3, Application Reference Number: 6.4.85).

13.6.139 Several subtidal biotopes within the footprint of the Marine Works are considered to be examples of rocky reef habitat listed on Annex I of the Habitats Directive and in accordance with Section 7 of The Environment (Wales) Act 2016, although they are not qualifying features of any nearby designated site (see appendix D13-3, Application Reference Number: 6.4.85). The localised extent of two of these falls entirely within the footprint of the Marine Works in Porth-y-pistyll and will therefore be lost from the immediate area. These include:

- *Laminaria saccharina* and *L.digitata* on sheltered sublittoral fringe rock (IR.LIR.K.Lsac.Ldig); and
- *Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock (IR.MIR.KR.Lhyp).

13.6.140 Of the total 23.5ha of subtidal habitats that falls under the footprint of the Marine Works, approximately 13.3ha are considered to be rocky reef' Annex I habitat. Recovery of subtidal rocky reef habitat within the footprint would not be possible in the long-term as conditions within Porth-y-pistyll and around the Cooling Water outfall will be permanently altered.

13.6.141 The remaining subtidal area under the footprint of the Marine Works in Porth-y-pistyll (10.2ha) represents predominately muddy sand sediments with smaller areas of coarse sediments and sandy mud. These habitats support a number of burrowing infaunal species (e.g. *Abra alba*, *Nicula nitidosa* and *Arenicola marina*) which are considered bioturbators, influencing the cycling of nutrients and oxygen as well as the structure of surface sediments.

13.6.142 Muddy sand sediments is recognised under the Annex I habitat 'Sandbanks which are slightly covered by seawater all the time', and a number of sublittoral sediment biotopes identified are also recognised as part of the broader Section 7 habitat 'Subtidal sands and gravels of The Environment (Wales) Act 2016. Although designated, these habitats are not qualifying features of any nearby designated sites and are considered to represent very large habitat resources at the local and regional scale. In light of this, these biotopes are not considered to be of conservation importance. The loss of sublittoral sediment habitat is small, and although permanent, it is not considered to affect the integrity of this receptor, which is very common around the north coast of Anglesey and the UK.

Colonisation of new substrate

13.6.143 Direct habitat and species loss within the footprint of the Marine Works has been assessed as a permanent effect, however following construction, new substrate and hard structures within Porth-y-pistyll will be available for colonisation within the intertidal and subtidal zone (see paragraph 13.5.82).

13.6.144 The early stages of recolonisation will occur quickly and in the intertidal area this is likely to involve green algae and *Porphyra* spp., followed by barnacles, and potentially mussels, depending on the nature of the surrounding environment [RD94]. Once habitats have become established, invertebrate fauna would be expected to move into the area rapidly from adjacent habitats.

13.6.145 Most subtidal, stable rock substrata within the photic zone are likely to be colonised by kelp. Rapid recolonisation of *L.hyperborea* has been demonstrated by Kitching [RD95] and Kain [RD96]. The latter study found that *L.hyperborea* forest regenerated within two years of the initial disturbance in shallow sublittoral waters. The establishment of new kelp fronds can be considered an important initial driver of community recovery and recolonisation which is only likely to facilitate the establishment of many other associated species.

13.6.146 For hard surfaces, recolonisation rates and the succession of species depends greatly on the physical conditions of new substrates, influenced by position within the tidal frame, gradient, exposure and surface and structural heterogeneity. The breakwater structures would represent a range of exposure conditions which would provide conditions suited to a range of macroalgae, invertebrate and fish species. However, it is not possible to accurately predict the new habitats that would colonise new structures. The presence of the structures alone (i.e. without incorporation of specific enhancement measures), does not reduce the magnitude of change relating to the loss of intertidal and subtidal habitats and species.

Summary of effects on habitats and communities from direct loss

13.6.147 Off the 7.6ha and 23.5ha of intertidal habitats and communities and subtidal habitats and communities that would be lost under the footprint of the Marine Works, 6.7ha and 13.3ha are considered to be of conservation importance, being examples of Annex I rocky reef.

13.6.148 Although the scale of rocky reef habitat loss is small in comparison to the availability of this habitat on a regional scale, the level of degradation and fragmentation means that the magnitude of change is considered to be medium. Whilst hard substrate on the breakwater structures could function as an artificial rocky reef, it is considered that there would be a medium magnitude of change and a moderate adverse effect from the direct loss of subtidal and intertidal habitats of conservation importance under the footprint of the Marine Works.

13.6.149 The remaining intertidal habitats (0.9ha) represent littoral sediments which fall under the receptor intertidal habitats and communities. Considering the extent of these habitats on a local and regional scale, the magnitude of change is predicted to be small and there would be a negligible effect from the direct loss of intertidal habitats and communities under the footprint of the Marine Works.

13.6.150 The remaining subtidal habitats (10.2ha) represent sublittoral sediments which fall under the receptor, ‘subtidal habitat and communities’. Considering the extent of these habitats on a local and regional scale, the magnitude of change is predicted to be small and there would be a negligible effect from the direct loss of subtidal habitats and communities under the footprint of the Marine Works.

Effects on invertebrates of conservation and commercial importance

13.6.151 The permanent loss of subtidal and intertidal habitat would have a direct effect on invertebrates of conservation and commercial importance from mortality under the footprint of the Marine Works.

13.6.152 Ocean quahog and spiny lobster are the only two invertebrate species of conservation importance that have been identified within the vicinity of the Wylfa Newydd Development Area. Both are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

13.6.153 A single individual ocean quahog was recorded in Porth-y-pistyll and would fall under the footprint of the western breakwater (see appendix D13-2, Application Reference Number: 6.4.84). This species is found around all British and Irish coasts as well as offshore, with a global distribution extending from Iceland to the Bay of Biscay [RD97]. This species is commonly found on firm sublittoral sediments, buried or partially buried in sand and muddy sand. In the North Sea, reported average densities of the ocean quahog range from 0.7 individuals/m^2 in southern areas to 2.1 individuals/m^2 in central regions [RD98]. Juveniles are found in the northern North Sea in densities of up to 286 individuals/m^2 [RD98]. The densest population around Anglesey was found to the south in Caernarfon Bay with 66 individuals/km dredged. A small population (1.6 individuals/km dredged) has been observed in Red Wharf Bay inhabiting a patch of muddy sand surrounded by coarser sands. Small isolated populations ranging from 1.0 to 4.2 individuals/km dredged have also been recorded in Cardigan Bay [RD99].

13.6.154 Records of ocean quahog around the north Wales coast and the eastern Irish Sea are sparse, an indication that it is rare in these areas [RD99]. This is further evidenced by the absence of this species in subtidal benthic surveys carried out around the north Anglesey coastline (see appendix D13-2, Application Reference Number: 6.4.84). It is therefore considered that loss of individuals from the footprint of the works would not affect the integrity of the wider population.

13.6.155 A single record of the European spiny lobster was recorded at Llanbadrig Head, outside the Wylfa Newydd Development Area. Although this species is mobile, therefore the potential for direct mortality is low.

13.6.156 Within the Wylfa Newydd Development Area there is limited commercial potting activity which suggests a low abundance of commercial invertebrate species including scallop, whelk, lobster and edible crab. Potting for prawns is believed to occur in the area although the intensity of this commercial fishery is unknown [RD25]. These commercial invertebrate species are mobile and therefore the potential for direct mortality is low.

13.6.157 For invertebrate species of conservation and/or commercial importance, notably the ocean quahog, the magnitude of change is predicted to be small as the potential for and extent of the loss is small. Therefore, it is considered that there would be a minor adverse effect from the direct loss of either individuals or habitat under the footprint of the Marine Works.

Effects on marine fish from the direct loss of individuals, habitats and the resource provided by these habitats

13.6.158 Fish would be vulnerable to direct mortality from initial dewatering activities. As fish are highly mobile, direct mortality is unlikely to occur within the remainder of the marine construction footprint; the magnitude of change is considered to be negligible and the effect in this area, negligible.

13.6.159 The permanent loss of subtidal and intertidal habitat would have an indirect effect on marine fish receptors due to the loss of habitat, feeding resource and refuge, resulting in displacement. The effects of underwater noise have been assessed from paragraph 13.6.263.

13.6.160 Fish assemblages in Porth-y-pistyll are reflective of a typical inshore community. Being a rocky bay, lower abundances of sandeel (Ammodytidae) and plaice, which live in association with softer sediments, are generally observed in Porth-y-pistyll, compared to other sites along the coastline which are characterised by sandy substrates. Conversely, species such as sand smelt, 15-spined stickleback (*Spinachia spinachia*), long-spined sea scorpion (*Taurulus bubalis*) and mullet (Muglidae), which rely on algae and detritus for shelter and food, are generally found in higher abundances (see appendix D13-4, Application Reference Number: 6.4.86). Juvenile clupeids (sprat and herring) are also known to use shallow intertidal areas as nursery grounds. Based on the abundance of these species in Porth-y-pistyll and the wide availability of food resource outside this area, the magnitude of change is predicted to be small. Therefore, it is considered that there would be a negligible effect on general fish and fisheries from the direct loss of either individuals or habitats under the footprint of the Marine Works.

13.6.161 Fish of conservation and/or commercial importance recorded in Porth-y-pistyll include herring, sea trout, sandeel (specifically Raitt's sandeel) and nursehound. Herring and sandeel are common to the wider sea area with abundances in Porth-y-pistyll considered to represent a small proportion of the overall population along the north Anglesey coastline. Therefore, given the low numbers of fish that are likely to be affected, the magnitude of change is predicted to be negligible and the effect on fish of commercial and/or conservation importance from the direct loss of either individuals or habitat under the footprint of the Marine Works is considered to be negligible.

13.6.162 Considering the embedded mitigation outlined in paragraph 13.5.82, freshwater habitats in the Afon Cafnan would remain accessible to migratory fish. Diadromous species such as European eel, river lamprey and Atlantic salmon are not known to utilise the habitats within Porth-y-pistyll but may transit through during migrations to and from the sea. Owing to the low abundance of these species recorded within Porth-y-pistyll and their mobility, the magnitude of change is predicted to be negligible and the effect on migratory species from the direct loss of habitats under the footprint of the Marine Works is considered to be negligible.

13.6.163 Although unlikely, there is a risk that European eel, river lamprey and Atlantic salmon may be present within the area behind the temporary cofferdams and would be vulnerable to mortality during initial dewatering activities. The

magnitude of change is predicted to be small and the effect on these species from the direct loss of individuals during dewatering is considered to be minor adverse.

Effects on marine mammals from the direct loss of individuals, habitats and the resource provided by these habitats

13.6.164 The permanent loss of intertidal and subtidal habitats and displacement of fish could have an indirect effect on marine mammals due to a loss of feeding resource (e.g. invertebrates and fish). The loss of intertidal areas under the footprint of the Marine Works may displace grey seals if suitable haul-out sites are lost. Marine mammals are highly mobile and the risk of direct mortality within the marine construction footprint is considered to be very low.

13.6.165 Marine mammal species most commonly recorded along the north Anglesey coastline and within the vicinity of Porth-y-pistyll (harbour porpoise, bottlenose dolphin and grey seal), exhibit similar food preferences. Gadoids are the dominant prey of harbour porpoise, bottlenose dolphin and grey seal representing 60%, 77% and 38% of their diet, respectively [RD100]. Species targeted include, but are not limited to, whiting, haddock (*Melanogrammus aeglefinus*), pollack (*Pollachius pollachius*), saithe (*Pollachius virens*), blue whiting (*Micromesistius poutassou*), *Trisopterus* sp. and common ling (*Molva molva*). Harbour porpoise also target clupeids (namely herring, *Clupea harengus*) and to a lesser extent Atlantic mackerel (*Scomber scombrus*), whilst bottlenose dolphin target Anguilliformes (namely conger eel) and scad/horse mackerel. Within the Irish Sea, sandeel is not considered to be an important prey species to either harbour porpoise or bottlenose dolphin [RD100].

13.6.166 Grey seal are considered to be a more generalist feeder; salmonids, flatfish (namely lemon sole; *Microstomus kitt*; plaice; Dover sole; and dab), Anguilliformes, sandeel, dragonets, sea scorpions, eelpout, wrasse and sea lamprey, all form important components of their diet [RD101]; [RD100].

13.6.167 Porth-y-pistyll is not considered to represent an important area for gadoids with very few individuals recorded in the area from intertidal surveys and subtidal surveys compared to elsewhere along the coastline. Species known to be present include pollack, poor cod and rockling. Higher abundances of whiting, cod and poor cod have been found in the subtidal area, particularly to the east of the Wylfa Newydd Development Area (see appendix D13-4, Application Reference Number: 6.4.86). As outlined in paragraph 13.6.160, few flatfish and sandeel are present in Porth-y-pistyll owing to the nature of substrates. Although clupeids have been recorded in the bay, they do not exhibit consistent seasonal presence, nor are they present in particularly high abundances (see appendix D13-4, Application Reference Number: 6.4.86). Higher clupeid abundances have generally been observed to the east in Cemaes Bay and Red Wharf Bay (see appendix D13-4, Application Reference Number: 6.4.86).

13.6.168 Given information regarding the diet of marine mammals and an understanding of fish communities within Porth-y-pistyll, the bay is unlikely to represent a key foraging area. Displacement of marine mammals due to

a loss of food resource is considered to be negligible and therefore the magnitude of change is predicted to be negligible. The indirect effect on marine mammals from the direct loss of habitats and species in the footprint of the Marine Works is considered to be negligible.

13.6.169 The grey seal relies on intertidal habitat for breeding and resting (hauling-out). There are no primary or secondary breeding haul-out sites for grey seal recognised along the north Anglesey coastline. The nearest site is located on The Skerries, which is over 7km from the Wylfa Newydd Development Area [RD41]; [RD102]. Sightings of grey seals in the vicinity of Porth-y-pistyll are typically of individuals or small groups in the water (see appendix D13-6, Application Reference Number: 6.4.88). The baseline surveys did not record any sightings of breeding seals or pups within the vicinity of the Wylfa Newydd Development Area, although incidental sightings have been reported along the wider north Anglesey coastline.

13.6.170 Whilst the loss of intertidal habitat has the potential to affect grey seal, the breakwater structure itself would provide suitable areas for seals to haul-out (see paragraph 13.5.82). It is therefore considered that the magnitude of change is negligible and the direct effect on grey seals from the direct loss of intertidal habitats would be negligible.

Effects on seabirds from the direct loss of habitats and the resource provided by these habitats

13.6.171 The permanent loss of intertidal and subtidal habitats and species could have an indirect effect on seabirds due to a loss of habitat, refuge and food resource (e.g. fish and invertebrates).

13.6.172 Porth-y-pistyll is not considered to be a key foraging area for target seabird species, for which the Anglesey Terns/Morwenoliaid Ynys Môn SPA is designated (i.e. Arctic tern, common tern, roseate tern and Sandwich tern). The tern tracking surveys did not record any terns feeding within Porth-y-pistyll and less that 2% of terns recorded in the bay in the VP surveys were actively feeding (appendix D13-7, Application Reference Number: 6.4.89). This suggests that Porth-y-pistyll is characterised by low value food resources with respect to the dietary preference of terns.

13.6.173 Sandwich terns from the Cemlyn Lagoon colony exhibit a preference for sandeel and clupeids [RD50]. It is likely that gadoids (namely rockling) as well as invertebrates and cephalopods make up the remaining diet although the relative contribution of these prey types is unknown. Arctic/common terns are believed to exhibit a broadly similar diet [RD50].

13.6.174 Tracking studies have shown terns fly from the breeding colony in Cemlyn Lagoon to feeding grounds primarily to the east in the case of Sandwich tern, and fanning out in a more northerly direction in the case of both common and Arctic tern (see appendix D13-7, Application Reference Number: 6.4.89). The tracking studies from 2009, 2016 and 2017 do not show any evidence of significant feeding activity in Porth-y-pistyll by any of the three tern species; feeding activity takes place in areas further out to sea, beyond the inshore bays surrounding the Wylfa Newydd Development Area.

13.6.175 Large areas of the north and eastern Irish Sea are characterised as spawning and nursery grounds for sandeel and herring as well as gadoid species such as whiting and cod [RD24]. Whilst sandeel and clupeid are known to be present in Porth-y-pistyll, their abundance relative to the highly productive areas in the eastern Irish Sea is considered to be low. The loss of food resource within Porth-y-pistyll is considered to be negligible for target seabird species, considering the limited use of this area by feeding birds and the availability and preference for food resources farther afield and therefore the magnitude of change is predicted to be negligible. The indirect effect on target seabirds from the direct loss of habitats and species in the footprint of the Marine Works is considered to be negligible.

13.6.176 Surveys have shown that a total of 30 secondary seabird species utilise the intertidal zone in Porth-y-pistyll for loafing and/or foraging. Herring gull and black-headed gull were present in the greatest numbers, with common gull and lesser black-back gull also recorded in high numbers. Great black-backed gull, cormorant and shag were also present, but in lower abundance (appendix D13-7, Application Reference Number: 6.4.89).

13.6.177 Displacement of secondary seabirds from Porth-y-pistyll due to the direct loss of intertidal habitats and species within the footprint is likely; however, owing to the low abundance of birds present in the area, there would not be an effect on the integrity of wider populations and therefore the magnitude of change is predicted to be negligible. It is considered that there would be a negligible indirect effect on secondary seabirds from the direct loss of habitats and species in the footprint of the Marine Works. It is also recognised that the development of intertidal habitats and species on the breakwaters could represent additional habitat, refuge and food resource for secondary seabird species.

13.6.178 The direct loss of terrestrial and intertidal habitats and species may affect local populations of black-headed gull. However, the various seabird surveys undertaken have indicated that this species is widely distributed in the area and, with the exception of Cemlyn Lagoon and Bay, tends to be found in small numbers. This species also uses a wide variety of habitats for foraging and loafing. As such, they are not considered to be reliant on intertidal habitats; therefore, the loss of intertidal habitats and species is considered to be negligible.

Effects on designated sites from the direct loss of habitats and the resource provided by these habitats

13.6.179 The permanent loss of terrestrial, intertidal and subtidal habitats and communities (including those of conservation importance) would have an indirect effect on designated sites, through loss of habitat, feeding resource and refuge for species, which are qualifying features.

13.6.180 None of the terrestrial, intertidal and subtidal habitats, associated invertebrate or fish species identified as being either directly or indirectly affected by the footprint of the Marine Works are qualifying features of any nearby designated sites. Furthermore, the magnitude of effects on receptors which are qualifying features of designated sites are considered to be

negligible (see paragraphs 13.6.164 to 13.6.177). It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites from the direct loss of habitats and species in the footprint of the Marine Works.

Impact pathway: disturbance of habitats and species including from wave action, scour, smothering (from dredging and land-based sources) and deposition of dust and air pollutants

General context

13.6.181 Increased wave action could cause disturbance to coastal habitats from increased salt spray and erosion, resulting in changes to community assemblages or changes in the overall extent of habitats. However, hydrodynamic modelling has demonstrated that changes in wave height resulting from the operation of the Power Station would be small and therefore the potential for increased wave action and the associated risk of overtopping is considered to be within the range of natural variation (see chapter D12, Coastal processes and coastal geomorphology, Application Reference Number: 6.4.12). The magnitude of change and effect on Cemlyn Lagoon from disturbance arising from changes in wave action is therefore considered to be negligible and has not been considered further in the assessment.

13.6.182 Air pollutants released from construction plant machinery and marine vessels can be deposited into the marine environment either by dry or wet deposition processes. Deposition of air pollutants, particularly nitrogen and sulphur compounds can cause disturbance to marine habitats and species through acidification. An assessment of air quality effects on designated sites of nature conservation importance and supporting features is presented within chapter D5 (air quality) (Application Reference Number: 6.4.5). Considering the embedded and good practice mitigation proposed (see section 5.4 in chapter D5, Application Reference Number: 6.4.5), this assessment concluded that there would be a negligible magnitude of change and effect to designated sites of nature conservation importance due to emissions from construction plant, machinery and marine vessels. Consequently, there is considered to be no effect to habitats and species, or any other marine environment receptors (e.g. water quality, fish, marine mammals and seabirds), due to emission of air pollutants.

13.6.183 The release of suspended solids, either from marine sources, namely dredging, or land sources such as drainage, dewatering and sewerage release, can lead to subsequent sediment deposition on the seabed and therefore physical disturbance. Similarly, the release and subsequent deposition of dust from both land-based construction (e.g. demolition, land excavation and vehicle movements) and marine-based construction (e.g. construction of the MOLF and breakwaters, dredging) may also cause physical disturbance to intertidal habitats and species.

13.6.184 The deposition of suspended solids can smother the seabed potentially resulting in changes to seabed geomorphology, sediment structure and habitats. This would have effects on species that currently rely on these

habitats for food or refuge, leading to potential indirect effects on survival, growth, reproduction or displacement of individuals. In shallow habitats smothering may also prevent photosynthesis, leading to lower growth rates of flora and potentially mortality if conditions persist.

13.6.185 Dust deposition would be limited to intertidal habitats as material would be dispersed rapidly within the wider marine environment with a negligible magnitude of effect on subtidal habitats. The potential effects on the marine benthos would be as described in paragraph 13.6.184 with a physical disturbance occurring as a result of smothering.

13.6.186 The effects of water quality deterioration arising from sediment dispersion (including the indirect effects of high turbidity on light levels and water chemistry) on habitats and species have been considered in paragraph 13.6.2.

13.6.187 Changes in hydrodynamic conditions (i.e. waves and currents) can lead to changes in bed shear stress; this, depending on the substratum has the potential to cause physical disturbance (scour) of the seabed if the changes in bed shear stress manifest as increases from baseline conditions. Conversely, a decrease in bed shear stress could lead to less disturbance of the substratum, depending on the nature of the sediment affected. Scour effects arising from changes in bed shear stress may cause physical disturbance to habitats and species through abrasive action.

13.6.188 While physical disturbance from deposition or scour has the potential to effect the benthic habitats and communities it is acknowledged that in high energy systems, where the quantity and changes to physical disturbance may not differ greatly from natural processes, the effects of scour are likely to be relatively small, as the community will consist of species with high tolerance to abrasion. Within sedimentary habitats many of the motile species present are able to vertically migrate through deposited sediments [RD103]; [RD104]; [RD105].

13.6.189 The effects from the potential impacts arising from smothering and dust deposition on marine benthic receptors are specifically considered in relation to the relevant key construction activities that can lead to sediment dispersion and/or dust deposition. The potential effects of scour, as a consequence of changes to bed shear stress from the presence of the marine structures, specifically the western and eastern breakwaters, are considered separately. Subsequent consideration is then given to the overall effects of physical disturbance on benthic habitats and communities (see paragraph 13.6.230*).*

13.6.190 The assessment uses the conclusions of chapter D12 (Application Reference Number: 6.4.12) and focussed modelling work (see below) and these are referred to as appropriate, while consideration is given to the embedded and best practice mitigation measures that have been proposed to reduce physical disturbance of habitats (see paragraphs 13.5.81 and 13.5.91).

13.6.191 It is recognised that physical disturbance could facilitate the introduction and spread of INNS and the associated effects have been assessed separately within paragraphs 13.6.239 to 13.6.262.

Modelling

Scour

13.6.192 Changes to coastal processes associated with construction at the Power Station Site, and how these changes could lead to alteration of bed shear stress have been identified through hydrodynamic (Delft3D) and wave (Simulating WAves Nearshore, SWAN) modelling investigations.

13.6.193 Hydrodynamic modelling of baseline conditions has demonstrated a wide range of bed shear stress both spatially and temporally. The highest seabed shear stress levels occur slightly offshore and around Trwyn Cemlyn, Cerrig Brith and Wylfa Head, with lower values found within coastal embayments. During the summer, wave energy from comparatively small waves does not penetrate to the seabed within the embayments. However, during winter the bed shear stresses, due to the occurrence of larger waves, increase across these inshore areas in particular, when the wave direction is from the north.

13.6.194 Based upon the results of the modelling studies, overall changes in maximum bed shear stress have been found to range mostly between -0.1N/m^2 and +0.1N/m^2 (figure D12-15, Application Reference Number: 6.4.101). Changes in bed shear stress ranging from -0.1N/m^2 and +0.1N/m^2 are judged to generate no more than minor differences in terms of the transportable sediment fraction for both sands and gravels (see chapter D12, Application Reference Number: 6.4.12).

13.6.195 However, a number of areas, specifically adjacent to the breakwaters and also around Cerrig Brith, Trwyn Cemlyn and Wylfa Head were predicted to experience changes in bed shear stress between -0.5N/m^2 and +0.5N/m^2 during spring tide conditions. From the modelling, these changes were generally shown to manifest as an increase in bed shear stress at localised areas around Cerrig Brith, Trwyn Cemlyn and Wylfa Head, and a decrease in those areas adjacent to the breakwaters. Adjacent to the breakwaters, the decrease was sometimes predicted to be between -0.5N/m^2 and -1.0N/m^2.

13.6.196 Only under certain wave and tide conditions would any of these changes manifest in Cemlyn Bay and then these would be highly localised, ranging from -0.5N/m^2 to +0.5N/m^2 changes in bed shear stress. The western breakwater does reflect waves from the west and northwest causing some minor refocussing of energy but only from relatively small waves. This refocussing (reflected in a minor increase of bed shear) affects the Cemlyn Bay seabed close to the most western part of the Esgair Gemlyn in an area of relatively hard bedrock. The levels of wave height increase remain lower than the baseline wave heights from the northeast (a direction unaffected by the breakwater).

13.6.197 The greatest increases in bed shear stress from baseline occurred in extremely localised areas of seabed dominated by bedrock and were almost

all confined to either the winter, but more usually, the high north wave conditions modelled.

13.6.198 As noted in chapter D12 (Application Reference Number: 6.4.12), the generally small changes in bed shear stress predicted by the modelling are judged to generate no more than minor differences in terms of the transportable sediment fraction for both sands and gravels. Far larger differences in bed shear stress are required to generate significant changes to mobilisation of these grain sizes. Furthermore, in chapter D12 (Application Reference Number: 6.4.12), based on the potential changes in bed shear stress modelled (spatial distribution, magnitude and extent) and acknowledging the type of substrata present, the significance of the effect on the seabed from bed shear stress was assessed as negligible.

13.6.199 To summarise, the levels of bed shear stress predicted are broadly comparable to baseline and where changes do occur they generally manifest as small differences and a reduction in bed shear stress. While increases of greater than 1.0N/m^2 from baseline are almost completely confined to bedrock dominated habitat.

Smothering – deposition of suspended sediments

13.6.200 Delft3D [RD106] was used to model the deposition of suspended solids discharged from the drainage system (i.e. drainage, dewatering and sewage effluent outfalls) around the Wylfa Newydd Development Area and fugitive sediments released during the dredging operations.

13.6.201 The dredge model simulation was set up to run from 1 July 2011 to 17 July 2011 as a spin up period. During this period the baseline fluvial discharges were in operation, but the wave model was not coupled to the hydrodynamics nor was the dredge spill included. The dredge activities were simulated for the period between 17 July and 21 August. After the 21 August, there was a six-day post dredge period with the baseline fluvial discharges still in operation. The fugitive spill from dredging activities was included at five locations, three along the western breakwater axis and two within the harbour area. The wave model was run coupled to the hydrodynamics hourly starting on the 17 July until the end of the simulation.

13.6.202 The drainage discharges simulation included a spring-neap-spring cycle as a spin up. During the spin up, the drainage discharges were in operation and hence the spin up allowed both the hydrodynamics and suspended solids concentrations to settle. The flows used in the scenario were the 1 in 2 year flows with the suspended solids concentrations ranging from 30 to 70 mg/L. The model ran from 17 June 2011 to 28 August 2011, with the discharges in operation from the outset (a total of 72 days). A 24 hour storm event (1 in 30 year flow) with elevated suspended solid concentrations was introduced on the 19 August.

13.6.203 During both simulations, the wave model was coupled to the hydrodynamics to allow the maximum sediment deposition to be demonstrated as a worst case scenario.

13.6.204 For both the dredge and drainage scenarios, it was assumed that the cofferdam and temporary causeway were in place.

13.6.205 Details of the drainage system modelled can be found in 13.5.7 to 13.5.9, with further information regarding the model assumptions presented in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.206 A summary of the information relating to the fugitive spills from the dredging operations can be found in paragraphs 13.5.38 to 13.5.40.

Smothering – deposition of dust

13.6.207 A construction dust assessment has been carried out to assess the levels of dust likely to be generated by construction activities (see appendix D5-1, Construction Dust assessment – Main Construction, Application Reference Number: 6.4.20). This has identified the level of dust mitigation (i.e. adoption of industry standard air quality and dust management procedures) required (see chapter D5, Application Reference Number: 6.4.5).

Effects on habitats and communities from physical disturbance

Scour

13.6.208 Scour effects, as a result of increases in bed shear stress, could potentially result in changes to seabed geomorphology, sediment structure and habitats.

13.6.209 The potential effects on soft sediment habitats, those that can be mobilised by hydrodynamic processes, and their associated communities would be greater than those on rocky habitats, with interfaces between different substrata, for example, at the base of fixed structures such as the breakwaters and the MOLF, being particularly vulnerable [RD107].

13.6.210 Modelling of bed shear stress has predicted comparatively small changes from the baseline environment (see above), and in the context of these changes, the greatest increases were generally shown to occur in areas dominated by bedrock tide-swept communities e.g. Cerrig Brith and Trwyn Cemlyn. Where sedimentary habitats were predicted to experience an increase, the change in bed shear stress was usually less than 0.5N/m^2.

13.6.211 Where sedimentary habitat is located within areas of increased bed shear stress, it is characterised by tide-swept communities indicative of the high tidal energy of the local environment (appendices D13-2, Application Reference Number: 6.4.84 and D13-3, Application Reference Number: 6.4.85). From drop-down camera surveys in 2010 and 2011 (appendix D13-2, Application Reference Number: 6.4.84) the seabed immediately to the north of the western breakwater and between the western breakwater and Wylfa Head is known to be dominated by brittle star beds ('*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittle star beds on sublittoral mixed sediments'). This habitat, coincident with the areas of increased bed shear stress on sediments, is found in a range of water flows, from weak to strong. Consequently, this brittle star bed biotope is not considered sensitive to the Marine Evidence based Sensitivity Assessment (MarESA) benchmark for change to mean spring bed flow velocity [RD108]. Using the same MarESA approach, a medium sensitivity is assigned against abrasion on this biotope; however, given the very small increases predicted by the modelling (usually

less than 0.5N/m^2) in an area already characterised by strong tidal flows it is not considered that the changes in bed shear stress would result in any detectable effect from scour.

13.6.212 Although beyond the predicted extent of much of the changes (as increases) in bed shear stress modelled, there may also be some overlap with the widely occurring biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand. Dominated by bivalve and polychaete infauna this biotope is not considered sensitive to the MarESA benchmark changes in water flows and, by virtue of its resistance and resilience, has a low sensitivity to abrasive activities such as scour [RD109].

13.6.213 The rocky habitats that overlap with the predicted changes in bed shear stress are characterised by communities well adapted to strong tidal flows and reasonably tolerant of sediment scour. Bearing in mind the comparatively small increases to bed shear stress predicted even at the rocky headlands i.e. Trwyn Cemlyn, Cerrig Brith and, to a lesser extent, Wylfa Head; it is not considered that the changes in bed shear stress would result in any detectable effect from scour.

13.6.214 Within the bays (Cemlyn, Porth-y-pistyll and Cemaes) the changes to bed shear stress, on subtidal and intertidal habitats, are minimal and, with the exception of Porth-y-pistyll, highly localised. Such small changes in Cemaes and Cemlyn leads to the conclusion that scour would not have any detectable effect on habitats in these bays. Within Porth-y-pistyll the changes are clearly dominated by a reduction in bed shear stress (figure D12-15, Application Reference Number: 6.4.101) with the only increases occurring to the north of the bay, between the breakwaters, and then only during the infrequent high north wave scenario. Hence the effects of scour are not considered further for Porth-y-pistyll.

13.6.215 Acknowledging the small changes in tidal flows and therefore bed shear stress predicted by the modelling, the spatial distribution of these changes, the types of communities present within the extent of the changes and the wide occurrence of these communities along the north Anglesey coastline the magnitude of change for habitats and communities (including habitats and communities of conservation importance) from scour is negligible. Therefore, there would be a negligible effect on intertidal and subtidal habitats and communities from scour.

Smothering – deposition of suspended sediments on subtidal and intertidal habitats and communities

13.6.216 According to the MarLIN MarESA criteria, deposition of up to 5cm in a single event is classified as light smothering with heavy smothering being up to 30cm in a single discrete event [RD110]; [RD111]; [RD112]. Deposition of up to 1cm in a single event is assumed to represent smothering comparable to natural events and is therefore considered to be of negligible magnitude. This assumption is based on extensive literature which contains studies relating to natural sedimentation processes and ecological effects [RD113].

13.6.217 For the assessment of the dredge scenario, the total duration of dredging activity (35 days) was assumed to represent a ‘single event’. Figure D13-28

(Application Reference Number: 6.4.101) shows the thickness of sediment deposited on the bed an hour after the last dredge activity; this delay allows time for the deposition of suspended sediments released near the surface. The majority of the area predicted to experience heavy smothering falls under the direct footprint of the Marine Works. This area has been assessed through direct loss and has therefore been excluded from the assessment of physical disturbance.

13.6.218 Outwith the direct footprint of the Marine Works, the highest levels of deposition are predicted to occur in subtidal areas adjacent to the western breakwater (figure D13-28, Application Reference Number: 6.4.101). Here, smothering from the deposition of sediment is predicted to range from negligible (<1cm) to light (up to 5cm).

13.6.219 With the exception of a localised area immediately to the west of the western breakwater, deposition of dredged material was less than 1cm, thus representing a negligible effect on habitats and species from smothering (i.e. <1cm in a single event). This included the intertidal environment and the subtidal areas within Cemlyn Bay, Porth-y-pistyll and Cemaes Bay.

13.6.220 Under the worst case drainage discharges scenario, the deposition of sediment on the seabed is predicted to be up to 6cm in a highly localised area from the Afon Cafnan (see appendix D13-8, Application Reference number: 6.4.90). This is based on no wind or wave effects which in reality would occur during a 1 in 30 year storm event; the effect of waves would be to reduce deposition in this area further. The area of seabed classified as heavy deposition (according to the MarLIN MarESA criteria) is restricted to 0.93ha in Porth-y-pistyll. In all other areas deposition is predicted to be less than 1cm (classified as light smothering) under the worst case modelling scenario (see figure D13-29, Application Reference Number 6.4.101) thus representing a negligible effect on habitats and species from smothering.

13.6.221 From analysis of survey data, in the areas of deposition (figures D13-28 and D13-29, Application Reference Number: 6.4.101) (see appendices D13-2, Application Reference Number: 6.4.84, and D13-3, Application Reference Number: 6.4.85), the habitats present are considered a combination of infralittoral rock, muddy sands and mixed sediments. Constituent biotopes of these habitats in the area such as ‘dense foliose red seaweeds on silty moderately exposed infralittoral rock’ *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand; *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittle star beds on sublittoral mixed sediments vary in their sensitivity to smothering. The biotope dense foliose red seaweeds on silty moderately exposed infralittoral rock has high resilience to both light and heavy smothering [RD114] and therefore it is not considered further in this assessment. Both the other biotopes (see above) have a medium resilience even to heavy smothering based on the ability of the characteristic species to move through sediment or away from the deposition.

13.6.222 In the case of bivalves, the MarESA notes how the character of the overburden is an important factor determining the degree of vertical migration i.e. individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type [RD109].

This is acknowledged in the context of the dredging and drainage as the material deposited will be broadly similar to the substrata receiving the deposition.

13.6.223 In relation to the effects of light smothering on brittle star beds MarESA states that 'in areas of high water flow dispersion of fine sediments may be rapid and this could mitigate the magnitude of this pressure by reducing the time exposed, where 'light' deposition of sediments is likely to be cleared in a few tidal cycles' [RD108].

13.6.224 The worst case modelling scenarios for dredging and drainage discharge assume no wind or waves which would aid dispersion and reduce overall sediment deposition. In the majority of areas where higher rates of deposition are predicted to occur, the bed shear stress is also increased therefore sediments are likely to be dispersed. An indication of this is shown in figure D12-15, (Application Reference Number 6.4.101) where a typical wave, winter wave and north wind wave all increase shear stress in areas of greatest sediment deposition. Therefore, any potential smothering effects within this area post dredging or from the land drainage discharge is likely to be short-term.

13.6.225 Some build-up of sediment is predicted to occur in areas of Cemlyn Bay, Porth-y-pistyll and Cemaes Bay from dredging and drainage discharge although maximum deposition is predicted to be <0.2cm and therefore the scale of the effect from smothering would be negligible.

13.6.226 Excavation of the seabed at the Cooling Water outfall would be carried out in the dry behind a cofferdam; suspended sediments would be released from dewatering, with possible resuspension of sediments during dredging. No modelling was carried out to assess sediment dispersion in this location; however, due to the very limited spatial extent of the works and the exposed nature of this area of coastline; any release of suspended solids would be rapidly dispersed.

13.6.227 Considering the small extent of intertidal and subtidal habitats of conservation importance that would be affected by smothering and the short-term nature of effects, the magnitude of change is predicted to be small and the effect negligible.

13.6.228 Subtidal habitat and communities affected are considered tolerant to sediment deposition. The likely remobilisation of deposited sediments over several tidal cycles, the highly localised area affected by deposition >1cm and recognition that those habitats potentially affected are widely occurring and extensive along the north Anglesey coastline; the magnitude of change is predicted to be small. Therefore, there would be a negligible effect on subtidal habitats and communities from smothering.

Smothering – deposition of dust on intertidal habitats and communities

13.6.229 With the incorporation of embedded mitigation (see paragraph 13.5.91), there would not be a noticeable change in baseline conditions and therefore the magnitude of change is predicted to be negligible. The indirect effect on intertidal habitats from the deposition of dust during construction is therefore considered to be negligible and is not considered further in this assessment.

Summary of effects on intertidal and subtidal habitats and communities from physical disturbance

13.6.230 The effects on intertidal and subtidal habitats and communities, including those of conservation importance, from scour and smothering were assessed as negligible. Therefore, it is considered that the overall effect of physical disturbance is negligible.

Effects on invertebrates of conservation and commercial importance

13.6.231 Commercial species including scallop, whelk, lobster, prawn and edible crab may be affected by smothering during the early construction phase. These species are generally considered to be tolerant of smothering to a depth of 5cm over a period of a month [RD115]; [RD116] and being mobile, are able to move away from the affected area.

13.6.232 The ocean quahog is considered to have medium sensitivity to smothering [RD97] whilst no comparative assessment is available for spiny lobster. However, given that this species is relatively large and mobile, it is unlikely to be significantly affected by smothering. The effects of smothering on invertebrates of conservation and/or commercial importance is therefore likely to be limited and therefore the magnitude of change is negligible and the effect is considered to be negligible.

Effects on marine fish from disturbance to habitat and loss of resource

13.6.233 The physical disturbance of subtidal habitats and species would have an indirect effect on marine fish receptors due to the loss of habitat, refuge and feeding resource (e.g. invertebrates and detritus) resulting in displacement. Fish are highly mobile and therefore direct effects of smothering on demersal species are predicted to be negligible.

13.6.234 The sensitivity of most habitats and species to physical disturbance ranges from zero (not sensitive) to moderate. This level of disturbance is not considered to result in a marked decline in biomass of either algae or species present in Porth-y-pistyll. The disturbance is therefore unlikely to represent a decline in food resource for marine fish which would be temporarily displaced from the area. Few fish species of conservation and/or commercial importance are present in significant numbers within Porth-y-pistyll (see paragraph 13.3.114). Therefore, it is considered that the magnitude of change is negligible and the indirect effect on marine fish receptors from physical disturbance of habitats and species is negligible.

13.6.235 Migratory species such as river lamprey, European eel, sea trout and Atlantic salmon typically follow the coastline. The presence of the Marine Works in Porth-y-pistyll therefore has the potential to affect those routes, although access would not be prevented and fish would find alternative routes. The numbers of river lamprey, European eel and sea trout in the vicinity of Porth-y-pistyll is low in comparison to wider populations and disturbance would not affect feeding or spawning. Therefore, the magnitude of change is predicted to be negligible and the effect on fish of conservation importance is negligible.

Effects on marine mammals from disturbance to habitat and loss of resource

13.6.236 Marine mammals feed on invertebrates and fish and therefore there is potential for indirect effects on marine mammals from the loss of food resource. As the effect on fish and invertebrates from disturbance is negligible, the effects on marine mammals are also considered to be negligible.

Effects on seabirds from disturbance to habitat and loss of resource

13.6.237 Seabirds feed on invertebrates and fish and there is potential for indirect effects on seabirds from the loss of food resource. As the effect on fish and invertebrates from disturbance is negligible, the effects on seabirds are also considered to be negligible.

Effects on designated sites from disturbance to habitat and loss of resource

13.6.238 The indirect effects on marine mammals and seabirds, which are qualifying features of sites of national/international importance, are considered to be negligible and therefore the effects on designated sites are considered to be negligible.

Impact pathway: introduction of non-native species during Main Construction

General context

13.6.239 Invasive, non-native, alien or exotic species are those that have been released into an environment beyond their native bio-geographic range or habitat, either by accident or intentionally [RD117]. On release into a new environment, a non-native species may or may not become established depending on its tolerances of the prevailing conditions or other random events such as predation.

13.6.240 A species is classed as 'invasive' when it establishes in the new environment and out-competes native species resulting in a detrimental impact on native habitats. The Great Britain Non-Native Species Secretariat defines INNS as *"any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live"* [RD118].

13.6.241 The most likely pathway for non-natives to be introduced to the Wylfa Newydd Development Area is from marine plant and vessels which can transport invasive non-natives, as fouling on hulls and in ballast waters. This is evidenced by the presence of hotspots for INNS in areas of high shipping traffic [RD119]; [RD120]; [RD121]. Non-native species can also be introduced in construction materials imported as a result of the Wylfa Newydd Project. General marine traffic associated with the marine construction works also has the potential to transfer INNS that are currently present within the Wylfa Newydd Development Area to other areas.

13.6.242 Although INNS could be introduced via activities not directly associated with the Wylfa Newydd Project (e.g. commercial fishing and recreational sports), the probability of transmission is low.

13.6.243 New substrates and artificial structures are often colonised by INNS owing to the absence of competition and predation; their presence can facilitate the establishment and spread of newly introduced INNS [RD122]. New substrates can also serve as 'stepping stones' in an otherwise unhospitable area (e.g. hard structures placed on soft sediment habitats can support the establishment of species associated with hard substrates), which can assist with the expansion of a species distribution [RD123]; [RD124].

13.6.244 There are several pathways by which conditions could alter during construction in favour of non-native species which include the following.

- Changes to the physical conditions (e.g. hydrodynamics) which can disrupt native species therefore allowing potential establishment of INNS.
- Disturbance of established communities containing INNS increasing the risk of releasing fragments into the marine environment which may then spread on currents or attach to vessels and establish elsewhere.

13.6.245 Increased water temperatures which could facilitate the establishment and spread of invasive non-natives adapted to warmer waters [RD125] and the effects of Cooling Water discharge have been assessed within paragraphs 13.6.720 to 13.6.724.

13.6.246 Embedded mitigation has been proposed to reduce the likelihood of transmitting non-native species during the construction phase (see paragraph 13.5.92).

Effects on phytoplankton and zooplankton from the introduction of non-native species

13.6.247 The introduction of INNS has the potential to displace native plankton species through competition for resources. Of the non-native plankton species listed under [RD19], only one has known environmental impacts: the diatom *C.wailesii* [RD20]. Blooms of this species are reported to form up to 90% of total phytoplankton biomass in the German Bight and may displace native phytoplankton species both physically and by stripping nutrients from the water [RD20]. These cells are so large that they are not easily grazed by zooplankton which as a result could become food deprived [RD20].

13.6.248 *C.wailesii* has been recorded from the Wylfa Newydd Development Area during baseline surveys. Over the monitoring period 2010 to 2014 only one cell of this species was recorded in December 2010. This indicates that despite being present *C.wailesii* has not established in the area and is not causing any adverse effects to local plankton populations. *C.wailesii* is widely distributed around British waters and is an established member of the phytoplankton community with the highest abundances occurring in the North Sea. It is able to grow in a wide range of environmental conditions including temperatures from 0°C to 20°C and salinities from 24 to 35 [RD18].

13.6.249 Only one other non-native plankton species was recorded from the baseline surveys, the diatom *O.sinensis* which was recorded at low abundances. It is widely distributed in British coastal waters and has no known environmental impacts [RD20]. No holoplanktonic (spending their entire life in the plankton) zooplankton non-native species were recorded during the baseline surveys.

13.6.250 By adhering to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and paragraph 13.5.92, the introduction and spread of other invasive non-native plankton species through ballast water exchange would be reduced and therefore the probability of transmission is low. Based on the presence of non-native plankton species in the area and their wider distribution, the magnitude of change is predicted to be negligible. Therefore, it is considered there would be a negligible effect on the phytoplankton and zooplankton from the introduction and spread of INNS.

Effects on intertidal and subtidal habitats and communities (including invertebrates of conservation and/or commercial importance) from the introduction of non-native species

13.6.251 The introduction of INNS has the potential to alter interactions within existing ecological assemblages. Potential effects on native species include competition for space and resources; alteration of substrata and water conditions; predation and depletion of native species; smothering of native species; consumption of pelagic larvae and loss of prey and refuge [RD126].

13.6.252 All INNS outlined in paragraph 13.3.80 represent benthic species, the introduction and spread of which would have a direct effect on intertidal and subtidal habitats and species.

13.6.253 The sensitivity of intertidal habitats and species to non-native introductions varies from low to moderate depending on the potential for non-native species to compete with native species for space and food. INNS already known to be present within intertidal areas of the Wylfa Newydd Development Area do not represent a significant risk, although the introduction of new substrate could allow these species to proliferate within the area. Consequently, vulnerability is considered to range from low (where already present) to moderate (where the Wylfa Newydd Project might allow colonisation or expansion of species already present). Of particular consideration are two species of invasive non-native algae, *S.muticum* and *C.fragile* sub sp. *t*. *S.muticum* was recorded at five intertidal locations in Porth-y-pistyll in 2014; four in the south-east corner of the bay under the footprint of the Marine Works and one in a rock pool on Cerrig Brith (see appendix D13-3, Application Reference Number: 6.4.85). It is associated with sheltered environments; being fast growing and able to reproduce within the first year of life and fertilise itself, this species can increase its extent rapidly outcompeting local species [RD127].

13.6.254 In 2015, *C.fragile* was recorded within the infralittoral zone in the vicinity of the Cooling Water outfall (see appendix D13-5, Application Reference Number: 6.4.87). This species grows on hard substrate in shallow sheltered

waters [RD128] and is known to be better adapted to warmer waters with its spread limited by cooler temperatures [RD125].

13.6.255 The sensitivity of subtidal habitats and species to non-native introductions is considered to range from low to high due to the potential introduction of high risk species such as *D.vexillum* and *U.pinnatifida* which are known to be present in Holyhead Harbour although absent from the Wylfa Newydd Development Area presently.

13.6.256 Recreational boating is considered the main source of transfer of *D.vexillum*. Significant movement of *D.vexillum* is not expected from commercial shipping due to antifouling coatings and ballast water procedures [RD129], although transfer may occur in water abstracted and discharged by the vessel for cooling or other uses [RD130]. Smaller vessels and equipment docking in Holyhead Harbour could provide a vector for transfer of *D.vexillum*. If introduced to the Wylfa Newydd Development Area, there would be a high probability of the species becoming established owing to the presence of suitable conditions and substrates. *D.vexillum* has the potential to cause major biofouling problems of marine structures and could have a significant effect on the abundance and diversity of benthic species leading to the degradation of subtidal habitats.

13.6.257 Large swathes of the subtidal area within the Wylfa Newydd Development Area are characterised by dense kelp forests or parks (see appendix D13-3, Application Reference Number: 6.4.85). Introduction of the kelp species (*U.pinnatifida*), which has morphological and reproductive traits that makes it a highly successful invasive species, could result in a decline in biomass of native species such as *L.hyperborea* and abundance of supporting species.

13.6.258 Other subtidal INNS, which are considered to represent a high or medium risk of introduction and establishment, include *S.clava*, *F.enigmaticus* and *C.fornicata*. All three species could be transferred via fouling of vessels and equipment and via ballast water. They have the potential to outcompete native species through competition and food.

13.6.259 INNS already present in the Wylfa Newydd Development Area or on the north Anglesey coastline could facilitate the spread of newly introduced non-natives. For example, the Japanese skeleton shrimp (*C.mutica*) is commonly found in association with *S.muticum* [RD128]. Similarly, the colonial sea squirt (*B.violaceus*) is often found attached to other unitary sea squirts such as *S.clava* [RD131].

13.6.260 By adhering to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and paragraph 13.5.92, the introduction and spread of INNS through ballast water exchange and on ships' hulls would be reduced and therefore the probability of transmission is low. However, the physical presence of the artificial structures (e.g. breakwaters, MOLF, Cooling Water intake and outfall) would create potential colonising space for non-native species. Changes in existing habitat would also influence the introduction and spread of non-native species, for example the carpet sea squirt (*D.vexillum*) which thrive in relatively sheltered environments on the inside of breakwater structures and shallow subtidal

areas. Dredging may remove non-native species present in the Wylfa Newydd Development Area (e.g. *S.muticum*) and translocate them to other areas. However, for most INNS the risk of translocation is considered low, as those species at risk of introduction and spread are not adapted to deeper site conditions and are therefore unlikely to survive at disposal sites.

13.6.261 Even with good practice mitigation in place (see paragraph 13.5.92), intertidal and subtidal habitats of conservation importance and invertebrates of conservation and/or commercial importance would be at risk from the introduction and spread of INNS. Based on the presence of non-native species and the potential for transfer and establishment of non-native species, the magnitude of change is predicted to be medium. Therefore, it is considered that there would be a moderate adverse effect on these receptors from the introduction and spread of invasive non-natives during construction.

13.6.262 Intertidal and subtidal habitats not considered to be of conservation importance would also be at risk from the introduction and spread of INNS for the reasons listed above. The magnitude of change is also predicted to be medium, and it is considered that there would be a minor adverse effect on intertidal and subtidal habitats and communities from the spread of invasive non-natives during construction.

Impact pathway: underwater noise from Main Construction activities

General context

13.6.263 Over the past 20 years it has become increasingly evident that noise from human activities in and around underwater environments can have an impact on the marine species in the area. The extent to which intense underwater sound might have an adverse environmental impact on a particular species is dependent upon the incident sound level, frequency, duration, and/or repetition rate of the sound wave.

13.6.264 The impacts of underwater sound can be broadly summarised into three categories:

- physical traumatic injury or fatality;
- auditory damage (either permanent or temporary); and
- behavioural disturbance.

13.6.265 Underwater noise generated during marine construction has the potential to impact upon fish and marine mammals. In terms of the Marine Works, the following construction activities are considered as sources of noise and vibration:

- dredging;
- rock breaking;
- rock cutting;
- drilling; and

- vessels.

13.6.266 For the purpose of this assessment each of these activities is assessed separately for each of the receptors taking into consideration good practice mitigation (see paragraphs 13.5.85 and 13.5.91).

13.6.267 Sound or vibration are defined in terms of their frequency (pitch) and amplitude (level or loudness). Frequency is measured in Hertz (Hz) (1Hz = 1 cycle per second), amplitude is measured in units of velocity, e.g. millimetres per second (mm/s), but is often expressed in decibels (dB) in biological applications. Sound pressure level is usually reported in decibels (dB) which is a logarithmic scale that compresses the wide ranging potential source pressures to ease description.

13.6.268 An animal's sensitivity to sound varies according to the sound frequency. The response to sound depends on the presence and levels of noise within the range of frequencies to which an animal is sensitive. For most fish, sound above 1kHz is not audible. Marine mammals such as pinnipeds and cetaceans typically hear best between 1kHz and 100kHz [RD132].

13.6.269 Sound may be expressed in many different ways depending on the particular type of noise, and the parameters of the noise that will allow it to be evaluated in terms of a biological effect.

13.6.270 The attenuation of sound in the water as it propagates from the noise source must be considered in an impact assessment. As the measurement or receiver point moves away from the source, the sound pressure measured will decrease due to spreading. To standardise all source levels, regardless of where they are measured, they are referred back to a conceptual point 1m away from the point of origin of the noise. Consequently, source levels should and will be presented with units of 'dB re 1µPa @ 1m'.

13.6.271 The sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature such as drilling, boring, or background sea levels. To calculate the SPL, the variation in sound pressure is measured over a specific time period to determine the root mean square (RMS) level of the time varying acoustic pressure. The SPL_{RMS} can therefore be considered to be a measure of the average unweighted level of the sound over the measurement period.

13.6.272 The peak sound pressure level (SPL_{peak}) is the maximum level of sound. This form of measurement is often used to characterise underwater blasts where there is a clear positive peak following the detonation of explosives.

13.6.273 The sound exposure level (SEL) is used when assessing the noise from transient sources such as impact piling. The SEL sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration for which the sound is present in the acoustic environment.

Modelling of noise sources

13.6.274 To assess the potential effects from marine construction, underwater noise modelling was completed for all planned elements of construction. Modelling was undertaken using the RAMSGeo software package which is designed to

model any noise source where it is reasonable to assume it is a point source (appendix D13-9, Underwater Noise Baseline and Modelling, Application Reference Number: 6.4.91). The model allows for the incorporation of variable bathymetry and a complex seabed and therefore provides an accurate representation of noise propagation.

13.6.275 A point at a depth of -10m above ordnance datum was selected for the modelling as it represents the deepest point for marine operations. Therefore, this acts as a worst case for noise propagation; noise attenuation will be greater in shallow waters and therefore noise will propagate shorter distances. Three transects were chosen for the modelling to illustrate the propagation of noise; one to the north-east (038º), one to the north-northwest (332º) and one to the south-southeast (156º) (appendix D13-9, Application Reference Number: 6.4.91).

Dredging

13.6.276 Dredging would be used to prepare the seabed for marine construction. The dredge method would use either a backhoe dredger or a cutter-suction dredger; the choice of plant would depend upon detailed information on sediments from the detailed offshore geotechnical investigations, as described in paragraph 13.5.29.

13.6.277 Cutter-suction dredging uses a rotating cutter head to loosen material and a suction inlet to bring the material onto the vessel. Backhoe dredging removes material from the seabed with a boat-mounted excavator which lifts material onto the vessel.

13.6.278 The noise generated during dredging depends on the method, with cutter-suction dredging resulting in short pulses of noise caused by the cutter tool (appendix D13-9, Application Reference Number: 6.4.91), and backhoe dredging creating a more variable noise corresponding with the processes taking place (appendix D13-9, Application Reference Number: 6.4.91). Noise levels modelled for dredging operations at similar ranges indicated that cutter-suction dredging operations produce more noise than backhoe. Therefore, modelling of dredging has been undertaken based on cutter-suction dredging as it is considered worst case.

Drilling

13.6.279 Drilling operations are required to install pre-bored piles for the MOLF and cofferdam construction. Modelling has been undertaken for the following.

- Rotary drilling of two diametres whereby a rotating head is forced into the ground. The source levels for the modelling have been extrapolated from measurements taken at close range to drilling operations in Strangford Lough, Northern Ireland (appendix D13-9, Application Reference Number: 6.4.91).
- Percussive drilling whereby there is a hammer action to the drilling head. The source levels for modelling has been based on measurements from Orkney.

- Concurrent drilling whereby two drilling rigs may be in operation at the site.

Rock breaking

13.6.280 During construction, rock within the outer harbour will be fractured and removed using a rock breaker (see section 13.5) with work scheduled to extend for up to 16 months.

13.6.281 The process of rock breaking involves using a thin head that rapidly strikes the seabed to break up the rock (much like a jack-hammer). The plant used to do this has not yet been finalised. Modelling has been based on option using a hammer with a diameter of 50cm, with a blow energy of 70kJ and a strike rate of 43 strikes/minute to represent the worst case noise levels for rock breaking.

13.6.282 For the purposes of modelling rock breaking, it has been assumed that the noise source will be similar to small-scale tubular piling operations, owing to the similar motion of metal hitting the bedrock. However, it is expected that this represents a worst case noise level (appendix D13-9, Application Reference Number: 6.4.91).

Rock cutting

13.6.283 During the construction of the semi-dry cofferdam a rock cutter will be used to cut a trench along the seabed prior to the placement of rock. This trench will improve the footing of the sheet piles that will be driven through the breakwater to form a seal.

13.6.284 A rock cutter is similar in design to the cutting head of a cutter suction dredger, with teeth designed to grind the rock in order to remove it. The rock cutting equipment is expected to be a Rockwheel G55 hydraulic cutting wheel. Due to the similarity in design, the levels from the cutter suction dredger have been scaled based on the power of the device.

Vessels

13.6.285 There will be increased vessel movement around the site during construction, with vessels being used to bring equipment to the site and to dispose of excavated material. In addition, there would be a number of small support vessels used for staff transfers. The peak number of vessels on-site is predicted to average approximately 15 per week over a three month period.

13.6.286 Vessel noise contributes to overall background noise and has the potential to cause disturbance and is therefore included in the assessment. For the purposes of modelling, vessels have been divided into two categories, medium sized and large sized. Medium vessels include smaller support boats such as tugs and workboats and the large vessels include the dredgers and vessels transporting equipment.

13.6.287 For the modelling it is also assumed that the vessels are travelling at a speed of approximately 10 knots; the speed of the vessel will alter the sound level, with faster moving vessels generally creating more noise. The dredging

vessels and jack-up barges required for construction activities are assessed as part of the noise source for those activities, and are not included under the vessel noise assessment.

13.6.288 Full details of the modelling work are available in appendix D13-9 (Application Reference Number: 6.4.91).

The effect of underwater noise on marine fish

13.6.289 Fish responses to noise are in part related to the anatomy of their hearing mechanisms. The presence of a swim bladder enhances hearing sensitivity as the bladder acts as a pressure transducer, converting sound pressure to particle velocity. Those species where the swim bladder is near to or connected to the ear have increased hearing sensitivity [RD133]. The hearing range of fish varies extensively amongst species, and it is not only related to anatomy; cod and Atlantic salmon both have a swim bladder, yet cod is sensitive to pressure at higher frequencies [RD133].

13.6.290 Hearing sensitivity in larval fish and eggs is poorly researched. However, evidence suggests that the hearing frequency range in larvae is similar to that of adults with similar startle thresholds [RD133].

Thresholds and criteria used for marine fish

13.6.291 A review of hearing sensitivity in fish, developed categories that can be used when assessing the effects of sound [RD133]. The categories are based on the presence or absence of a swim bladder and the potential for the swim bladder to enhance hearing sensitivity. The relevant categories are listed below.

- Fishes with no swim bladder or other gas chamber – e.g. flatfish. These species generally only detect particle motion and are less sensitive to sound pressure.
- Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume – e.g. Atlantic salmon. These species hear through particle motion.
- Fishes in which hearing involves a swim bladder or other gas volume – e.g. herring and cod. These species detect sound pressure and particle velocity.
- Fish eggs and larvae.

13.6.292 The presence of a swim bladder makes these species more susceptible to pressure related injury (such as rupture of the swim bladder) associated with sudden changes in hydrostatic pressure (water depth) or sound pressure. Those species lacking a swim bladder (elasmobranchs, flatfish etc.) are less vulnerable to pressure changes.

13.6.293 Guideline criteria have been established by Popper *et al*., [RD133] for the assessment of underwater noise on fish, based on extensive literature review, and are provided based on the type of noise source (e.g. explosives, piling, continuous noise source). The criteria adopted in this assessment are shown in table D13-13. Where actual data are not available, criteria have

been set based on the risk to species at different distances from the source (near is tens of metres, intermediate is hundreds of metres and far is thousands of metres).

Table D13-13 Summary of criteria used in the assessment of underwater noise on fish [RD133] relating to shipping and continuous noise sources

Effect	Criteria	Metric	Species
Mortality and potential mortal injury	Low risk at near, intermediate and far field	n/a	All adult fish categories larvae and eggs
Recoverable injury	170dB re 1µPa for 48 hours	Unweighted SPL_{RMS}	Fish with swim bladder associated with hearing
	Low risk at near, intermediate and far field	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
Temporary Threshold Shift (TTS)	158dB re 1µPa for 12 hours	Unweighted SPL_{RMS}	Fish with swim bladder associated with hearing
	Moderate risk at near source and low risk at intermediate and far from source	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
	Low risk at near, intermediate and far field	n/a	larvae and eggs
Behaviour	Moderate risk at near and intermediate to source and low risk at far from source	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
	High risk at near source and moderate risk at intermediate to	n/a	Fish with swim bladder

Effect	Criteria	Metric	Species
	source and low risk at far from source		associated with hearing

13.6.294 The fish in the vicinity of the Wylfa Newydd Development Area are a mixed community with species of conservation and/or commercial importance, and other more common species. The dominant species varies seasonally but whiting and dab are consistently abundant in subtidal areas.

13.6.295 Intertidal fish surveys within Porth-y-pistyll have indicated that catches are low across the board with limited species diversity. Dominant species include sand smelt, clupeids and sandeel as well as species common to rich habitats e.g. gobies, rockling, wrasse, and dogfish (appendix D13-4, Application Reference Number: 6.4.86). These results show that the fish community within Porth-y-pistyll is characterised by species with hearing sensitivities ranging from high (clupeids) to low (dogfish and gobies).

13.6.296 Several species of conservation interest were identified, including sea trout, river lamprey and European eel. Sea trout are considered to have hearing abilities similar to the Atlantic salmon and are assessed as being generalists (fish with swim bladder not associated with hearing).

13.6.297 River lamprey and European eel are considered to be, at the most, hearing generalists, with little in the way of anatomical adaptation to assist hearing [RD134]. There has been no research to date on the response of lamprey to sound, and Popper [RD134] presented that sound may not be biologically important for lamprey. Owing to the lack of research into the hearing of lamprey, the criteria from Popper [RD133] for fish with no swim bladders has been adopted for the assessment.

13.6.298 The hearing ability of European eel is also poorly documented with only one known study that looked specifically at hearing in the eel [RD135]. The anatomy of the eel is such that the swim bladder is positioned some distance from the ear. Therefore, for the purposes of this assessment eel are considered to be hearing generalists and the criteria from Popper *et al*., [RD133] for fish with no swim bladders has been adopted.

13.6.299 The marine construction methods of dredging, drilling, rock cutting and vessel movements are continuous sounds and therefore the criteria defined by Popper *et al*., [RD133] can be used for the assessment of effect.

13.6.300 Those fish with swim bladders that are associated with hearing are considered specialists in terms of hearing ability and are therefore at higher risk of injury resulting from sound pressure. This includes species such as herring and sprat.

13.6.301 For this group there are only defined sound levels for effects of Temporary Threshold Shift (TTS and recoverable injury (table D13-13) based on research on the goldfish (*Carassius auratus*) [RD133]. For other species the assessment is based on the risk of effect rather than a defined sound level (table D13-13). The ranges of effect for fish with swim bladders associated

with hearing for each of the continuous noise sources are provided in table D13-14.

Table D13-14 Summary of modelled impact ranges for fish with swim bladders involved in hearing [RD132] to sound pressure levels (SPL_{RMS}) for cutter-suction dredging, rock cutting and drilling

Activity	Range to effect	
	Recoverable injury (48 h) 170 dB re 1 µPa (SPL_{RMS})	TTS (12 h) 158 dB re 1 µPa (SPL_{RMS})
Cutter-suction dredger	2m	13m
Rock cutting	<1m	3m
Rotary drilling (242kW)	<1m	2m
Rotary drilling (570kW)	<1m	3m
Percussive drilling	7m	67m

13.6.302 Sound levels known to cause TTS in hearing specialists are in the region of 158dB re 1µPa (SPL_{RMS}), and for recoverable injury are in the region of 170dB re 1µPa (SPL_{RMS}). Modelling results for dredging, rock cutting and drilling have shown that sound levels of this magnitude are limited to close proximity of the works with recoverable injury at and within 7m and TTS within 67m. Recoverable injury includes damage to sensory hair cells or minor internal/external injury, whilst TTS is defined as any change in hearing of 6dB or greater that persists [RD133].

13.6.303 Modelling has also been undertaken to examine the potential impact with concurrent drilling rigs. Assuming there would be two drilling rigs working concurrently, the range of effect for TTS would not change for the 242kW rig and would increase from 3m to 5m for the 570kW drilling rig. For percussive drilling, the range of effect for concurrent rigs would increase from 67m to 100m for TTS and from 7m to 13m for recoverable injury. These ranges are again very localised to the area and as such effects will be limited with fish moving away from the sound source.

13.6.304 Rock breaking is considered a multiple pulse sound and as such different criteria apply. The range of effects from noise generated from rock breaking are shown in table D13-15. Modelling of rock breaking has been undertaken using piling operations as a proxy as it is assumed that the method of impact pulse would be similar.

Table D13-15 Summary of modelled impact ranges for fish with swim bladders involved in hearing ([RD133] to sound levels for rock breaking

Activity	Range to effect		
	Mortality and potential mortal injury >207 dB re 1 µPa (SPL_{peak})	Recoverable injury 203 dB re 1 µPa^{2}s (SEL_{cum})	TTS (12 h) 186 dB re 1 µPa^{2}s (SEL_{cum})
Rock breaking	1m	10m	180m

13.6.305 Sound levels known to cause mortality and recoverable injury in hearing specialists from noise sources such as piling are greater than 207dB re 1µPa (SPL_{peak}). Modelling results have shown that sound levels of this magnitude are limited to within 1m of the source.

13.6.306 Criteria for TTS resulting from pile driving is 186dB re 1µPa^2 (SEL_{cum}) for all fish and is modelled to extend out to 180m from the source. This indicates that fish are at moderate risk of TTS within these ranges.

13.6.307 The risk of mortality resulting from dredging, rock cutting and drilling is considered low, with potential effects of recoverable injury being restricted to within 2m of the works (using hearing specialists as a worst case). For rock breaking, the risk is also considered low with potential effects of recoverable injury being restricted to within 10m of the works (using hearing specialists as a worst case).

13.6.308 There are no defined sound levels for which behavioural affects are likely in marine fish; instead this is based on the risk to fish at arbitrary distances. For hearing sensitive species, the risk of behavioural effects from continuous noise sources is considered high when close to the source (within tens of metres), reducing to medium at distances of hundreds of metres and then low at ranges in the kilometres [RD133]. Behavioural effects include long-term changes in behaviour such as moving away from areas of feeding refuge or alteration of migration patterns [RD133].

13.6.309 For multiple pulse sounds, the risk of behavioural effects for hearing sensitive species is considered high when close to the source (within tens of metres), high at distances of hundreds of metres and then moderate at ranges in the kilometres [RD133]. The risk of behavioural effects to generalists is considered high risk near to the source, moderate in the intermediate (hundreds of metres) and low risk at distance.

13.6.310 Intertidal fish surveys within Porth-y-pistyll have indicated that catches are generally low with peaks in the abundance of sprat, herring and sand smelt in the summer months (appendix D13-4, Application Reference Number: 6.4.86). Despite the increased abundance of clupeids, the noise levels generated during the Marine Works are considered low, and the ranges to which behavioural effects are high risk are local to the works. In addition, the north Anglesey coast is typically rocky in nature with numerous inlets and bays and therefore fish displaced from within Porth-y-pistyll would have access to other similar habitats.

13.6.311 Sea trout, river lamprey and European eel identified from the baseline programme to date have been recorded in very low numbers. Effects on these species are considered highly unlikely as a result of the low level of noise generated by dredging and their limited presence in the area.

13.6.312 The larval fish community in the vicinity of the Power Station was characterised through dedicated ichthyoplankton surveys, and was dominated by sandeel, flatfish (pleuronectidae), clupeids and gobies, with inshore reef species also present (dragonets, blennies, wrasse etc.).

13.6.313 Modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots and have not accounted for bathymetry. This can therefore be considered representative of ships travelling to site, and a worst case scenario, as ships within Porth-y-pistyll will be moving considerably slower, and therefore are assumed to be quieter.

13.6.314 The modelling has shown that noise levels are low with sound pressure levels of 160dB re 1µPa (SPL_{RMS}) being limited to within 4m for large vessels and 1m for medium vessels (appendix D13-9, Application Reference Number: 6.4.91). Existing natural background noise levels for the wider area were recorded to be between 111.4dB re 1µPa (SPL_{RMS}) and 120.9dB re 1µPa (SPL_{RMS}) (based on all transects measured) (appendix D13-9, Application Reference Number: 6.4.91). This indicates that the noise levels generated from vessel movements will not be discernible above background noise after approximately 4.4km for large vessels and 2.4km for medium vessels.

13.6.315 The modelled ranges of effect for fish that are considered hearing specialists (those with a swim bladder involved in hearing) are shown in table D13-16. The ranges of effect for fish are localised with auditory injury being limited to within a meter of the vessels, and TTS occurring for large vessels within 4m. This is considered a worst case distance of effect as the vessels within Porth-y-pistyll and those involved in the construction activities will be small and slow moving.

Table D13-16 Summary of modelled ranges to effect for fish with a swim bladder involved in hearing [RD133] for vessel movements

SPL_{RMS}	Large vessels	Medium vessels
Recoverable injury (48h) 170dB re 1 µPa (SPL_{RMS})	<1m	<1m
TTS (12h) 158 dB re 1 µPa (SPL_{RMS})	4m	<1m

13.6.316 The modelling of marine construction activities has shown that the potential for mortal injury, recoverable injury and TTS are limited to within close proximity of the works. The duration of these activities extends over a number of months, although it is unlikely that all activities would occur simultaneously as they would require sequential elements. In addition to this, the Marine Works construction would not be undertaken continuously for the whole duration and therefore their use would be intermittent. 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.

13.6.317 It is considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. Therefore, the effect of underwater noise from construction is considered to be negligible for all fish receptors.

The effect of underwater noise on marine mammals

Marine mammal hearing

13.6.318 The auditory system in marine mammals is similar to that in terrestrial mammals, in that hearing apparatus can be divided into the outer ear, an air-filled middle ear and a liquid filled inner ear. In odontocetes (toothed cetaceans), sound is channelled to the middle ear through the lower jaw [RD136], whilst in mysticetes (baleen whales) sound is channelled in two ways, either through the soft tissue or through the skull itself [RD137].

13.6.319 Pinnipeds' hearing capabilities both in air and water have been reviewed by the Department of Commerce [RD138] who stated that the hearing range for this group is greatly reduced in air to 1kHz to 22kHz with sensitivity at 12kHz, compared to 1kHz to 180kHz in water with peak sensitivity at around 32kHz. Phocinid seals have a hearing range from 1kHz to 60kHz [RD139] with sensitivity between 8kHz and 35kHz.

13.6.320 The absolute hearing threshold is the minimum sound level at a specific frequency that can be heard in the absence of any other sounds. In mammals, exposure to sound levels above absolute hearing thresholds can result in either a TTS, when hearing sensitivity returns to normal after temporary loss, or a permanent threshold shift (PTS) when hearing is lost permanently. In the past, reliable information on the levels of sound that cause damage in marine mammals was not available and therefore common practice was to apply human damage risk criteria [RD139].

13.6.321 Applying damage risk criteria to marine mammals, it would be predicted that at low frequencies (<500Hz), TTS would occur at around 165dB re 1μPa to 180dB re 1μPa in seals, and at around 180dB re 1μPa to 210dB re 1μPa in small dolphins [RD140].

Thresholds and criteria used for marine mammals

13.6.322 There have been various studies looking at the effects of noise on marine mammals from which criteria have been established that set noise levels at which PTS and TTS are likely to occur. Southall *et al*., [RD141] presented a set of interim criteria for noise levels that may result in PTS or TTS for marine mammals. The Southall *et al*., [RD141] criteria are generally based on marine mammals grouped by their hearing sensitivity, based on frequency ranges, as follows:

- low-frequency cetaceans (7Hz to 22kHz);
- mid-frequency cetaceans (150Hz to 160kHz);

- high-frequency cetaceans (200Hz to 180kHz);
- pinnipeds in water (75Hz to 75kHz); and
- pinnipeds in air (75Hz to 30kHz).

13.6.323 More recent studies for harbour porpoise have indicated that this species is potentially more sensitive than as generalised in the study by Southall *et al*., [RD141]. Stricter criteria have therefore been developed by Nehls *et al*., [RD142] based on work by Lucke *et al*., [RD143] and Kastelein *et al*., [RD144] which looks at the SEL. In addition, the work by Lucke *et al*., [RD143] also sets levels where a minor behavioural effect may occur in harbour porpoise.

13.6.324 The auditory injury criteria based on unweighted metrics and sources used in this assessment are shown in table D13-17.

Table D13-17 Summary of criteria used in the assessment of underwater noise on marine mammals

Effect	Criteria	Weighting	Species	Reference
Lethal effect	240dB re 1µPa	Unweighted SPL_{peak}	All	[RD144]
Physical injury	220dB re 1µPa	Unweighted SPL_{peak}	All	
PTS	230dB re 1µPa	Unweighted SPL_{peak}	Low, Mid, High-frequency cetaceans.	[RD140]
TTS	22 dB re 1µPa	Unweighted SPL_{peak}		
PTS	218dB re 1µPa	Unweighted SPL_{peak}	Pinnipeds (in water)	
TTS	212dB re 1µPa	Unweighted SPL_{peak}		
PTS	180dB re 1µPa^2 s	Single strike unweighted Sound Exposure Level (SEL)	Harbour porpoise	[RD141]
TTS	165dB re 1µPa^2 s	Single strike unweighted SEL		
Behavioural effect	145dB re 1µPa^2 s	Single strike unweighted SEL		[RD142]

13.6.325 Additional criteria based on an individual's hearing ability have also been used in the assessment (M-weighted criteria). M-weighted SELs from Hammond and Harris [RD140] have been used for the four groups of cetaceans as described in paragraph 13.6.322. The M-weighted criteria are based on PTS and TTS and depend on the noise source; pulsed (single/multiple) or non-pulsed (continuous) and are presented in table D13-18.

Table D13-18 M-weighted criteria for PTS and TTS from [RD141]

Criteria	Effect	Species	Source
198dB re 1µPa^{2}s (M)	PTS	Cetaceans	Single and multiple pulsed over a 24-hour period
186dB re 1µPa^{2}s (M)		Pinnipeds	
215dB re 1µPa^{2}s (M)		Cetaceans	Non-pulsed (continuous) over a 24-hour period
203dB re 1µPa^{2}s (M)		Pinnipeds	
183dB re 1µPa^{2}s (M)	TTS	Cetaceans	Single pulse sounds
171dB re 1µPa^{2}s (M)		Pinnipeds	

13.6.326 Behavioural responses of marine mammals to noise are highly variable and dependent on a suite of internal and external factors [RD139]. Behavioural responses can include changes in surfacing patterns, cessation of vocalisations, active avoidance of or exit from the area [RD139]. It is likely that responses are context-specific, and internal factors include:

- individual hearing sensitivity and tolerance;
- activity pattern;
- motivational and behavioural state at the time of exposure;
- past exposure of the animal to the noise (which may have led to habituation or sensitisation);
- predation risk; and
- demographic factors such as age, sex and presence of dependent offspring.

13.6.327 External factors that influence behavioural responses of marine mammals can include the size of the sound source and whether the sound source is stationary or moving (e.g. a vessel). Physical habitat characteristics can also influence sound transmission, such as being in a confined location or in proximity to a shoreline.

13.6.328 To assess the behavioural avoidance of marine mammals, criteria from Finneran and Jenkins [RD146] have been used (appendix D13-9, Application Reference Number: 6.4.91). These criteria use several different weightings listed as 'Type I', which is the same as M-Weighting from Southall *et al*., [RD141] and 'Type II', which is a modified version of the filter based on an alternative weighting function.

13.6.329 This criterion is based on blasting operations however provides a criterion against which behaviour can be assessed. Finneran and Jenkins [RD146] state that, for single detonations, behavioural disturbance is likely to be limited to a short-lived startle reaction; therefore Finneran and Jenkins [RD146] do not suggest any unique behavioural disturbance thresholds for marine mammals exposed to single explosive events. The criteria for multiple successive detonations are set 5dB below the SEL based on the

level at which TTS occurs. These would represent a worst case and are used for rock breaking activates in lieu of further information on behavioural avoidance in marine mammals.

13.6.330 These criteria are presented in table D13-19 and have been based on a modelled stationary animal subject to multiple explosions over a 24 hour period. As a result of this, the criteria is only used in the assessment of rock breaking as it is not representative for continuous noise sources such as drilling and dredging.

Table D13-19 Behavioural avoidance criteria after [RD150]

Criteria	Weighting	Species
167dB re 1µPa^{2}s SEL	Type II Weighting	Mid-frequency cetacean
141dB re 1µPa^{2}s SEL	Type II Weighting	High-frequency cetacean
172dB re 1µPa^{2}s SEL	Type I Weighting	Pinnipeds (in water)

13.6.331 Of the three cetacean species frequently observed, the harbour porpoise is considered a high-frequency species, and both the bottlenose dolphin and Risso's dolphin are considered mid-frequency species [RD141].

Dredging and drilling operations

13.6.332 The modelling results for high-frequency cetaceans (harbour porpoise) uses the criteria of Nehls *et al*., [RD142] and Lucke *et al*., [RD143] and are summarised in table D13-20.

Table D13-20 Summary of modelled impact ranges for harbour porpoise from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by [RD142] (PTS and TTS) and [RD143] (behavioural). *Unit ss represents single strike

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1µPa^{2}s (SELss*)	Range to TTS in harbour porpoise 165dB re 1µPa^{2}s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1µPa^{2}s (SELss*)
Cutter-suction dredger	<1m	4m	99m
Rock cutting	<1m	<1m	15m
Rotary drilling (242kW)	<1m	<1m	9m
Rotary drilling (570kW)	<1m	<1m	18m
Percussive drilling	2m	17m	390m

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1μPa²s (SELss*)	Range to TTS in harbour porpoise 165dB re 1μPa²s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1μPa²s (SELss*)
Concurrent rotary drilling rigs	<1m	1m	28m
Concurrent percussive drilling rigs	3m	36m	530m

13.6.333 For mid-frequency cetaceans (bottlenose dolphin) the modelling uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] with summary results in table D13-21. There are no M-weighted criteria for TTS given by Southall *et al*., [RD141] for non-pulsed continuous sound, and therefore no range to TTS is presented. In the absence of other criteria for behavioural avoidance of bottlenose dolphin the cumulative criteria of Finneran and Jenkins [RD146] is used. This is based on a worst case situation with noise exposure on a stationary animal over 24 hours of operation. This is precautionary as it is a highly unlikely scenario; if an animal moves away from the noise source the effect will be greatly reduced to a negligible range.

Table D13-21 Summary of modelled impact ranges for bottlenose dolphin from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by Southall *et al*., [RD141] (PTS and TTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mmf represents M-weighting for mid-frequency cetacean

Activity	Range to PTS in bottlenose dolphin 215dB re 1μPa²s (Mmf*)	Range to behavioural effect in bottlenose dolphin 167dB re 1μPa²s (Type II)
Cutter-suction dredger	<1m	130m
Rock cutting	<1m	88m
Rotary drilling (242kW)	<1m	7m
Rotary drilling (570kW)	<1m	16m
Percussive drilling	3m	480m
Concurrent rotary drilling rigs	<1m	26m
Concurrent percussive drilling rigs	4m	620m

13.6.334 During drilling, cutting and dredging operations there is no potential risk of physical injury for marine mammals from underwater noise as the noise levels generated are below those required to cause physical injury.

13.6.335 It is apparent that, for these works, the risks of PTS and TTS are localised to the noise source and are therefore very unlikely to result in injury. Modelling results for dredging and drilling show that PTS would within 4m of the source for concurrent percussive drilling on bottlenose dolphin, and within 3m of the source for harbour porpoise.

13.6.336 Baseline surveys and available literature have shown that sightings of harbour porpoise within the shallow bays of Porth-y-pistyll and Cemaes are generally low, with higher numbers observed around Wylfa Head (appendix D13-6, Application Reference Number: 6.4.88). In addition, incidental sightings collected during the detailed offshore geotechnical investigations within Porth-y-pistyll have shown that between 7 July and 14 August 2016, no harbour porpoise were seen within a zone of 150m radius.

13.6.337 The range to PTS in harbour porpoise is shown to be a maximum of 3m from the source. Using the Wylfa Newydd Development Area densities it is estimated that considerably less than one harbour porpoise (0.00004) would be affected by PTS as a result of the dredging and drilling operations. This represents a very small proportion (0.00001%) of the estimated population of 104,695 (CV=0.32) individuals within the Celtic and Irish Sea Management Unit [RD151].

13.6.338 Behavioural effects in harbour porpoise have been modelled using criteria set by Finneran and Jenkins [RD143]. Using the ranges of effect from the works, and assuming that they are constant around the source (worst case), it shows that dredging and drilling could cause behavioural avoidance within a maximum area of approximately 83ha (based on concurrent percussive drilling). Using harbour porpoise densities determined within the Wylfa Newydd Development Area (126ha) it is estimated that less than two harbour porpoise (1.05) would show behavioural avoidance.

13.6.339 Existing records show that the distribution of bottlenose dolphin tends to be concentrated to the east of Anglesey between Bull Bay and Llandudno [RD37]. Very few sightings have been recorded from the Wylfa Newydd Development Area (appendix D13-6, Application Reference Number: 6.4.88). The nearest population estimates for bottlenose dolphin are those within the Irish Sea (SCANS II, survey block O) and are reported to be in the region of 235 individuals (CV = 0.75) with a density equivalent of 0.0052 individuals/km^2 ([RD33] cited in [RD147]).

13.6.340 The range to PTS in bottlenose dolphin is shown to be a maximum of 4m from the source. Using the Wylfa Newydd Development Area densities it is estimated that considerably less than one bottlenose dolphin (0.000017) would be affected by PTS as a result of the dredging and drilling operations. This represents a very small proportion (<0.00001%) of the reference population of 235 individuals ([RD33] cited in [RD147]).

13.6.341 Behavioural effects in bottlenose dolphin have been modelled using criteria set by Finneran and Jenkins [RD146]. Using the ranges of effect from the works, and assuming that they are constant around the source (worst case), it shows that dredging and drilling could cause behavioural avoidance within a maximum area of approximately 111ha (based on concurrent percussive drilling). Using the bottlenose dolphin densities determined within the Wylfa

Newydd Development Area (0.34/km^2) it is estimated that less than one bottlenose dolphin (0.38) would show behavioural avoidance.

13.6.342 Like the bottlenose dolphin, Risso's dolphin is considered to be a mid-frequency species which suggests that the effects on these two species from dredging and drilling operations could be broadly similar. Although existing records show that the distribution of Risso's dolphin tends to be concentrated around the north and west Lleyn Peninsula, east Anglesey and the Isle of Man (appendix D13-6, Application Reference Number: 6.4.88), this species is much less common in the area than harbour porpoise and bottlenose dolphin. There are currently no population estimates for the Risso's dolphin.

13.6.343 Considering the low abundance of Risso's dolphin in the area and the effects of underwater noise disturbance on bottlenose dolphin which is assumed to be a proxy, it is unlikely that dredging and drilling operations will have an effect on this species.

13.6.344 The modelling results for pinnipeds in water uses the criteria of Southall et al., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-22.

Table D13-22 Summary of modelled impact ranges for pinnipeds in water from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by Southall *et al*., [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1µPa^{2}s (Mpw*) (pulsed)	Range to PTS 203dB re 1µPa^{2}s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1µPa^{2}s (Type II)
Cutter-suction dredger	n/a	5m	500m
Rock cutting	n/a	4m	320m
Rotary drilling (242kW)	n/a	1m	130m
Rotary drilling (570kW)	n/a	1m	230m
Percussive drilling	n/a	41m	4.1km
Concurrent rotary drilling rigs	n/a	3m	300m
Concurrent percussive drilling rigs	n/a	71m	5.9km

13.6.345 Modelling results using the M-weighted criteria of Southall *et al*., [RD141], for continuous sounds, show that in pinnipeds, PTS would be experienced within 5m from the source. Based on drilling rigs running concurrently and side by side (an unlikely scenario), PTS would be experienced within 71m of the

sound source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 500m, for dredging, though for concurrent drilling this would extend out to 5.9km.

13.6.346 Based on the range to PTS of 71m, and assuming that this distance is taken from the furthest seaward point of the dredge and drilling operations, the area in which PTS could occur for pinnipeds in water would be approximately 1.6ha. For behavioural effects the area of effect would be approximately 6054ha.

13.6.347 Grey seal are present along the north Anglesey coast throughout the year. The relative density of grey seal in the vicinity of the Wylfa Newydd Development Area is estimated to be 0.24 individuals/km^2. Observations made during the detailed offshore geotechnical investigations within Porth-y-pistyll have shown that between 7 July and 14 August 2016, only three seals were seen within a mitigation zone of a 150m radius; an additional two were seen outside. Using these densities PTS is predicted to affect less than one (0.004) grey seal, representing 0.00006% of the reference population of 6,000 individuals.

13.6.348 The modelling has indicated that the effects associated with PTS and TTS are within close proximity to the works, and behavioural avoidance could extend out to approximately 530m, 620m and 4.1km for harbour porpoise, bottlenose dolphin and grey seal, respectively. Dredging and drilling operations are programmed to extend over several months, although the work will not be continuous for the whole period. It is therefore assumed that behavioural effects are likely to result in temporary displacement of marine mammals from the area around the works, with avoidance occurring before any mortality or physical damage would occur.

Rock breaking and cutting

13.6.349 The modelling results for high-frequency cetaceans (harbour porpoise) uses the criteria of Nehls *et al*., [RD142] and Lucke *et al*., [RD143] and are summarised in table D13-23.

Table D13-23 Summary of modelled impact ranges for harbour porpoise from rock breaking based on criteria set by Nehls *et al*., [RD142] (PTS and TTS) and Lucke *et al*., [RD143] (behavioural). *Unit ss represents single strike

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1μPa^{2}s (SELss*)	Range to TTS in harbour porpoise 165dB re 1μPa^{2}s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1μPa^{2}s (SELss*)
Rock breaking	3m	25m	490m

13.6.350 For mid-frequency cetaceans (bottlenose dolphin) the modelling uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] with summary results in table D13-24.

Table D13-24 Summary of modelled impact ranges for bottlenose dolphin from rock breaking based on criteria set by Southall et al., [RD141] (PTS and TTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mmf represents M-weighting for mid-frequency cetacean

Activity	Range to PTS in bottlenose dolphin 198dB re 1μPa^{2}s (Mmf*)	Range to behavioural effect in bottlenose dolphin 167dB re 1μPa^{2}s (Type II)
Rock breaking	36m	600m

13.6.351 The modelling results for pinnipeds in water uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-25.

Table D13-25 Summary of modelled impact ranges for pinnipeds in water from rock breaking based on criteria set by Southall *et al.*, [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1μPa^{2}s (Mpw*) (Pulsed)	Range to PTS 203dB re 1μPa^{2}s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1μPa^{2}s (Type II)
Rock breaking	450m	n/a	3.3km

13.6.352 During rock breaking and cutting operations there is no potential risk of physical injury for marine mammals from underwater noise as the noise levels generated are below those required to cause physical injury.

13.6.353 Modelled results (table D13-23) for rock breaking show that for harbour porpoise, PTS would be experienced up to 3m from the source (an approximate area of 0.003ha). Behavioural avoidance would be limited to within 490m using the unweighted criteria set by Lucke *et al.*, [RD143] which is approximately 72ha.

13.6.354 Observations of harbour porpoise numbers within the direct footprint of the works are low. Using the harbour porpoise densities for the Wylfa Newydd Development Area rock breaking activities would affect considerably less that one (0.00004) harbour porpoise. This represents a very small proportion (<0.00001%) of the reference population [RD147]. Damage resulting from PTS is therefore considered unlikely. Likewise, rock breaking has the potential to only affect less than one (0.91) harbour porpoise through behavioural avoidance.

13.6.355 Modelling results (13.6.350) of rock breaking in mid-frequency cetaceans (bottlenose dolphin and Risso's dolphin), shows that PTS would be experienced within approximately 36m of the source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 600m.

13.6.356 Based on the modelled range to PTS of 36m, and assuming that this distance is taken from the furthest seaward point of dredge operations, an approximate area of 104ha would be the area of behavioural effect for bottlenose dolphin and Risso's dolphin.

13.6.357 Using the bottlenose dolphin densities for the Wylfa Newydd Development Area, it is considered unlikely that bottlenose dolphin will be affected by the rock breaking operations. Owing to Risso's dolphin being less common in the area, a similar assumption could be made in that it is unlikely that dredging operations would affect this species.

13.6.358 For rock breaking the modelling results (table D13-25) show that in pinnipeds, PTS would extend out to 450m from the source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 3.3km.

13.6.359 Based on the range to PTS for rock breaking and assuming that this distance is taken from the furthest seaward point of dredge operations, the area of effect for pinnipeds in water would be approximately 61ha. Using grey seal densities for the Wylfa Newydd Development Area, PTS is predicted to affect less than one (0.15) grey seal, representing 0.0025% of the reference population.

Vessel movements

13.6.360 The predicted noise levels for vessels when compared with other construction methods are low, with cumulative noise exposure from large vessels being comparable to that of dredging. The predicted noise levels from vessel movements is not discernible above measured background noise levels at distances of 2.4km for medium vessels and 4.4km for large vessels.

13.6.361 The impact ranges based on criteria from Nehls *et al*., [RD142], and Lucke *et al*., [RD143] show that PTS and TTS from vessel movements is considered unlikely (table D13-26). The ranges to behavioural effects are limited to within 60m of large vessels and 10m of medium vessels. These ranges are localised to the vessels and as such no impacts to marine mammals are predicted, with only localised avoidance.

Table D13-26 Summary of modelled impact ranges for harbour porpoise from vessel movements based on criteria set by Nehls *et al*., [RD142] (PTS and TTS) and Lucke *et al*., [RD143] (behavioural)

Activity	Range to effect		
	Range to PTS in Harbour porpoise 180dB re 1µPa^{2}s (SELss)	Range to TTS in Harbour porpoise 165dB re 1µPa^{2}s (SELss)	Range to behavioural effect in Harbour porpoise 145dB re 1µPa$_2$s (SELss)
Large vessels	<1m	<1m	60m
Medium vessels	<1m	<1m	10m

13.6.362 The modelling results for pinnipeds in water uses the criteria of Southall et al., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-27.

Table D13-27 Summary of modelled impact ranges for pinnipeds in water from vessel movements based on criteria set by Southall *et al*., [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1µPa^{2}s (Mpw*) (pulsed)	Range to PTS 203dB re 1µPa^{2}s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1µPa^{2}s (Type II)
Large vessels	n/a	<1m	<1m
Medium vessels	n/a	<1m	<1m

13.6.363 It has been suggested that the primary effect of vessel movements is the masking of biologically important sounds [RD148]. However, most shipping generates low frequency sound below 1kHz and is therefore outside of the auditory range for most cetaceans and it is likely to be only detectable to pinnipeds [RD149]. The effect to cetaceans is considered to be negligible and has not been considered further in the assessment.

Summary of effects to marine mammals

13.6.364 Modelling results for underwater noise during construction have shown that marine mammals would not be at risk of physical injury or fatality from underwater noise generated by any of the construction activities.

13.6.365 There is potential for PTS and TTS effects although these would be localised (≤71m). Considering marine mammal densities within the vicinity of the Wylfa Newydd Development Area, the number of individuals and the proportion of marine mammal populations potentially at risk of PTS or TTS is considered to be small, with avoidance expected to occur before any auditory damage (temporary or permanent). In addition, as good practice mitigation, the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8) sets out best practice guidance

(i.e. JNCC guidance) to reduce the risk of PTS and TTS effects to marine mammals.

13.6.366 Modelling results of underwater noise during construction have shown that behavioural disturbance could occur over a larger area (pinnipeds could be affected up to 5.9km away as a result of underwater noise disturbance generated from concurrent percussive drilling rigs). However, considering marine mammal densities within the vicinity of the Wylfa Newydd Development Area, the number of individuals and the proportion of marine mammal populations potentially at risk of behavioural disturbance is considered to be low. Nonetheless, the marine construction works are likely to result in displacement of individuals from the area around the works.

13.6.367 The total duration of the Marine Works is expected to be 32 months; rock breaking would occur for 16 months whilst all other activities (e.g. dredging, drilling and rock cutting) are each expected to occur for only a few months. Generally, these construction activities are not expected to occur concurrently as they will require sequential elements. In addition, they would not be undertaken continuously for the whole duration of the works and therefore underwater noise disturbance over the two years would be intermittent. Any displacement of marine mammals is likely to be temporary with the area around the works available to marine mammals outside the periods of construction activity.

13.6.368 Considering the information presented above and the good practice mitigation proposed, the magnitude of change is considered to be small resulting in a minor adverse effect from underwater noise on marine mammals.

The effects of underwater noise on designated sites

13.6.369 Of the marine construction activities assessed above, rock breaking is the only one that has the potential to result in a significant effect on the harbour porpoise and therefore has the potential to affect the North Anglesey Marine cSAC. Based on the modelled range to PTS of 3m from the source, and assuming that this distance is taken from the furthest seaward point of rock breaking operations, the area of effect for harbour porpoise would be approximately 0.003ha. Using the densities for harbour porpoise presented by Shucksmith *et al*., [RD35], PTS could affect considerably less than one (0.00004) harbour porpoise.

13.6.370 No population estimate has been defined for harbour porpoise within the SAC but a value of 1,084 individuals is provided within the SAC selection assessment document [RD150]. It is noted that this figure is only indicative as it is based on a single month's survey in a single year, but can be used to provide an indication of numbers within the SAC. It is also recognised that harbour porpoise are most prevalent in the SAC during the summer months [RD150].

13.6.371 The reference populations used for the harbour porpoise are therefore the estimated abundance of 104,695 (CV=0.32) individuals within the Celtic and Irish Sea Management Unit [RD151], of which the effect of PTS is a very small proportion (less than 1%).

13.6.372 A potential minor adverse effect on the harbour porpoise has been identified owing to a temporary displacement effect, and therefore there is potential for a minor adverse effect on the North Anglesey Marine cSAC.

Impact pathway: airborne noise from Main Construction activities leading to species disturbance

General context

13.6.373 An increase in noise may lead to avoidance behaviour and could potentially affect breeding or foraging activities which may have wider implications for populations. This pathway considers noise transmitted via the air; the effects on marine receptors from underwater noise are considered above. During construction the main sources of airborne noise generation are likely to be:

- stripping of topsoil and placing stripped topsoil in storage mounds with installation of associated drainage;
- demolition of existing buildings to ground level;
- rock excavation by blasting;
- piling, including sheet piling, to construct a temporary cofferdam and reinforce the southern causeway;
- rock cutting, to excavate the core of the temporary cofferdam and reinforce the southern causeway;
- dewatering, which would require generators for pumps;
- soil clearance and mound creation; and
- construction of haul roads, platforms and laydown areas.

13.6.374 The total construction period is seven years, and in the first two years there would be both marine-based and land-based construction. Noise modelling of the construction works has been carried out for four periods during the construction period and the results compared to the existing baseline conditions (see chapter D6, noise and vibration, Application Reference Number: 6.4.6). Additional noise predictions have been undertaken specifically to assess the bounding-case for marine ecological receptors (see appendix D13-13, Noise at Marine Ecological Receptors, Application Reference Number: 6.4.95).

13.6.375 The construction activities on-site are inherently dynamic. The noise levels that a receptor would experience at a particular point in time will depend on the nature of the activities being undertaken at that moment, and the location of the activities in relation to the receptor. It is not possible to predict the noise level that a receptor would experience at a particular time of day. Instead the prediction of noise from the construction works aims to represent typical noise levels that would be expected at a location over a three month period.

13.6.376 A number of good practice mitigation measures are proposed to reduce the effects of airborne noise during the construction phase (see paragraphs 13.5.90 and 13.5.91).

Effects on marine mammals

13.6.377 Rock fracturing work would be carried out in line with the relevant guidelines, which ensures the protection of human receptors. Vibration effects decay quickly with distance and would not lead to an effect on sound underwater. As such, a pathway arising from airborne noise or vibration disturbance to cetaceans has been ruled out.

13.6.378 Pinnipeds (e.g. grey seals) that have surfaced or have hauled out could be affected by airborne noise from land-based and marine-based construction activities. Disturbance from noise could potentially cause grey seals to stop feeding, resting, travelling and/or socialising, with possible long-term effects of repeated disturbance including permanent displacement and/or a decline in fitness and productivity.

13.6.379 There are no primary or secondary breeding haul-out sites for grey seal along the north Anglesey coastline, with the nearest one located on The Skerries, which is over 7km from the Wylfa Newydd Development Area [RD41]; [RD102]. Sightings of grey seals in the vicinity of Porth-y-pistyll are typically of individuals or small groups in the water (see appendix D13-6, Application Reference Number: 6.4.88). Throughout the marine environment baseline survey period, there have been no sightings of breeding seals or pups within the vicinity of the Wylfa Newydd Development Area, although incidental sightings have been reported along the broader north Anglesey coastline.

13.6.380 Based on the predicted noise modelling described in appendix D13-13 (Application Reference Number: 6.4.95) it is predicted that the A-weighted maximum sound ($L_{AF,max}$) levels to be generated within Porth-y-pistyll result from rock breaking within the intertidal area where the Cooling Water intake would be (66.7dB $L_{AF,max}$). Works within Porth-y-pistyll may require impact piling through the temporary causeway and cofferdam should vibratory piling not be sufficient. In this instance, noise levels within the Porth-y-pistyll would reach a maximum of 80.3dB $L_{AF\ max}$, and levels in Cemlyn Bay would reach a maximum of 63.4dB $L_{AF\ max}$.

13.6.381 There is little best practice guidance relating to the review of airborne noise disturbance on hauled-out seals directly. The sensitivity of grey seals to airborne noise is thought to be similar to human sensitivity [RD151]. General industry best practice is to establish a 500m exclusion zone around seal haul-out sites located within the vicinity of a development [RD152]. There are no primary or secondary grey seal haul-out sites along the North Anglesey coast and although the haul-out of individuals or small groups of grey seals would be expected along the coastline, the likelihood of this occurring within 500m of the Marine Works in Porth-y-pistyll is extremely low.

13.6.382 If grey seals were to haul-out within 500m of the Marine Works, temporary or permanent physical damage to these individuals as a result of airborne noise disturbance is highly unlikely; an avoidance response would be the most likely pathway of effect. There is wide availability of habitats known to be used as haul-out sites (intertidal rocky outcrops, beaches and sea caves that are tidally exposed) along the north Anglesey coastline [RD153]. Therefore, the effects of airborne noise on hauled-out seals would not have an effect on the integrity of the wider population.

13.6.383 As very few individual grey seals are likely to be affected and there would be no wider effects on populations, the magnitude of change is predicted to be negligible and the effect on grey seals from airborne noise is considered to be negligible.

Effects on seabirds

13.6.384 An increase in airborne noise can mask biologically useful sounds (i.e. 'signals' e.g. birds' contact calls from predators) or impair hearing of seabirds. This could result in the range and distribution of seabirds being constrained, and the potential for decreased fitness and productivity if breeding birds are disturbed by noise. Nesting birds can also be vulnerable to human-induced disturbance from noise and or visual sources that can directly affect reproductive success or survival, with effects including reduction in daytime nest attentiveness and reduction in time spent incubating eggs (potentially leading to a reduction in hatch rates and an increased risk of egg and chick predation), smaller proportions of collected food being allocated to chicks, and energetic costs to birds engaged in avoidance behaviours [RD158].

13.6.385 Airborne noise disturbance effects could also lead to abandonment of the tern colony, if sufficiently high in magnitude and frequency of the effect. Tern colony abandonment normally occurs after eggs and or chicks are lost to predators or flood events, or when levels of disturbance (human or otherwise) are sufficiently high as to present an imminent and repeated danger to adult birds or their eggs and chicks. Disturbance effects which do not pose an obvious danger to the birds can elicit a reaction from the birds, e.g. a fly up of adults from the colony, but are not likely to result in colony abandonment. Noise effects alone, with no associated visual threat of danger, are unlikely to lead to colony abandonment.

13.6.386 Flying or actively feeding seabirds may react to unexpected noise disturbance by diverting their flight or avoiding an affected area; this could affect seabirds by reducing access to feeding resources if present within noisy areas and/or increasing energy demands due to flight deviation, thus affecting breeding success and population sustainability.

13.6.387 Garthe and Hüppop [RD155] produced a sensitivity index to measure the potential vulnerability of seabirds to marine wind farms. The sensitivity index was informed by nine different factors, including the species vulnerability to disturbance by ship and helicopter traffic as this was believed to give an indication of the general behaviour of birds towards disturbances (albeit noise and visual combined). The study concluded that Sandwich tern, common tern and Arctic tern are relatively tolerant of disturbance, with each species being scored a '2', on a scale from '1' (hardly any escape/avoidance behaviour and/or none/very low fleeing distance) to '5' (strong escape/avoidance behaviour and/or large fleeing distance). Gulls (herring, lesser black-backed, common and black-headed) and great-crested grebe were also deemed to be relatively tolerant of disturbance, with each species being scored a '2'. Guillemot and razorbill (*Alca torda*) were deemed less tolerant with a score of '3'. Cormorant (*Phalacrocorax carbo*) displayed

stronger escape/avoidance behaviour and/or with a larger fleeing distance and were given a score of '4'.

13.6.388 For the purpose of this assessment, seabirds are differentiated into target species (i.e. qualifying species of the Anglesey Terns/Morwenoliaid Ynys Môn SPA: Arctic tern, common tern, roseate tern and Sandwich tern) and secondary species (i.e. those species other than terns, which are specially protected or are of conservation concern). Black-headed gull is assessed as a secondary species, but is also considered within the assessment of effects on target species during the breeding season due to its commensal relationship with Sandwich terns

13.6.389 The construction activities from which disturbance to seabirds can potentially arise can be differentiated into two categories. These categories comprise regular construction activities that produce noise levels which can be modelled such as piling, drilling and the use of machinery and those activities that produce airborne pressure waves over frequencies that are made up of audible sound, and concussion.

Construction noise

13.6.390 Worst case noise levels generated by the construction works have been modelled for four periods, each with a three-month duration, during the construction period (see chapter B6, Application Reference Number: 6.2.6) for detail on the noise modelling methodology employed). The assessment of noise effects is partly based on these modelled noise levels (see chapter D6, Application Reference Number: 6.4.6) for a description of the construction scenarios and effects on humans). Additional bounding-case noise modelling (with one or more inputs set to their limit values) has also been undertaken for marine receptors. This assumes that all construction plant would be close to the sea and that all construction plant would be operating at under full load simultaneously (see appendix D13-13, Application Reference Number: 6.4.95). It is not expected that the bounding-case conditions will occur in practice, but if a similar situation was to occur, then it would only be for a very short time. The results of the bounding-case noise modelling are therefore considered to be representative a short period of time, and are presented in terms of the A-weighted equivalent continuous noise level over five minutes ($L_{Aeq,5min}$).

13.6.391 Based on construction noise modelling described in chapter D6 (Application Reference Number: 6.4.6), i.e. without blasting taken into account, it is predicted that the highest noise level (presented in terms of a typical equivalent continuous noise level over one hour, $L_{Aeq,1\text{-}hour}$) during construction at the tern breeding colony at Cemlyn Lagoon would be 60dB $L_{Aeq,1\text{-}hour}$, whereas for the majority of Porth-y-pistyll it would be between 70 and 80dB $L_{Aeq,1\text{-}hour}$, with a very small area at the south-east of the bay at 80-85dB $L_{Aeq,1\text{-}hour}$ (see chapter D6, Application Reference Number: 6.4.6). The bounding-case construction scenario predicts highest noise levels of 55dB $L_{Aeq,5min}$ to 65dB $L_{Aeq,5min}$ (averaged over five minutes) at the tern breeding colony and 75dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ over the majority of Porth-y-pistyll, with 80dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and greater than 85dB $L_{Aeq,5min}$ within very small areas.

13.6.392 Although wind direction and strength can affect how noise attenuates with distance, the construction noise models do not take into account wind conditions. This is because the code of practice which sets out the method for predicting noise from construction sites in the UK (BS 5228-1:2009+A1:2014 [RD156]) does not include the effects of wind direction, the effects of atmospheric attenuation or several other attenuation effects. However, comparison with more sophisticated noise modelling methodologies (e.g. ISO9613-2 [RD157]) show that BS 5228-1 [RD156] provides higher estimates of noise at distance even when downwind conditions are specified in the more sophisticated noise model.

13.6.393 The baseline noise levels at the tern colony at Cemlyn Bay have been monitored and are very variable, including many impulsive noise events above 70dB $L_{AF,max}$. Baseline noise is dependent on factors such as wind conditions, the state of the tide and the number of terns present. Baseline noise levels can vary in any particular hour between 35dB and 45dB on a quiet day, to between 60dB and 68dB on a noisier day. There are however many noisier events, from known sources such as low flying jet aircraft and unknown sources (see appendix D13-7, Application Reference Number: 6.4.89 and D13-12, Application Reference Number: 6.4.94). The highest noise event which was identified was that caused by a low flying RAF jet of 88.8dB $L_{AF,max}$.

13.6.394 Seventy-six hours of monitoring identified 179 events of potentially disturbing occurrences and/or reactions from the terns. From these 179 events, 121 reactions from terns were recorded. Approximately two thirds (66%) of these reactions (80 reactions) have no obvious attributable cause detected by the surveyors, and for which no noise stimulus was recorded by the microphone. On these occasions, the terns were potentially reacting to a stimulus missed/ not detected by the surveyors and microphone. It is also possible that not all tern fly ups at a colony happen in reaction to a disturbing stimulus, and that a proportion of fly ups are attributable to social behaviour of the colony. Of the reactions from terns where a cause was detected by the surveyors, 18% were caused by predators; 5% caused by non-predator species (e.g. geese); and 10% by human-induced causes (including aircraft, vehicles, people and dogs).

13.6.395 Fifty-eight disturbance events were recorded that did not lead to any reaction from the terns, with an average associated noise level of 72.6dB $L_{AF,max}$ and the highest being 87.6dB $L_{AF,max}$. There were 13 instances where the terns flew up in reaction to anthropogenic disturbance sources (visual and noise), with an average level of 77.5dB $L_{AF,max}$ and a minimum level of 69.7dB $L_{AF,max}$. These events included jets flying overhead, with noise levels of 78.2dB(A) and 88.8dB $L_{AF,max}$.

13.6.396 For the thirteen anthropogenic events resulting in a reaction from the terns described above, the disturbance sources were a combination of visual and noise. There were 10 noise-only events recorded during the disturbance monitoring surveys, none of which elicited a response from the terns. Decibel values ranged from 46.8dB to 76.6dB, average 66.5dB.

13.6.397 Three of the disturbance events were from sources giving impulsive noise with a sharp attack/rise-up time, the loudest of which was a tractor door slamming shut at 75.6dB. The other sources were a distant gunshot and a grain container slamming closed. None of these impulsive noise events caused a reaction from the terns.

Blasting noise

13.6.398 Blasting operations are required in a number of locations across the site to facilitate excavation. The nearest blasting activities to seabird receptors would be located within the marine environment in Porth-y-pistyll (dry blasting) and on land at approximately 1.5km from the islands in Cemlyn Lagoon which support terns in the breeding season. Blasting activities could occur up to six times per day during construction.

13.6.399 When blasting is carried out, energy is transmitted from the blast site in the form of airborne pressure waves. The effects of blasting have the potential to disturb nesting, roosting, foraging and flying seabirds, depending on factors such as:

- the source-receiver distance (i.e. the distance between blasting and sensitive areas);
- the maximum instantaneous charge weights used (which is related to the magnitude of air overpressure/ground-borne vibration generated at source);
- the frequency of blasting (how many times per day); and
- the blast design (for example, good blast design can reduce the magnitude of air overpressure generated for a given maximum instantaneous charge weight).

13.6.400 For highly confined blasts conducted for the deep excavations, which would be the large majority of blasting operations, the maximum sound levels are predicted to be 60dB $L_{AF,max}$ at the tern and black-headed gull breeding colony.

13.6.401 Proposed blast sites are also located within Porth-y-pistyll. At the tern and black-headed gull breeding colony, this would lead to noise levels of 62.9dB $L_{AF,max}$. At the gull colony at Porth Wnal, approximately 450m from the blasts, noise levels would be between 70.4dB $L_{AF,max}$ to 72.6dB $L_{AF,max}$. At 100m (i.e. distance from blast site to the closest typical flying route of terns as they fly between the colony and feeding grounds to the east), the noise levels are predicted to be 85.8dB.

13.6.402 The prevailing wind conditions in the Wylfa Newydd Development Area (south westerlies) mean that on most commonly the tern and black-headed gull colony is likely to be upwind of the sites where blasting may occur. However, when downwind conditions exist (as defined by wind coming from a direction of 50º to 130º) the noise levels experienced at the tern colony would be increased, potentially to above 80dB.

Effects on target species – construction noise

13.6.403 During the breeding season, common, roseate, Sandwich and Arctic terns are all sensitive to disturbance through effects on foraging and breeding behaviour [RD158]. The black-headed gull colony at Cemlyn comprises a large proportion of the population in Wales and it is recognised that any effects on black-headed gull could have implications for Sandwich terns owing to the commensal relationship between these two species.

13.6.404 Disturbance monitoring (see appendix D13-7, Application Reference Number: 6.4.89) showed the background noise level recorded at the shingle ridge adjacent to the breeding colony varied dependent on weather and tide conditions and gradually declined as the season progressed. Regular peaks over 70dB and occasional peaks of over 80dB have been recorded at the colony, some of which had known sources such as Royal Air Force jets and some of which had no apparent source.

13.6.405 Of the 13 potential anthropogenic disturbance events associated with a marked increase in noise, two were associated with responses by the terns with loud noise levels of 78dB(A) and 89dB(A) (overflying jets). The mean noise level for the remaining 11 noise events that produced no tern response was 65.5dB(A), with values ranging from 47dB(A) to 78dB(A) and being 65dB(A) or above in 10 of these events.

13.6.406 Based on the lack of response of the birds at the colony to noisy events and the predicted noise levels being below thresholds that disturb the colony, the effects of disturbance to target and secondary seabirds at the breeding colony from noise generated during construction are considered to represent a small magnitude of change and therefore result in a minor adverse effect.

13.6.407 Terns in flight could potentially divert away from noise generated by construction activities, which could lead to an increased energetic burden and affect fitness. As Arctic/common terns were generally observed to fly northwards from the colony and out to sea, terns using this route are likely to not come in to contact with areas that are predicted to have a significant increase in noise levels.

13.6.408 Sandwich terns were generally observed to fly along the coast through Porth-y-pistyll and around Wylfa Head to favoured feeding grounds to the east (see appendix D13-7, Application Reference Number: 6.4.89). Tern species are considered to be highly manoeuvrable in flight [RD155]. This suggests that they would be able to respond to any sudden noise disturbance encountered whilst in flight or actively feeding by diverting rapidly and efficiently and without experiencing a significant energetic burden.

13.6.409 Results from additional VP surveys during offshore ground investigation works in Porth-y-pistyll in 2016 indicate that terns flying in the vicinity of unusual stimuli (which included the presence of noisy marine machinery) either did not deviate or deviated only slightly and returned to their general flight direction shortly afterwards.

13.6.410 It is considered likely that birds flying through Porth-y-pistyll would habituate to construction noise as they learn that no danger would accompany the noise.

13.6.411 Seabird surveys undertaken from 2010 to 2017 revealed very low use of Porth-y-pistyll and the adjacent bay by actively feeding Sandwich terns, common terns and Arctic terns (appendix D13-7, Application Reference Number: 6.4.89). The vast majority of Arctic/common tern recorded were observed flying from the breeding colony northward and out to sea. Most Sandwich terns recorded were observed flying from the colony to feeding grounds to the east, including waters around Middle Mouse and Point Lynas (approximately 5.8km and 15.3km away respectively) [RD151]; [RD159]; appendix D13-7 (Application Reference Number: 6.4.89).

13.6.412 Boat-based transect surveys and visual tern tracking surveys have been undertaken in 2016 and 2017. Results from these surveys corroborate previous findings from tracking surveys undertaken in 2009. Tracked Sandwich terns did not feed in Cemaes Bay, Porth Wnal or Porth-y-pistyll. Arctic terns and common terns were not recorded diving in Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay. The nearest clusters of data indicative of active feeding (by the three species) are greater than 1km from the Wylfa Newydd Development Area. Cemlyn Bay was the only inshore area where any of the tern species were observed in predictably significant numbers during tracking surveys, as they flew to and from the colony. Small numbers of Sandwich terns were observed diving within 500m of Wylfa Head (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.413 The bounding-case noise levels during construction over the majority of Porth-y-pistyll are predicted to be 75dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ with 80dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and greater than 85dB $L_{Aeq,5min}$ within very small areas. Although these noise levels may result in some temporary displacement, it is likely that the birds would habituate to the noise as they learn that no danger would accompany the noise.

13.6.414 Based on the above, the effect of disturbance to flying and actively feeding terns in the marine environment due to construction noise is considered to have a negligible magnitude. The effect on target species from construction noise is therefore considered to be negligible.

Effects on target species - blasting noise

13.6.415 Noise levels for the majority of blasting operations due to well confined blasting for the deep excavations is predicted to be 60dB $L_{AF,max}$ at the tern and black-headed gull breeding colony during favourable (i.e. outwith a 50° to 130° direction range) wind conditions. Noise levels for blasting within Porth-y-Pistyll are predicted to be 62.9dB $L_{AF,max}$. The background noise level recorded at the shingle ridge adjacent to the breeding colony in May and June 2017 was between 39dB $L_{Aeq,2\text{-}hours}$ and 65dB $L_{Aeq,2\text{-}hours}$, with regular peaks over 70dB $L_{AF,max}$ and occasional peaks of over 80dB $L_{AF,max}$. Terns and black-headed gulls did not generally react to instances of RAF jets flying nearby, even when noise levels were up to 83.5dB $L_{AF,max}$, but were observed to fly up twice during 76 hours of monitoring, when jets flew directly over at low altitude and produced noise levels of 73.4dB $L_{AF,max}$ and 88.8dB $L_{AF,max}$. Additionally, non-breeding black-headed gulls monitored during trial blasts in March 2017 (see appendix D13-7, Application Reference Number:

6.4.89) did not react to blasting generated noise until a level of 68.2dB $L_{AF,max}$ was exceeded.

13.6.416 The maximum noise level at Porth-y-pistyll during blasting is predicted to be over 85.8dB $L_{AF,max}$ (for a highly confined construction blast). This could result in terns avoiding this area when actively feeding. However, the various seabird surveys have shown that there is very little use of Porth-y-pistyll by actively feeding terns of any species (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.417 The maximum noise level at the closest commuting route of terns to the blast site (i.e. an essentially direct line from the coast at Trwyn Pencarreg to Porth y Gwartheg) is predicted to be 85.8dB $L_{AF,max}$, decreasing to 75.3dB $L_{AF,max}$ at a distance of approximately 300m.

13.6.418 It is considered that flying terns are unlikely to significantly deviate from flight paths. Terns flying in the vicinity of unusual stimuli (presence of noisy marine machinery) during the offshore Ground Investigation VP surveys either did not deviate or deviated only slightly and returned to their general flight direction shortly afterwards. The disturbance monitoring has indicated that these species are habituated to sudden typical anthropogenic noise levels of up to 83.5dB $L_{AF,max}$ at the breeding colony (e.g. low flying jets, slamming vehicle doors), where they are likely to be most sensitive to disturbance due to potential threat to their eggs or chicks. Whilst in flight between the colony and at-sea feeding areas, terns are likely to be less sensitive to noise disturbance than when at the colony.

13.6.419 The disturbance monitoring surveys showed no reaction of terns either to noise-only events or to impulsive noises. Terns only reacted to known disturbance sources with a visual, as well as noise, component. When the terns did react to a sudden disturbance, they displayed the same behaviour regardless of the nature of the disturbance (other than the NWWT wardens' visit), and quickly settled back to the colony when no obvious sign of danger was apparent.

13.6.420 Based on the above, the effects of disturbance from blasting in typical conditions on target species of seabirds are considered to be of small magnitude and therefore are considered to be minor adverse. However, during downwind conditions, the noise levels could rise potentially to over 80dB as described previously, causing birds to fly up. In this worst case circumstance, the terns could be subject to additional fly ups from the colony in response to loud noises from blasting operations. The disturbance monitoring surveys show an average number of fly-ups per day of c. 25, and for less than a minute each time. A small number of extra fly-ups in response to loud noise from blasting during times of unfavourable wind conditions is not likely to represent a level of disturbance sufficient to lead to colony abandonment as the noises will not be accompanied by an obvious threat of danger to the birds, their eggs or chicks. Previous abandonments of the Cemlyn tern colony have all been in response to predation pressures. Extra time spent by adult birds off the nests during fly-ups could lead to reduced productivity via reduced egg hatching rates or increased predation of eggs or chicks. The small proportion of extra time spent off nests due to a potential

increase in the number of fly-ups during blasting operations under unfavourable wind conditions is not likely to lead to a significant decrease in colony productivity. During the 121 fly-up events observed during the disturbance monitoring surveys, predation occurred in only one instance. It is considered that in the worst case scenario the magnitude of change would be small and that such a change would result in minor adverse effects on the nesting birds. Additional mitigation is presented in paragraphs 13.8.15, 13.8.16 and 13.8.17.

Effects on secondary species – construction and blasting noise

13.6.421 There is potential for disturbance of secondary seabirds that may be nesting, loafing, foraging or flying in the waters around the Wylfa Newydd Development Area, particularly within Porth-y-pistyll. Noise associated with construction works could cause birds to be flushed and avoid certain areas.

13.6.422 If disturbance is continuous and intense, and combined with louder, irregular noises such as blasting, it could result in increased stress levels and costs to birds in expending more energy if birds make unnecessary movements or have to fly an increased distance to alternative nests and feeding sites. This could impair the birds' condition and potentially increase their susceptibility to predation, which could affect the breeding success of populations.

13.6.423 A total of 19 secondary seabird species were recorded using (i.e. roosting, loafing and/or foraging) VP1 (the survey area in which Porth-y-pistyll is located) during the VP surveys. Seven secondary seabird species were recorded using the intertidal zone at Porth-y-pistyll. The majority of the species recorded in high numbers in this location use the bay during winter for roosting and loafing due to its sheltered location (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.424 Similar habitats exist in the vicinity, including Cemlyn Bay and Lagoon, Porth y Wylfa and Cemaes Bay, and Hen Borth and Porth Wen further afield. Although these birds may regularly move between these areas (due to different tidal states and disturbance levels) it is considered likely that adequate roosting and loafing places are available for any displaced individuals.

13.6.425 Secondary seabird species that regularly use Porth-y-pistyll for foraging, such as gulls, cormorants and common auks (defined as guillemots/razorbills not identified to species level during surveys), may also be displaced by construction and blasting noise. However, low numbers of these species have been recorded using Porth-y-pistyll for foraging when compared to the wider area (peak counts of 56 herring gulls, 20 lesser black backed gull, seven great black-back gulls, 40 common gulls, 50 black-headed gulls, three cormorants, six shags and eight common auks recorded during foraging in Porth-y-pistyll during the VP surveys (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.426 The bounding-case noise level during construction over the majority of Porth-y-pistyll is predicted to be 70dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ without blasting. Although these noise levels may result in some temporary displacement, it is likely that the less sensitive species such as gulls would habituate to the

noise as they learn that no danger would accompany the noise. Additionally, the noise levels during construction would be present when birds that breed in the area arrive, and therefore these birds would not be exposed to new noise levels during the active breeding period.

13.6.427 More sensitive species that use Porth-y-pistyll for roosting and loafing, such as cormorant and auks, may be displaced due to an increase in noise levels, but again, it is considered likely that adequate roosting and loafing places are available for any displaced individuals.

13.6.428 Blasting noise within Porth-y-pistyll is predicted to be between 67.2dB $L_{AF,max}$ and 85.8dB $L_{AF,max}$, which could result in secondary species being displaced from this area as a foraging resource. However, it is considered that adequate foraging resources are also available in the wider area for any displaced individuals.

13.6.429 Cemlyn Lagoon regularly supports high numbers of birds, with black-headed gull recorded in the greatest numbers with a peak count of 812 taken during April 2013. Herring gull was also recorded in relatively high numbers with a peak count of 364 (appendix D13-7, Application Reference Number: 6.4.89). The highest average noise level during construction at islands in Cemlyn Lagoon is predicted to be 60dB(A) with favourable wind conditions. These noise levels would not be expected to result in displacement, as monitoring has shown black-headed gulls are habituated to this level of noise.

13.6.430 Although the noise levels from blasting may result in some temporary displacement from Porth-y-pistyll, it is likely that the birds would habituate to the noise as they learn that no danger would accompany it.

13.6.431 There is potential for the gull colony (herring gull, lesser black-backed gull and great black-backed gull) at Porth Wnal to be disturbed by excavation and construction of the temporary cofferdam and Cooling Water outfall structures and by blasting. Disturbance during the breeding season (March to August inclusive) could cause gulls to be flushed from their nests resulting in stress and potential affects to foraging routines. Acute disturbance could affect breeding if the works were carried out when gulls are beginning to lay/incubate eggs [RD160]. The breeding success of the gull species present could be affected if brooding adults are flushed from eggs or chicks, or adults bringing food items are delayed from returning.

13.6.432 The gulls may become habituated to regular noise disturbance within Porth Wnal, however any loud, intermittent construction activities, including blasting, within the immediate vicinity of the colony would be expected to potentially result in a flyup type response.

13.6.433 The bounding-case noise levels during construction at the gull colony is predicted to be 70dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and the maximum noise level during blasting is predicted to be between 70.4dB $L_{AF,max}$ and 72.6dB $L_{AF,max}$.

13.6.434 Although these noise levels may result in some temporary displacement, it is likely that the birds would habituate to the regular noise disturbance as they learn that no danger would accompany the noise. Additionally, the noise levels during construction would be present when the birds arrive in the area,

and therefore these birds would not be exposed to new noise levels during the active breeding period.

13.6.435 Based on the above, the magnitude of effects of disturbance from construction noise and blasting is considered to be small. Therefore, the effect on secondary species of seabirds is considered to be minor adverse.

Impact pathway: changes in visual stimuli during Main Construction leading to species disturbance

General context

13.6.436 The land-based and marine-based construction activities that would lead to an increase in visual stimuli are outlined in paragraph 13.5.72. As with noise, a change in visual stimuli could potentially lead to avoidance behaviour and could affect breeding or foraging activities, which could have wider implications for populations.

Effects on fish

13.6.437 Marine-based construction activities and the presence of humans, vessels, construction plant and artificial lighting, would result in direct visual disturbance to marine fish receptors. This could lead to a variety of behavioural responses, including displacement and/or disruption to feeding and reproduction, leading to a decline in fitness and productivity.

13.6.438 Most fish species are photoreceptive, with key activity rhythms and behavioural patterns (e.g. feeding) stimulated by light. Daytime feeders, which are typically planktivorous, detritivorous or grazers, are generally attracted to light [RD161]. Conversely, nocturnal species, which are typically carnivores, would show a strong avoidance of light. Crepuscular species that show peaks of activity during the twilight periods are likely to exhibit a varied behavioural response [RD161].

13.6.439 For species that are deterred from the area due to the presence of a visual disturbance, displacement is unlikely to affect the integrity of populations (i.e. reduction in fitness and productivity through effects on reproduction and feeding) given the availability of alternative habitats along the north Anglesey coastline.

13.6.440 The distribution of fish species attracted to artificial lighting is also likely to be influenced by other factors such as the availability of resources (e.g. food and refuge). It is unlikely that species typically attracted to artificial lighting (e.g. mullet) [RD161] will significantly increase in abundance within the vicinity of the Marine Works. Any localised increase is unlikely to affect the integrity of wider populations.

13.6.441 Whilst some sources of artificial lighting might be permanently in place during the construction phase, the majority of lighting (designed to reduce light spill), plant and personnel would be mobile. Visual disturbance effects would therefore be intermittent and localised. As construction of the Marine Works progress, the loss and decline in suitable habitats within the Wylfa Newydd Development Area is likely to result in displacement of fish receptors (this effect has been assessed within paragraphs 13.6.158 and 13.6.163) which

would reduce the possible effect of visual disturbance during the construction phase. Visual disturbance is therefore considered to have a negligible magnitude of change on fish receptors, including fish of conservation and/or commercial importance and general fish and fisheries. Therefore, the effect on marine fish receptors from visual disturbance during the construction phase is considered to be negligible.

Effects on marine mammals

13.6.442 Pinnipeds (e.g. grey seals) that have surfaced or have hauled-out could be affected by changes to visual stimuli from marine-based construction activities. Visual disturbance could potentially cause grey seals to stop feeding, resting, travelling and/or socialising, with possible long-term effects of repeated disturbance including permanent displacement and/or a decline in fitness and productivity.

13.6.443 Seals that are hauled out on land, either resting or breeding, may be particularly sensitive to visual disturbance [RD162]. In general, shipping traffic more than 1,500m away from a haul-out site is unlikely to evoke any reaction; between 900m and 1,500m, grey seals could be expected to detect the presence of vessels; and at closer than 900m, a flight reaction could be expected [RD163]. However, the level of response is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the source of disturbance. Jansen *et al*., [RD164] studied the effects of approaching vessels on harbour seals and found that hauled-out seals 100m away from the ship were 25 times more likely to enter the water compared to seals that were located 500m away. Other studies have recorded a flight response in harbour seals by boats at a distance of around 500m [RD165].

13.6.444 As described in paragraph 13.3.169, there are no primary or secondary breeding haul-out sites for grey seal along the north Anglesey coastline, and sightings within the Wylfa Newydd Development Area generally represent sporadic individuals or small groups which are either in the water or hauled-out (see appendix D13-6, Application Reference Number: 6.4.88).

13.6.445 The likelihood of grey seals hauling-out within the immediate vicinity of the Wylfa Newydd Development Area (i.e. within 500m) is considered extremely low. Visual disturbance due to the presence of human activity is therefore considered to be of negligible magnitude. Therefore, the effect on grey seals from visual disturbance during the construction phase, is also negligible.

Effects on seabirds

13.6.446 Land-based activities and marine developments during construction could potentially affect target and secondary seabirds, due to an increase in visual and light disturbance. Potential sources of visual stimuli include: construction activities for the breakwater, MOLF, temporary cofferdam and subsequent CWS intake and outfall works; increased barge/vessels in construction areas; lighting for offshore ground works; ground works and construction activities, and increased presence of human activity.

13.6.447 Responses from seabirds could potentially occur if there are lines of sight to construction activities whilst birds are nesting, loafing, actively feeding or in flight between breeding sites and feeding grounds. The minimum response to a visual stimulus is head turning or scanning behaviour. A more severe response could be the initiation of flight, the deviation from a flight path or avoiding a certain area.

13.6.448 The effect on seabirds refers to visual stimuli that may result in species disturbance, leading to changes in normal behaviour, including avoiding or being attracted to certain areas that otherwise would not occur. This could result in the range and distribution of seabirds being constrained and the potential for decreased fitness and productivity. Potential effects could range from temporary disturbance to brooding or foraging adults being regularly delayed from returning to eggs or chicks.

13.6.449 The scale of effect of visual disturbance on seabirds can vary between species and stimuli, and some species appear to become habituated to regular disturbance [RD166]. As discussed in paragraph 13.6.387, Garth and Hüppop [RD155] concluded that Sandwich tern, common tern and Arctic tern are relatively tolerant of disturbance when in flight at sea.

Effects on target species

13.6.450 At nest sites, terns can be susceptible to visual disturbance, notably in the form of human presence in close proximity to nest sites [RD154] and unaccustomed movement along the skyline (when viewed from nest sites). Common terns frequently make mass out-flights when a threat is perceived, especially early in the process of settlement at a breeding site [RD167].

13.6.451 There are a number of studies that provide information on the thresholds at which tern species would start to exhibit behaviour associated with visual disturbance. Erwin [RD168] described how nesting colonies of least terns (*Sternula antillarum*) were found to exhibit a flight response when people were 70m away and recommended 100m buffer zones to offset disturbance to least terns and royal terns (*Thalasseus maximus*), and 200m for common terns. Other studies on terns have identified a flight response at distances of 20m [RD169] and 28m [RD170] for least terns, 31m for Caspian terns (*Hydroprogne caspia*) and 24m for Forster's tern *(Sterna forsteri*) [RD170]. [RD154] advised that 'larger' parties of people should be restricted to 300m to avoid disturbance to the most sensitive species of birds at sensitive times of year. These studies are of similar species but not specifically of Sandwich terns; also these studies primarily consider the effect of the presence of people, which represent a predatory threat to terns, as opposed to large-scale machinery. Therefore, a precautionary factor of safety has been applied to these published disturbance buffers and a value of 500m has been adopted as the distance beyond which it is considered unlikely that changes in visual stimuli during construction would affect target species of seabirds.

13.6.452 Activity associated with the construction works would extend into the Anglesey Terns/Morwenoliaid Ynys Môn SPA, but it would not encroach the breeding colony at Cemlyn Lagoon. The nearest point to the nesting islands at which works could take place is approximately 520m away. There is potential for the operation of machinery and personnel to disturb breeding

terns if present within 500m of the colony, or if sightlines exist between the breeding colony and the proposed working areas.

13.6.453 The breeding terns at Cemlyn Bay attract daily visitors throughout the months of April to July, for example in 2016 approximately 3,064 people visited the site during this period [RD54]. Although visitor numbers were down by 32%, compared with 2015 [RD54], it is clear that the April to July period represents the annual peak in visitor numbers to the site, due to the terns' presence. In monitoring of baseline disturbance in May and June 2017, an average of 12 visitors an hour was recorded over 76 hours of monitoring, with a peak of 18 per hour. During this, no disturbance was caused to the birds during normal visiting behaviour i.e. staying behind the shingle ridge at approximately 50m from the tern and black-headed gull colony. Visitors park either side of the lagoon and walk along the shingle ridge that runs across the northern boundary of the lagoon, with some visitors staying overnight in the car parks. At its closest point the ridge is approximately 40m from the breeding islands. People and dogs approaching the colony closer than the top of the ridge did however cause fly up reactions from the colony.

13.6.454 The proposed construction works will bring a high number of visual changes to the area. The extent of visual change with potential to affect the terns (either at the colony or at sea) is not likely to generate levels of visual disturbance significantly above existing background levels (i.e. in terms of potential disturbance to terns, they would be consistent with disturbance generated by other industrial, agricultural and recreational activities that are routinely undertaken in the local landscape, and would be unlikely to be greater than visual disturbance generated by e.g. visitors and walkers utilising public rights of way and accessing the shingle ridge).

13.6.455 Terns and breeding black-headed gulls may also be sensitive to the use of lighting at night. With the exception of the main site compound and marine developments, work areas would not be required to be illuminated at night. The proposed MOLF and breakwaters are located over 1km from the breeding colony. As such, the effects of lighting on terns and breeding black-headed gulls, which do not normally fly or actively feed at night, are not considered likely to result in anything more than negligible change and are therefore negligible.

13.6.456 There is also potential to disturb terns that are actively feeding or in flight within and immediately adjacent to the construction site, with unobstructed views of construction activities. These terns may react to unexpected visual stimuli by diverting their flight or avoiding an affected area. Despite the ability of terns to deviate without significant energetic costs, the duration of the works in Porth-y-pistyll (two years) would increase the overall distance of flight paths between the colony and feeding grounds. This could lead to increasing energy demands which could affect individual fitness and breeding success of terns.

13.6.457 Both land-based and boat-based baseline surveys of terns from the Cemlyn Bay colony revealed insignificant use of Porth-y-pistyll for feeding. This work also showed that the majority of Arctic and common terns fly northwards and

out to sea, whereas Sandwich terns fly along the coast to preferred foraging grounds to the east (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.458 In July 2016, tern behaviour was monitored during the offshore ground investigation works in Porth-y-pistyll (see appendix D13-7, Application Reference Number: 6.4.89). These works required the use of two jack-up rigs, one smaller rig within the intertidal area and a larger rig within the subtidal area. Sandwich tern was the only tern species observed during the surveys and approximately 300 flights were recorded involving approximately 500 birds. Results indicate that birds whose chosen flight path would have taken them straight at/over a rig tended to deviate either horizontally by up to approximately 200m, or vertically by up to approximately 30m, to bypass the rig. Some birds showed no deviation at all and flew immediately adjacent to or directly over the rig. Birds whose flightpath did not take them directly to or close to the rig showed no obvious deviations (see appendix D13-7, Application Reference Number: 6.4.89). These observations indicate that terns can easily deviate from their flight path in response to a sudden disturbance without experiencing a significant energetic burden; this is unsurprising given the high manoeuvrability of terns and their propensity to actively feed, fly and forage across considerable areas.

13.6.459 It is considered that the proposed works would be extremely unlikely to significantly disturb birds flying over the sea, especially when considered in context of the size of the SPA (101,931ha) and the propensity of terns to make use of this entire resource. Therefore, the magnitude of change is predicted to be negligible and the effect on target seabird species from changes in visual stimuli during the construction phase, also negligible.

Effects on secondary species

13.6.460 A total of 19 secondary seabird species were recorded using (i.e. roosting, loafing and/or foraging) VP1 (the survey area in which Porth-y-pistyll is located) during the VP surveys. Seven secondary seabird species were recorded using the intertidal zone surveys at Porth-y-pistyll. The majority of the species recorded in high numbers in this location use the bay during winter for roosting and loafing due to its sheltered location (see appendix D13-7, Application Reference Number: 6.4.89). Seabirds that regularly use Porth-y-pistyll for foraging, such as gulls, cormorants and common auks, were generally recorded in lower numbers.

13.6.461 The majority of seabird species that were recorded regularly using Porth-y-pistyll for roosting and loafing (i.e. herring gull, lesser black-backed gull, common gull, black-headed gull and great black-backed gull) are considered to be relatively tolerant of disturbance, as according to Garth and Hüppop [RD155] these species have a low sensitivity value.

13.6.462 Sensitive species that use Porth-y-pistyll for roosting and loafing, such as cormorant and auks, may be displaced due to an increase in visual stimuli. However, similar relatively undisturbed, habitats are available for any displaced individuals.

13.6.463 The vegetated cliffs at Porth Wnal to the north of the Wylfa Newydd Development Area support a breeding gull colony of herring gull, lesser black-backed gull and great black-backed gull. Visual disturbance of the gull colony is likely to be limited to construction activities associated with the excavation and construction of the cofferdam and Cooling Water outfall structures although flying and actively searching adults may also be disturbed by construction activities in Porth-y-pistyll. These species are considered to be relatively tolerant of disturbance and are therefore likely to habituate to the disturbance.

13.6.464 Secondary species of seabirds that can be active at night (as well as by day), such as shearwaters and storm-petrels could potentially be affected by the use of lighting at night. Of these species, only Manx shearwater has been regularly recorded within the VP survey areas, although no nocturnal surveys have been conducted. Juvenile Manx shearwaters (and storm-petrels) can be attracted to strong light sources during their first flight away from the natal colony, usually only during bad weather [RD172]. Light sources (e.g. lighthouses, coastal town lights) near shearwater/storm-petrel colonies can disorientate juvenile birds, attracting them towards the light source and put them at risk of collision with nearby buildings or the light source itself. Sources of light further away (>20km) from shearwater/storm-petrel colonies do not normally effect birds in the same way as light sources closer to the colonies - the effect is localised to some extent. The only UK colonies from which juvenile birds are likely to migrate past the Wylfa area are the Copeland Islands (off the east coast of Northern Ireland) and the Calf of Man (the south of the Isle of Man). These colonies are situated approximately 150km and 70km from the construction site. Young Manx shearwaters from the Scottish colonies (primarily on Rhum and St. Kilda) normally migrate down the west coast of Ireland and not through the Irish Sea. By the time juvenile birds from the Copeland Islands and Calf of Man colonies have reached the Wylfa area, their migration flight will be well underway and the birds will typically be past the stage of being vulnerable to disorientation effects of artificial light sources.

13.6.465 Visual disturbance during construction would be noticeable but would occur intermittently and therefore the magnitude of change is predicted to be small. It is likely that most species will habituate to the majority of disturbances and adequate resources are available for any displaced individuals in the vicinity of the construction site. As such it is considered that the magnitude of change is predicted to be negligible and the effect on secondary seabird species from changes in visual stimuli during the construction phase, also negligible.

Effects on designated sites

13.6.466 The effects of visual disturbance have been considered in relation to terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA. The assessment determined that there would be a negligible effect on terns as a result of visual disturbance during the construction phase and therefore there is a negligible effect on the Anglesey Terns/Morwenoliaid Ynys Môn SPA and Cemlyn Bay/Bae Cemlyn SAC/SSSI.

Impact pathway: physical injury of marine mammals from vessel strikes

General context

13.6.467 Moving marine plant and vessels could strike marine mammals, resulting in physical injury (e.g. corkscrew injuries) and, in the worst case, mortality [RD173].

13.6.468 Marine construction would require plant (e.g. drilling rigs, cranes and dredgers), barges, work boats and safety boats to be brought to site with movement occurring within the Wylfa Newydd Development Area during the construction phase. Once the Marine Works are complete and the MOLF is operational, there would be continued marine traffic from vessels transporting materials, equipment and parts required for the construction of the Power Station.

13.6.469 Marine mammals are considered to be agile species possessing quick reflexes, good sensory capabilities and fast swimming abilities (over 6m/s for harbour porpoise) [RD174]; [RD175]. However, there have been a number of reported incidents of mortality or injury of cetaceans from vessel strikes in UK waters [RD176]. In addition, several cases of seal injury, thought to be caused by propellers and thrusters (used for the dynamic positioning of vessels), have also been reported in recent years [RD177]; [RD178].

13.6.470 Marine mammals are relatively robust to potential strikes as they have a thick subdermal layer of blubber which would protect their vital organs from minor strikes or collisions [RD179]. Consequently, incidents of mortality or injury of marine mammals caused by vessels are recognised as being a very rare occurrence in UK waters [RD180]; [RD181]. However, a direct strike from a sharp object such as a moving blade would have significant potential to cause injury to marine mammals. Juvenile grey seal pups, which are inexperienced in the water, are likely to be particularly vulnerable to vessel strikes. Inquisitive species such as bottlenose dolphins would also be vulnerable. Marine mammals distracted by activities such as foraging and social interactions may not perceive the threat of moving vessels and could therefore be vulnerable to vessel strikes [RD179].

13.6.471 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 [RD182].

Effects on marine mammals from vessel strikes

13.6.472 Prior to construction and on completion of the Marine Works, marine plant and vessels would be required to transit to/from the Wylfa Newydd Development Area. The numbers of vessel are small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Once on-site, much of the marine plant would be stationary for long periods of time or travelling at relatively slow speeds. Work boats and safety boats may travel at faster speeds but movement would generally be limited to the Wylfa Newydd Development Area. Marine mammals have been recorded in low abundance here and given the likely occurrence of other disturbance effects

(e.g. underwater noise), displacement of individuals from the area is probable. The risk of vessel strikes from marine plant and vessels transiting to site and once on-site is therefore considered to be negligible.

13.6.473 During operation of the MOLF, vessel movement within the area would be expected to occur on average twice a day although, for most of the time, there would be fewer movements than this. Marine traffic would be comprised of primarily large slow moving vessels required to transport general equipment, cement and aggregate. Considering the slow travelling speeds of these vessels, the likelihood of marine mammal strikes is considered to be low and therefore the magnitude of change is predicted to be negligible and the effect on marine mammals from vessel strikes is negligible.

Effects on designated sites due to the physical injury of marine mammals from vessel strikes

13.6.474 As outlined in paragraph 13.6.472, the effect on marine mammals from vessel strikes is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Operation

Impact pathway: impingement of marine organisms

General context

13.6.475 During operation, Cooling Water would be abstracted from the sea, and biota such as fish and invertebrates would be at risk of being drawn into the CWS. The CWS design incorporates fish protection measures, including deterrents, coarse and fine screens on the intake, and a fish and invertebrate recovery and return system (see 13.5.96 for a detailed description of these measures). Fish and invertebrates small enough to pass through the CWS coarse screens, but large enough to be impinged on the fine screens, would be taken through the recovery and return system before being discharged back to the sea. It is during these stages of impingement and subsequent handling that fish and invertebrates would be most vulnerable to mortality.

13.6.476 The impingement process exposes biota to a range of stresses including mechanical effects (such as impacts from falling onto hard structures and abrasion), increased predation risk and emersion. On return to ambient conditions (i.e. once discharged from the recovery and return system), damaged and disorientated organisms may also be vulnerable to predation [RD184]. It has long been recognised that large numbers of organisms are impinged by power plants and that the mortalities incurred might cause ecological harm over wide temporal or spatial scales [RD184].

13.6.477 The susceptibility of biota to impingement on Cooling Water intake screens depends on factors such as water temperature, the life stage of the organism, species-specific hearing ability and swimming ability. Once impinged, the subsequent survival of biota depends on the life stage and their tolerance of stressors experienced and the effectiveness of the return and recovery

system. Early life stages of fish and invertebrates and other small planktonic organisms are unable to swim against the intake currents and are therefore particularly at risk of being drawn into the CWS. Owing to their small body size they would pass through the fine screen mesh to form the entrained component (see paragraph 13.6.544).

Impingement at the Existing Power Station

13.6.478 Fish and invertebrate impingement data are available for the Existing Power Station, from both historical (i.e. from 1985 to 1987, [RD26] and recent surveys (see appendix D13-10, Application Reference Number: 6.4.92). These data have been used alongside fish and invertebrate population data from the surrounding waters (where necessary, e.g. for less common species that may not have been present in the impingement survey data) to produce annual impingement predictions for the Power Station.

13.6.479 The CWS intake will be in a more sheltered location further south along the coastline, compared to the Existing Power Station intake. It is acknowledged that communities may differ between the two localities and therefore the abundance, biomass and species complement impinged may differ from that predicted. It is not possible to quantify or predict exactly what these differences might be, if any, and therefore impingement predictions have been based on existing data for the area. The assessment of impingement effect does however consider qualitatively, possible differences between the two localities and how these may influence impingement predictions.

13.6.480 The construction works would alter the habitat within Porth-y-pistyll (e.g. from habitat loss and physical disturbance), which may affect the communities present and therefore the species vulnerable to impingement. Furthermore, fish and invertebrate communities may change over the operational lifetime of the Power Station in response to climate change. It is not possible to quantify or predict exactly if or how communities might change and therefore impingement predictions are based on existing data for the area. The assessment of impingement effect does however consider qualitatively, possible community changes within Porth-y-pistyll and how these may influence impingement predictions.

Predictions

13.6.481 Impingement results from the most recent 2011 to 2012 impingement surveys on the Existing Power Station have been scaled up to a tidally averaged abstraction rate of 126m^3/s. This value includes 5% contingency and represents the most realistic worst case. Fish and invertebrate abundances have been extrapolated from numbers of individuals per m^3 sampled in the impingement surveys during each month and then summed to give an annual prediction, allowing for changes in abundances owing to seasonality. It is noted that these numbers are indicative and are presented to support the assessment.

13.6.482 It is recognised that the intake design of the Existing Power Station does not meet current best practice; therefore, predictions are likely to be worst case. The new intake at the Power Station would be designed to reduce

impingement of fish and invertebrates (see paragraph 13.5.70) and increase survival through the recovery and return system.

13.6.483 Whilst studies have been undertaken at other power stations to investigate the efficiency of AFD and fish and invertebrate recovery and return systems, the design of the CWS (including these mitigation measures) is ongoing and therefore efficiencies for the Power Station can only be inferred. In the absence of this information, the assessment has taken a precautionary approach assuming 100% mortality. However, estimated efficiencies associated with low approach velocities, the AFD and the fish and invertebrate recovery and return system, have been applied where applicable, in order to demonstrate how these embedded mitigation measures could lower annual impingement predictions and mortality of fish and invertebrates.

Effects of impingement on intertidal and subtidal habitats and communities (including invertebrates of conservation and commercial importance)

13.6.484 Impingement of benthic invertebrates may result in mortality as a result of mechanical damage and abrasion. Emersion may also be a factor, however many species, such as those that inhabit the intertidal zone, are robust and adapted to survive out of water for short periods of time.

13.6.485 Estimated losses of benthic invertebrates have been quantified, although owing to the practicalities of enumerating some individuals (e.g. colonial organisms or those that are very small) the invertebrate data used refer to crustaceans and molluscs only. Obtaining fully quantitative data for some species of crustacean and mollusc was also not possible; therefore, the lists of taxa presented here are not exhaustive. Fauna from the other groups (e.g. sponges, polychaete worms) also likely to be impinged are summarised in appendix D13-10 (Application Reference Number: 6.4.92).

13.6.486 In terms of crustaceans, pink shrimp (*Pandalus montagui*) and edible crab (*Cancer pagurus*) are predicted to be impinged in the highest abundances each year (based on abundance in existing data). For molluscs, the most abundant species impinged are likely to be edible mussel (*M. edulis*) and little cuttle (*Sepiola atlantica*). Around 40 to 50 species of each phyla (crustaceans and molluscs) are likely to be impinged at the CWS intake annually (Table D13-28).

Table D13-28 Estimated numbers of crustaceans and molluscs impinged per year, extrapolated to 126m^3/s. Numbers over 100 are presented to two significant figures. Species shaded grey represent 95% of the catch by number

Crustaceans	Total	Molluscs	Total
Pandalus montagui	880,000	*Mytilus edulis*	680,000
Cancer pagurus	220,000	*Sepiola atlantica*	35,000
Palaemon serratus	98,000	*Musculus* sp.	6,400
Mysidae	49,000	*Eledone cirrhosa*	5,600
Pasiphaea sivado	26,000	Anomiidae sp.	5,600

Crustaceans	Total	Molluscs	Total
Necora puber	23,000	*Loligo* sp.	4,100
Pilumnus hirtellus	21,000	*Nucella lapillus*	3,600
Liocarcinus sp.	17,000	Pleurobranchaeidae	2,600
Macropodia sp.	13,000	*Helcion pellucidum*	1,900
Liocarcinus holsatus	10,000	*Nassarius reticulatus*	1,200
Inachus sp.	9,700	Gibbula sp.	1,200
Processidae sp.	8,300	Patellidae sp.	1,000
Pandalina brevirostris	7,000	*Pecten maximus* (juv.)	960
Gammarellus sp.	5,300	*Trivia arctica*	720
Carcinus maenas	5,000	*Archidoris pseudoargus*	710
Pisidia longicornis	3,300	*Aequipecten opercularis*	620
Crangon crangon	3,300	*Onchidoris bilamellata*	590
Liocarcinus depurator	1,600	*Buccinum undatum*	590
Isopoda indeterminate	1,500	Nudibranch indeterminate	520
Pinnotheridae	670	Pectinidae	500
Hyas sp.	640	*Trivia monacha*	230
Galathea sp.	600	*Littorina littorea*	150
Paguridae sp.	490	*Gastropoda* sp.	130
Shrimp indeterminate	440	*Flabellina* sp.	120
Corophiidae	330	Bivalvia indeterminate	94
Crab indeterminate	260	*Aplysia punctata*	77
Porcellana platycheles	230	Aeolidia sp.	46
Pagurus bernhardus	210	Trivia sp.	37
Hippolytidae	200	*Janolus cristatus*	30
Processa edulis edulis	190	*Aeolidia papillosa*	28
Hyperia galba	180	*Patella vulgata*	17
Pycnogonida	150	Tellinoidea	15
Crangon allmanni	130	*Velutina velutina*	15
Homarus gammarus	120	*Dendronotus frondosus*	15
Galathea squamifera	110	*Facelina* sp.	12
Pisinae sp.	100	Opisthobranchia	12
Gammaridae	94	*Philine aperta*	12
Hyas coarctatus	92	*Polycera quadrilineata*	12
Maja squinado	86		
Hyas araneus	77		
Pirimela denticulate	75		
Caprellidae	74		
Hippolyte varians	68		
Megalopa	58		

Crustaceans	Total	Molluscs	Total
Palaemon elegans	47		
Galathea strigose	35		
Caprella linearis	30		
Dromiidae	24		
Eualus occultus	23		
TOTAL	1,400,000	TOTAL	760,000

13.6.487 Taking into consideration the life history characteristics of the crustacean and mollusc species listed in Table D13-28 (i.e. short-lived and high fecundity) and their widespread abundance, the number predicted to be impinged annually (assuming an unmitigated system) is considered low in comparison to experience from other stations.

13.6.488 There is no significant commercial fishery for pink shrimp around the coast of Anglesey (ICES rectangle 35E5) [RD25] although this species is an important target species for fisherman operating in Cardigan Bay. Fishing pressure on shrimp and prawn populations within the Irish Sea is generally low [RD25] and therefore impingement at the Power Station is unlikely to affect local populations and wider commercial fisheries.

13.6.489 Edible crab was commonly impinged at the Existing Power Station and therefore annual impingement predictions for the Power Station are reasonably high. A commercial fishery for edible crab is present around the coast of Anglesey (ICES, rectangle 35E5), although within the vicinity of the Wylfa Newydd Development Area, this is classified as low intensity (less than two pots lifted and dropped per hectare per day), with higher intensity areas identified to the east [RD28]. Around six tonnes of edible crab are reported to be landed from coastal waters around Anglesey annually (2010-2014 average) [RD25]. Edible crab is known to be highly abundant; low commercial landings are likely to reflect the poor retail price of this species and are not indicative of local population sizes.

13.6.490 Annual impingement predictions based on data from the Existing Power Station are believed to overestimate impingement of edible crab at the new Power Station as abundances within Porth-y-pistyll are anticipated to be lower than those observed along regions of more exposed rocky coastline. Considering this and the low commercial fishing pressure operating in the area, it is unlikely that impingement would affect populations and wider commercial fisheries.

13.6.491 Scallop, whelk and lobster are also targeted by commercial and recreational fishing around the coast of Anglesey, although the intensity of activities within the vicinity of the Wylfa Newydd Development Area is low [RD28]. Impingement of these taxa at the Power Station is predicted to be low (<1,000 of each taxa per year).

13.6.492 The high abundance of edible mussel within impingement samples at the Existing Power Station has been attributed to the settlement of young juveniles (spat) within the CWS which became dislodged either by operations or by natural process such as storms or waves, and subsequently impinged.

The predicted impingement of *M.edulis* should therefore be interpreted with caution as this is not considered to represent a true effect on natural populations. The biofouling regime at the Power Station is likely to influence the settlement of spat and vulnerability of this species to impingement.

13.6.493 It is possible that species characteristic of the lower intertidal zone such as common shore crab (*Carcinus maenas*) may be more prevalent in impingement catches than predicted. Gastropod molluscs (e.g. *Patella vulgata* and *Gibbula umbilicalis*), which are currently at the northern limit of their extent on the west coast of Anglesey, may also become more prevalent due to climate change. Slightly higher possible impingement rates for some species will likely be offset by lower than predicted impingement of other species (e.g. edible crab). Any changes are therefore unlikely to alter the overall magnitude of impingement predicted for benthic invertebrates.

13.6.494 Based on the numbers presented here for an unmitigated system, effects of impingement on benthic invertebrates including commercial catches (e.g. scallop, whelk and lobster), would be minimal. The predicted impingement of edible crab (based on survey data from the Existing Power Station) whilst reasonably high, is considered to overestimate the impact on this species. Considering this and the low commercial fishing pressure operating in the area, it is unlikely that impingement would affect populations and wider commercial fisheries. The magnitude of change is therefore predicted to be small and the effect of impingement on subtidal and intertidal habitats and communities, including invertebrates of conservation and commercial importance, is predicted to be negligible.

13.6.495 In terms of mortality through the impingement process, survival rates for crustaceans are good (>80%) [RD80]. Studies undertaken at Pembroke Power Station have shown that prawns and shrimps exhibit 86% and 99% survival 24 hours post-capture respectively, and crabs and spider crabs exhibit 81% and 100% survival, respectively [RD189]. It is expected that many molluscs will also exhibit high survival rates as most have the protection of a shell and many are able to close their shells (bivalves) or operculum (gastropods) to survive emersion.

13.6.496 Once invertebrates have been returned to the sea, they could be at risk of predation from predatory fish and seabirds attracted to the area around the discharge of the recovery and return system due to an artificially increased abundance of (possibly compromised) prey. However, if the invertebrates are in a viable condition, many would have a good chance of survival.

Effects of impingement on marine fish

13.6.497 During the impingement process, fish are vulnerable to mortality through mechanical effects (such as impacts from falling onto hard structures and abrasion), increased predation risk (e.g. from crabs once in constricted areas) and emersion.

13.6.498 Over 60 species of fish from all habitat guilds (pelagic, proximo-benthic and benthic) are at risk of impingement at the CWS intake. Pelagic species such as sprat, sand smelt and herring are predicted to be impinged in the highest abundances each year (see 13.6.498). Impingement of fish would be

expected to peak during the winter when it is likely higher numbers of sprat, herring, dragonets, scorpion fish and lesser-spotted dogfish would be impinged.

Table D13-29 Annual fish impingement catches extrapolated to 126m^3/s. Abundances/biomass over 100 are displayed to two significant figures. Species shaded grey represent 95% of the catch by number

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Sprat	54,000	77	Butterfish	150	1
Sand smelt	18,000	51	Short-spined sea scorpion	140	4
Herring	7,600	43	Grey gurnard	140	0.2
Long-spined sea scorpion	6,200	98	Leopard-spotted goby	130	0.2
Whiting	5,700	34	Thornback ray	130	1
Five-bearded rockling	5,400	110	Tadpole fish	120	10
Common dragonet	5,300	26	John Dory	120	1
Pogge	4,500	52	Two-spot goby	94	0.1
Pollack	4,200	290	Bass	80	54
Lesser-spotted dogfish	3,400	1,400	Northern rockling	64	0.3
Lesser weever	3,000	14	Solenette	49	0.1
Dragonet	2,800	3	Tompot blenny	48	1
Fifteen-spined stickleback	2,700	8	Striped sea snail	47	0.3
Greater pipefish	1,900	9	Sea snail family	41	0.2
Lesser sandeel	1,800	12	Ling	41	0.04
Poor cod	1,800	22	Topknot family	41	0.2
Dab	1,600	41	Montagu's sea snail	40	0.2
Cod family (Gadoid indeterminate)	1,100	2	Spotted dragonet	35	0.2
Corkwing wrasse	1,000	28	Red gurnard	35	1

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Ballan wrasse	960	150	Dover sole	35	6
Plaice	730	28	Common goby	35	0
Shanny	680	4	Conger eel	32	53
Sandeel	680	12	Blenny family	29	0.03
Herring family	640	1	Flounder	28	6
Indeterminates	420	1	Sea scorpion family	28	0.03
Pouting	410	7	River lamprey	23	1
Cod	400	70	Pearlside	17	0.02
Scaldfish	340	3	Horse mackerel	17	0.1
Snake pipefish	340	4	Haddock	15	0.05
Pipefish family	330	0.4	Grey mullet family	15	22
Goby family (Gobiidae)	320	0.3	Three-spined stickleback	15	0.03
Reticulated dragonet	320	2	Cuckoo wrasse	15	1
Lumpsucker	300	37	Spotted ray	15	15
Saithe	280	26	Golden grey mullet	12	11
Rock goby	280	1	Gurnard family	12	0.01
Nursehound	260	92	Poor cod family	12	0.02
Three-bearded rockling	260	24	Transparent goby	12	0.01
Rock cook	250	1	Wrasse family	12	0.01
Sand goby	240	0.4	Dogfish family	12	0.02
Thick-lipped grey mullet	220	240	Nilsson's pipefish	12	0.01
Goby sp. (*Pomatoschistus* sp.)	200	0.2	Total abundance	143,000	

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Goldsinny wrasse	200	3	Total biomass		3,200

13.6.499 Species of conservation concern are known to be present in the area and are vulnerable to impingement. Of these, only three species (nursehound, thornback ray and cod) are expected to be impinged in low numbers based on data from the Existing Power Station. River lamprey and European eel have both been recorded historically within impingement catches at the Existing Power Station [RD26] whilst sea trout is known to be present in the vicinity of the Wylfa Newydd Development Area. These species are considered at very low risk of impingement, with a likely abundance in the order of tens per year. All other species of conservation importance (including Atlantic salmon) are expected to have a very low rate of impingement.

13.6.500 In terms of commercial species, in addition to sprat and herring described earlier the following are at risk of impingement:

- plaice;
- Dover sole;
- whiting;
- cod;
- haddock; and
- bass.

13.6.501 Haddock, Dover sole and bass would likely be impinged in very low numbers (less than 100 per year), even without embedded mitigation. Sprat, herring and whiting could be caught in numbers of around 54,000, 7,600 and 5,700 per year, respectively.

13.6.502 Approximately 87% of all fish species impinged during the surveys at the Existing Power Station were 11cm or below (standard length) which is the smallest minimum landing size for a fish species, based on pilchard (*Sardina pilchardus*) as stipulated by the Council Regulation (EC) No. 850/98. Historically, impingement of fish at the Existing Power Station has been assessed as very low; it remains lower than at other UK power stations and has been assessed as not posing a threat to commercial stocks [RD26].

13.6.503 To allow impingement predictions (based on an unmitigated system) to be contextualised against commercial fish landings they can be converted to potential equivalent adult values (EAVs) (see paragraph 13.6.569). Table D13-30 presents the equivalent number of the following predicted to be impinged annually as a proportion of the most recent international landing estimates:

- adult whiting;
- plaice;
- Dover sole;

- herring;
- sprat; and
- bass.

13.6.504 Information on commercial fishing efforts for whiting, plaice and Dover sole within the Irish Sea (ICES assessment division VIIa) is provided by the ICES Working Group for the Celtic Sea Ecoregion [RD186] whilst the ICES Herring Assessment Working Group [RD187] provide landing statistics for herring in the northern Irish Sea (ICES assessment division VIIaN). Limited commercial fishing for sprat occurs in the Irish Sea; the nearest and most reliable sprat landing statistics are reported for the English Channel (ICES assessment division VIId-e). ICES does not publish commercial landing statistics for Irish Sea bass stocks specifically [RD186] although Welsh landings for 2015 have been reported [RD188]. Whilst it is acknowledged that coastal waters around the north coast of Anglesey are important for recreational fishing of bass, reliable estimates of recreational landings are not available and therefore no quantitative comparison to impingement predictions has been made.

Table D13-30 Predicted impingement EAVs as proportion of commercial landings.

Species	Weight at 50% maturity	Stock	Condition of stock	Latest landings (tonnes)	Proportion of landings
Whiting	[RD189] [RD190]	Irish Sea (VIIa)	Undefined	73 (2014)	0.07%
Plaice	131g [RD191] [RD190]	Irish Sea (VIIa)	Stock size increasing	1,005 (2015)	0.01%
Dover sole	211g [RD192] [RD190]	Irish Sea (VIIa)	Below reproductive capacity	76 (2015)	0.003%
Herring	109g [RD193]	North Irish Sea (VIIaN)	Full reproductive capacity	4,900 (2015)	0.003%
All clupeids as herring					0.0001%
Sprat	7g [RD194] [RD190]	English Channel (VIId-e)	Undefined	3,003 (2015)	0.01%
All clupeids as sprat					0.0001%
Bass	519g [RD195]	Welsh waters	Reduced reproductive capacity	61 (2015)	0.07%

13.6.505 For all species listed in table D13-30, the numbers of equivalent adults predicted to be impinged annually represent a tiny fraction (<0.1%) of those being removed by commercial fishing activities within the Irish Sea (and the English Channel in the case of sprat). Stocks of herring and plaice in the

Irish Sea and northern Irish Sea respectively are in good condition and therefore the biomass of equivalent adults predicted to be lost annually due to impingement (0.2 tonnes and 0.1 tonnes of herring and plaice, respectively) is unlikely to have a significant effect on wider stocks.

13.6.506 Stocks of Dover sole, whiting and sea bass within the Irish Sea are considered to be in poor condition. The biomass of Dover sole in the Irish Sea has shown a declining trend since the mid 1980s; the 2011 to 2014 recruitment was the lowest in the time series. Although a slight increase in recruitment was observed in 2015, populations remain below reproductive capacity. Although the Irish Sea whiting stock and exploitation pressure is currently undefined, the recent decline in fishery landings has been interpreted by ICES as a collapse in biomass. This has been attributed to poor recruitment and high discards (1,894 tonnes in 2014). The biomass of bass in the North Sea, English Channel, Celtic Sea and Irish Sea has also exhibited a decline caused by poor recruitment and continued high levels of fishing. Given that the biomass of equivalent adult Dover sole, whiting and bass predicted to be lost annually is very low (0.003 tonnes, 0.05 tonnes and 0.04 tonnes, respectively), impingement is unlikely to have a significant effect on the condition of these stocks.

13.6.507 The biomass of equivalent adult sprat predicted to be impinged annually represents the highest estimate of any species. The condition of stocks within the Irish Sea, Celtic Sea and English Channel is currently unknown. No significant commercial fishery for sprat exists within the Irish Sea and given the apparent abundance of this species, the biomass of equivalent adults predicted to be lost annually due to impingement (0.3 tonnes plus 0.003 tonnes assuming all clupeids are sprat) is unlikely to have a significant effect on wider stocks.

13.6.508 Other population metrics can also be used to contextualise impingement catches for species such as dab. Selsay [RD196] examined the population ecology of dab in the eastern Irish Sea, off the coast of north Wales. The survey area included Red Wharf Bay, Conwy Bay and the offshore grounds on the north Wales coast. The total survey area was 656km^2, and the population of dab within this area was estimated to be 2.34x10^6 individuals. The estimated number of equivalent adult dab potentially impinged annually at the Existing Power Station represented 0.02% of the local population.

13.6.509 Considering the design (i.e. onshore) and locality of the Cooling Water intake in Porth-y-pistyll (i.e. in a heavily modified, sheltered rocky bay), it is possible that fewer gadoids will be impinged than predicted based on entrapment surveys at the Existing Power Station. Taxa typically associated with soft sediments (e.g. flatfish, weeverfish and sandeel) may also be less prevalent in impingement catches than predicted. Conversely, species affiliated with inshore rocky habitats such as the following might be more prevalent within impingement catches than predicted:

- gobies;
- scorpionfish;
- sea snails;

- blennies;
- sticklebacks; and
- wrasse.

13.6.510 Once habitats and associated fish communities become re-established within the area following disturbance during the construction phase, species such as sprat, herring, sand smelt, rockling and lesser-spotted dogfish are likely to be a core component of impingement catches as predicted. The accuracy of impingement predictions for pelagic species such as sprat, herring and sand smelt however, is highly dependent. This can depend on recruitment success and the frequency of shoals within the vicinity of the Power Station intake can be driven by weather conditions (seeking shelter) or the presence of predators.

13.6.511 Over the operational lifetime of the Power Station, the distribution of Lusitanian species may shift northwards in response to increased sea temperatures due to climate change. It is therefore possible that species such as sprat, Dover sole and horse mackerel may become more prevalent in impingement catches than predicted whilst pilchard and anchovies, which are currently not predicted to be impinged, may also be present. A decline in the abundance of boreal species (e.g. herring, cod and plaice) impinged may also be observed as their distribution moves northwards or into deeper waters.

13.6.512 It is not possible to reliably quantify these potential temporal or spatial changes in fish communities and therefore the assessment of impingement effect has been based on existing data for the area. Slightly higher possible impingement of some species will likely be offset by lower than predicted impingement of other species and therefore any changes are unlikely to alter the overall magnitude of predicted impingement of fish.

13.6.513 With the inclusion of embedded mitigation, the number and biomass of fish impinged would be lower than predicted for an unmitigated system. The mortality of individuals that do become impinged would also be reduced.

13.6.514 The embedded mitigation includes:

- a low approach velocity (less than 0.3m/s) allowing fish to actively avoid impingement;
- the use of AFDs to deter fish from the area; and
- a fish and invertebrate recovery and return system.

13.6.515 Efficiency data for working examples of these protection systems are available (obtained from available literature and the survivability studies undertaken in 2015 and 2016 [RD185]. These efficiencies have been applied to impingement predictions to demonstrate how overall impingement effects on fish could be reduced.

13.6.516 The method used to determine those fish that will be able to swim away is based on size-class information and swimming performance at different water temperatures [RD197] and is based on the ‘Fish Escape Model’ [RD198]. The lengths of the individual fish impinged on the screens at the

Existing Power Station were used to estimate the efficiency of the low design approach velocity. In doing this consideration was given to the length of fish, and the water temperature at the time of impingement. The Fish Escape Model was then used to estimate whether the fish would be able to swim away from an approach velocity of 0.3m/s and therefore avoid impingement. The estimated efficiencies are shown in Table D13-31. It must be noted that these efficiencies are based on the size classes of fish observed through the entrapment monitoring at the Existing Power Station, and are not applicable for smaller individuals.

13.6.517 The efficiencies for acoustic deterrents are based on trials undertaken at operational power stations; Hartlepool [RD199]; [RD80] and Doel [RD200]. AFDs are most effective for pelagic species (that are hearing specialists as they possess a swim bladder e.g. herring) and least effective for benthic species (hearing non-specialists with reduced or no swim bladder e.g. flatfish).

13.6.518 The FRR system would be most effective for reducing mortality of benthic species such as flatfish, gobies, rocklings and dragonets (typically >80% survivability), whereas more delicate pelagic species would exhibit lower survivability (typically less than 10%); species such as sprat and herring normally suffer 100% mortality. However, the most recent studies at Pembroke Power Station showed the pelagic sand smelt to exhibit 30% survival through the screen handling and FRR [RD185]. Proximo-benthic species such as cod, whiting and gurnard would likely exhibit survival rates of between 50% and 80% [RD80].

Table D13-31 The estimated efficiency of low approach velocities in reducing impingement at the Existing Power Station, the efficiency of AFDs, and the efficacy of fish and invertebrate return and recovery systems

Species	Length range (mm)	Low velocity efficiency	AFD efficiency	Source of AFD trial data	Survival through return and recovery systems
Cod	60 – 390	>95%	55%	Hartlepool	65%
Poor cod	45 – 205	86%	55%	Hartlepool	65%
Pouting	55 – 140	>95%	55%	Hartlepool	65%
Whiting	20 – 275	53%	54%	Hartlepool	65%
Clupeid	20 – 105	73%	92%	Doel (avg.)	0%
Herring	30 – 230	>95%	95%	Doel	0%
Sprat	20 – 115	>95%	88%	Doel	0%
Dab	25 – 215	71%	16%	Hartlepool	80%
Flounder	235 – 270	>95%	38%	Doel	80%
Plaice	25 – 475	77%	16%	Hartlepool	80%
Grey mullet	310 – 540	>95%	76%	Doel	65%

Species	Length range (mm)	Low velocity efficiency	AFD efficiency	Source of AFD trial data	Survival through return and recovery systems
Sand smelt	30 – 140	90%	55%	Hartlepool	30%

Note: Sand smelt AFD efficiency based on Hartlepool gadoid data, as considered to be a hearing generalist; fish return efficiencies from percent survival figures and data from Jacobs 2016 [RD80].

13.6.519 The efficiencies of these measures when installed together, i.e. low approach velocity, acoustic deterrent and FRR, have been taken into consideration when assessing the effects of impingement on fish populations in the area.

13.6.520 A reduction in catch of greater than 76% of the original annual impingement total may be possible. As an approximation, if this reduction factor was applied to the extrapolated catch, this could potentially reduce the impingement mortality rate from around 143,000 (3.2 tonnes) to around 34,320 (0.8 tonnes) per year. The relatively high numbers of species such as sprat and sand smelt impinged will therefore be reduced considerably. Similarly, the mortality of commercial species would potentially be reduced. It is likely that the level of impingement will vary through the year reflecting the different life stages of fish and winter storm events, although this variability is accounted for within the assessment as the surveys were carried out throughout the year. As with invertebrates, once impinged fish have been returned back to the sea, there is a risk of predation e.g. from predatory fish and seabirds around the outfall. However, if they are in a viable condition, many would have an increased rate of survival.

13.6.521 Based on an understanding of the scale of loss of fish from impingement in relation to fish populations, the overall magnitude of change is predicted to be small on all marine fish receptors. The impingement of all fish receptors, including those of conservation and/or commercial importance is considered to be negligible.

Effects of impingement on marine mammals

13.6.522 Marine mammals are very unlikely to be at risk of impingement owing to the low approach velocities embedded into the design of the intake. In addition, coarse bar screens positioned upstream of the fine mesh screens would prevent marine mammals from entering the CWS.

13.6.523 Impingement of fish and invertebrates may have an indirect effect on marine mammals in the area through a reduction in their prey populations. Harbour porpoise and grey seal are the most common marine mammal species around the north coast of Anglesey and would likely be most affected. Dietary equivalent modelling (using weight composition data) has been carried out to quantify the potential loss of food resources to harbour porpoise and grey seal as a result of fish impingement. Minke whale and bottlenose dolphin are also present but in much lower abundances and not all year round; impingement is unlikely to affect the wider food resources available to these marine mammals.

13.6.524 In the Irish Sea, harbour porpoise predominately prey upon gadoids (namely whiting and haddock) and herring [RD100]. Although sprat, blue whiting, cod, *Pollachius* sp., sandeel, horse mackerel, and Atlantic mackerel are also consumed, these are not considered to be key prey taxa (each contributing <2% to the overall weight of prey consumed). Harbour porpoise in the Irish Sea are not known to prey upon gobies and sand smelt although elsewhere these species are an important dietary component [RD201]; [RD202] [RD203]. The majority of fish targeted by harbour porpoise represent juveniles (<10cm) [RD100].

13.6.525 Grey seal feed on available inshore fish, cephalopods and crustaceans. In the Irish Sea, grey seal target a wide range of fish taxa including gadoids (namely whiting, *Trisopterus* sp., cod, rockling and *Pollachius* sp.), clupeids (i.e. sprat and herring), dragonet, sandeel, wrasse (*Labrus* sp.), flatfish (namely sole, plaice and dab), gurnards and rays [RD45]; [RD100]; [RD202]. Although other taxa including salmonids, conger eel, haddock, tadpole fish (*Raniceps raninus*), Atlantic mackerel, sandeel, goby, sea bass, sea bream (Sparidae), mullet (Mugilidae), as well as a number of other flatfish species (e.g. Lemon sole and long rough dab; *Hippoglossoides platessoides*) are also consumed, these are not considered key prey species (each contributing <2% to the overall weight of prey consumed). The majority of fish targeted by grey seal represent juveniles (<17cm) [RD100].

13.6.526 The dietary equivalents assessment for harbour porpoise includes all fish classified as Clupeiformes, Gadiformes and Perciformes. The dietary equivalents assessment for grey seal also considers Pleuronectiformes, Scorpaeniformes, Anguilliformes, Salmoniformes and Rajiformes. This broad taxonomic approach is considered precautionary, taking into consideration the degree of uncertainty associated with dietary analysis as well as possible geographical and seasonal variations in dietary composition.

13.6.527 A single harbour porpoise consumes between 4% and 9.5% of its body weight daily [RD204]; [RD205]. Assuming an average adult weight of 45kg to 60kg [RD206], harbour porpoise are predicted to consume between 1.8kg and 5.7kg per day. This is equivalent 657 kg to 2,081 kg per year. Of the overall weight of fish predicted to be impinged annually (based on an unmitigated system), 40% represents fish belonging to the three taxonomic orders outlined above and would therefore represent a possible food resource for harbour porpoise. This would feed the equivalent of one to two harbour porpoise per year.

13.6.528 Based on a mean adult weight of 194kg, a grey seal will consume approximately 4.6kg per day [RD100]. This is equivalent to 1.7 tonnes per year. Of the overall weight of fish predicted to be impinged annually (based on an unmitigated system), 51% represents fish belonging to the eight taxonomic orders outlined above and would therefore represent a possible food resource for grey seal. This would feed the equivalent of one to two seals per year.

13.6.529 Embedded mitigation would reduce the impingement and possible mortality of fish prey species, thereby reducing the indirect effect on marine mammals.

13.6.530 Considering the quantity of food resource lost in relation to the food requirements of harbour porpoise and grey seal populations, the magnitude of change is predicted to be negligible and it is therefore considered that the effect on marine mammals from impingement would be negligible.

Effects of impingement on seabirds

13.6.531 The impingement of fish could have an indirect effect on seabirds through a loss of food resource. Dietary equivalents modelling (using bioenergetic data) has been carried out to quantify the potential loss of food resources to terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA. Dietary equivalents modelling (using generic bioenergetic data) has also been used to quantify the potential loss of food resources to other seabirds. The indirect food resource loss to primary and secondary seabird receptors has been considered collectively and assigned a value of high.

13.6.532 Clupeids and sandeel are known to be the principal prey species of terns, representing between 78% and 95% of the overall diet of adults and chicks [RD207]; [RD50]; [RD208]; [RD209]. The majority of individuals consumed represent juveniles [RD50]. It is likely that gadoids (e.g. rockling) as well as invertebrates and cephalopods make up the remaining diet of terns although the relative contribution of these prey types is uncertain. For the purpose of the assessment, only sandeel and clupeids have been considered.

13.6.533 Using information regarding feeding ecology and energy requirements [RD210]; [RD211]; [RD50]; [RD54], it is estimated that during the breeding season (April-July), each adult Arctic, common and Sandwich tern needs to consume 9kg, 8kg and 9kg of sandeel and clupeids combined to meets its own energetic demands, respectively. Based on this, the estimated number of clupeid and sandeel predicted to be impinged during the breeding season would support 0.21, 0.24 or 0.22 adult Arctic, common or Sandwich terns, respectively.

13.6.534 A total of 1.9kg of sandeel and clupeids is predicted to be impinged during the tern breeding season (based on an unmitigated system). This equates to 0.01% of the diet of the tern populations of the Anglesey Terns/Morwenoliaid Ynys Môn SPA (calculations assume a five year mean population size: 1992–1996 for Arctic and common terns and 1993-1997 for Sandwich terns) during the breeding season. This figure is likely to be reduced owing to the presence of embedded mitigation measures.

13.6.535 In terms of secondary seabird species, the effects of impingement on their food source can be quantified in terms of total fish biomass removed by the Power Station. This is presented as a worst case (i.e. based on an unmitigated system and assuming all fish species are preyed upon by seabirds).

13.6.536 Camphuysen *et al*., [RD212] undertook a study to investigate the number of seabirds that would be supported by fish discards from fishing vessels. Their figures (i.e. 4.5kJ/g as an average value for fish and a 1kg seabird basal rate requirement of 6.57×10^5kJ/y) provide a basis for assessing the number of seabirds that would be supported by the fish impinged at the Power Station. By applying these values to the potential annual impingement catch biomass

of 3.2 tonnes, the potential loss of food resource from impingement equates to around 22 seabird equivalents per year. In reality this figure would be much lower, as a large proportion of the fish caught would either avoid impingement or would be returned alive, through the recovery and return system.

13.6.537 The biomass of clupeids and sandeel potentially impinged at the Power Station represents only 0.01% of that required to support the tern population of the Anglesey Terns/Morwenoliaid Ynys Môn SPA annually. In addition, the weight of fish predicted to be impinged would equate to the annual diet of 22 seabirds. Whilst fish impingement predictions assume 100% loss from the system, with embedded mitigation measures in place, a large proportion of fish are likely to either avoid or be deterred from the intake. Furthermore, a large proportion of those that are impinged are likely to be returned to the sea via the return and recovery system, becoming available prey again for seabirds. The magnitude of change is therefore predicted to be small and the effect on seabirds from impingement negligible.

Effects of impingement on designated sites

13.6.538 The indirect loss of food resource to marine mammals and seabirds due to impingement would have a further indirect effect on current and proposed designated sites for which they are qualifying features.

13.6.539 As described in the preceding sections on marine mammals and seabirds, impingement catches are only likely to represent a small proportion of the food requirements of the populations of terns of the currently newly designated Anglesey Terns/Morwenoliaid Ynys Môn SPA. Similarly, the fish biomass potentially impinged each year would equate to the annual diet of up to two harbour porpoises (within the North Anglesey Marine cSAC). As already stated, with embedded mitigation in place this impingement biomass is likely to be reduced further still with mortality of impinged fish predicted to be less than 8%.

13.6.540 The magnitude of effect on receptors which are qualifying features of designated sites is considered to be negligible. It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites from impingement.

Impact pathway: entrainment of marine organisms

General context

13.6.541 During operation, Cooling Water would be abstracted from the sea, and fish, invertebrates and plankton would also be drawn (entrained) into the CWS. The CWS design incorporates fish protection measures, including fine mesh screens. However, ichthyoplankton (larval fish), phytoplankton (microscopic plants) and zooplankton (including partly planktonic animals such as invertebrate larvae and truly planktonic animals such as copepods) are small enough to pass through these screens. Once entrained, they would transit the entire CWS during which they would be vulnerable to mortality. Any marine organisms entrained would be returned to the sea via the Cooling Water discharge.

13.6.542 Passing through a CWS exposes planktonic organisms to a range of stressors, including pressure and temperature differentials, mechanical effect and abrasion, hydraulic shear stress and biocide toxicity (chlorine and its derivatives). On return to ambient conditions of temperature and pressure, damaged and disorientated organisms may also be at an increased risk of predation [RD213]. It has long been recognised that large numbers of organisms are entrained by power plants and that the mortalities incurred might cause ecological harm over wide temporal or spatial scales [RD213].

13.6.543 Survival of planktonic organisms through the CWS depends on species-specific tolerance to the stressors experienced during cooling system passage. Planktonic organisms are incapable of avoiding entrainment due to their inability to swim against the intake currents and therefore typical mitigation measures used for juvenile and adult fish species are not effective.

Entrainment at the Existing Power Station

13.6.544 Fish entrainment data are available from surveys carried out at the Existing Power Station (see appendix D13-10, Application Reference Number: 6.4.92). These data have been used to produce annual entrainment predictions for the Wylfa Newydd Power Station.

Predictions

13.6.545 Entrainment results from the 2011 to 2012 entrainment surveys on the Existing Power Station have been scaled to a constant tidally averaged abstraction rate of 126m^3/s. This value includes 5% contingency and represents the worst case. Ichthyoplankton abundances (eggs and larvae) have been extrapolated from numbers of individuals per m^3 sampled in the entrainment surveys at the Existing Power Station during each month and then summed to give an annual prediction, allowing for changes in abundances owing to seasonality. It is noted that these numbers are indicative and are presented to support the assessment.

13.6.546 It is recognised that the intake design of the Existing Power Station does not meet current best practice. The new intake at the Wylfa Newydd Power Station would be designed to reduce the mortality of marine organisms. However, the design of the CWS (including these mitigation measures) is ongoing and therefore efficiencies for the Power Station are not known. In the absence of this information, the assessment has taken a precautionary approach assuming 100% mortality. However, predicted survival rates have been presented, where available, in order to demonstrate how the mortality of marine organisms entrained could be reduced.

Effect on phytoplankton and zooplankton of entrainment

13.6.547 Phytoplankton communities in the area are dominated by diatoms (phylum Ochrophyta), with dinoflagellates (phylum Myzozoa) being the second most abundant group. These important groups of the phytoplankton community would not be able to avoid entrainment through the CWS.

13.6.548 The zooplankton community is dominated by Copepoda (e.g. Harpacticoida, Calanoida and Cyclopoida) and Thecostraca (Sessilia) which would also not be able to avoid entrainment through the CWS. Both phytoplankton and zooplankton would be vulnerable to mortality, the degree of which would depend on the individual species, developmental stage, size and condition. The distribution of zooplankton (i.e. patchiness and stratification) would also play a role in determining the magnitude of losses.

13.6.549 When examining the effects of entrainment on particular species, simulation studies in controlled conditions, such as the entrainment mimic unit (EMU), provide more robust data compared to entrainment survivorship studies on operational power stations. This is firstly because entrainment of individual species is very intermittent and it has proved difficult to obtain sufficiently large sample sizes for statistical analysis, and secondly, because it is hard to distinguish damage caused by collection in plankton nets from CWS passage injuries [RD213].

13.6.550 The EMU was first designed in the late 1970s and was based on the design of Sizewell B Nuclear Power Station, Suffolk. The EMU aimed to assess the effect of entrainment on various planktonic species. The unit was designed to mimic and assess the individual and combined effects of temperature, physical stress and biocide dosing.

13.6.551 Effects on the planktonic stages of Pacific oyster, common shrimp, lobster and copepods were investigated by Bamber and Seaby [RD214]; [RD215]; [RD216]; [RD217]; and Turnpenny and Taylor [RD218]. Mortality of the organisms passing through the EMU was found to vary according to the type and strength of stressors encountered. Evidence from studies such as these suggests that a large proportion of entrained plankton is able to survive passage through the CWS. In general, the results of experiments suggest that crustacean larvae are more tolerant than fish or mollusc larvae (table D13-34).

13.6.552 Mortality and injury to organisms occur due to mechanical damage, pressure-related effects, thermal shock and toxic biofouling-control agents. The magnitude of each effect varies according to each individual power station's operating regime and the time of year, the latter dictating the degree of thermal shock and use of biofouling control.

Table D13-32 Survival rates of entrained species from CWS passage simulation [RD218]

Species	Life stage	Entrainment survival rate	Prime causes of mortality
Shrimp (Crangon crangon)	Larvae	60% – 70%	Chlorine toxicity
Lobster (*H.gammarus*)		92%	Mechanical stress
Pacific oyster (*Megallana gigas*)	Embryo	0%	Chlorine toxicity and pressure stress

Species	Life stage	Entrainment survival rate	Prime causes of mortality
Copepod (Acartia tonsa)	Adult	80%	Chlorine toxicity and pressure stress

13.6.553 A study at Fawley Power Station found that phytoplankton productivity fell by 50% to 60% once it had passed through the circulating water system under routine conditions (ΔT 8°C to 10°C, 0.2mg/L chlorine at outfall) [RD219]. The main cause, however, was considered to be chlorine rather than temperature. In an experiment focused on the effects of water temperature, it was found that productivity increased by 15% with temperatures up to 23°C but then decreased by up to 11% when temperatures exceeded 23°C [RD220].

13.6.554 A study which considered the effects of temperature on zooplankton determined survival to be around 90% up to a temperature of 29.5°C and that the change in temperature did not have any effect [RD221]. In another study, thermal shocks with an increase of 10°C, 12°C, 15°C and 17°C were applied to diatom populations for durations of five to 40 minutes under various temperatures (12°C, 16°C, 20°C and 24°C). The effects of thermal shock were assessed by analysing the percentage growth after seven days in relation to a control. Two species, *Phaeodactylum tricornutum* and *Gyrosigma spenceri*, were not significantly adversely affected by the thermal shock when grown at temperatures of 12°C and 16°C [RD222]; [RD223]. The cultures were destroyed under a temperature increase of 15°C and 17°C, while their growth was inhibited with temperature increases of 10°C and 12°C [RD222]; [RD223]. The two species behaved differently in extreme temperature conditions; *G.spenceri* showed similar growth to control cultures up to a temperature of 35°C whilst *P.tricornutum* was more affected.

13.6.555 Responses to increased temperature exposure during entrainment may be seen in phytoplankton community composition, e.g. changes in the relative proportions of component species. However, changes to communities as a whole are not likely to be significant because of the very small percentage of the overall community being entrained and high productivity of such groups.

13.6.556 Subsequent effects may be seen in zooplankton, with populations changing in extent or phenology in response to prey abundance. Direct effects on zooplankton species may also occur resulting in changes in population composition, although this is likely to affect only a very small proportion of species. The literature suggests that it is likely that the most abundant components of the zooplankton communities, i.e. Crustacea, would exhibit a large degree of survivability (e.g. around 80%, with mortalities mostly from biocide or pressure stress) and therefore zooplankton would have a better potential for survival through the CWS than phytoplankton.

13.6.557 For the purposes of this assessment, 100% mortality of phytoplankton and zooplankton through the CWS has been considered. There could be reduced productivity in the immediate waters receiving the discharge, perhaps by up to 60%, mainly owing to biocide effect rather than

temperature. It is expected that any reduced phytoplankton abundance as a result of entrainment through the CWS would be short-term as the water body is well mixed.

13.6.558 Although replenishment from the wider area is likely, the reduced productivity may have a subsequent effect on zooplankton which would have, in effect, less prey. The complex dynamics of phytoplankton and zooplankton interactions mean that species-specific effects are difficult to predict and may be masked by other variables. For example, in theory, changes in water temperature, e.g. a permanent uplift, may also affect primary production such as increasing growth rate, changing the kinetics of nutrient recycling and causing an earlier start to the plankton spring bloom. In UK waters, light rather than temperature appears to be the limiting factor in primary production [RD224]. Subsequent effects may be seen in zooplankton wider communities, with populations changing in extent or phenology in response to prey abundance.

13.6.559 Overall, the magnitude of change to wider phytoplankton and zooplankton populations present off Wylfa Head is predicted to be small and the effects on phytoplankton and zooplankton from entrainment through the CWS is considered to be negligible.

Effects of entrainment on intertidal and subtidal habitats and communities (including invertebrates of conservation and commercial importance)

13.6.560 The plankton populations entrained through the CWS would likely contain meroplanktonic life stages (i.e. eggs and/or larval stages) of benthic invertebrates present in the wider area (e.g. barnacles, brittlestars, shrimps, crabs, bivalves and polychaete worms). As described in paragraph 13.6.551, it is likely the mortality rates would be relatively greater for mollusc larvae compared to crustaceans. There is therefore the potential effect of a reduction in density of early life stages of molluscs available for recruitment to the benthic communities. Although it is difficult to quantify this effect, recruitment from the wider environment would likely offset any losses owing to entrainment mortality.

13.6.561 There may also be a reduction in food resource if plankton densities are reduced. Filter feeders such as bivalves and barnacles, particularly populations closest to the outfall, would be most affected. Plankton suffering mortality would still be a viable resource as it would not be lost from the ecosystem. However, again it is difficult to quantify this effect.

13.6.562 Although the effects on benthic invertebrate communities are difficult to quantify, the magnitude of change is predicted to be small and it is considered that there would be a negligible effect on benthic invertebrates from entrainment.

Effects of entrainment on ichthyoplankton and marine fish

13.6.563 Based on survey data from the Existing Power Station, a total of 151 million fish larvae and 1.6 billion eggs are predicted to be entrained at the Power

Station per year. It is predicted that the following species would be entrained in the highest abundances (each in the order of tens of millions per year):

- gobies;
- dragonet;
- right-eyed flatfish (namely dab);
- blenny;
- scorpionfish; and
- sandeel (namely *Ammodytes* sp.) larvae.

13.6.564 Annual entrainment predictions of larvae belonging to each of the remaining taxonomic families are in the order of millions or less per year (see appendix D13-4, Application Reference Number: 6.4.86).

13.6.565 In terms of abundance of species of conservation importance, it is likely that Raitt's sandeel and gobies (sand and common goby) would be entrained in the greatest numbers (each in the order of millions per year). A proportion of species that are likely to be entrained are also of commercial importance. The key commercial species include plaice, Dover sole, sprat, whiting and herring. With the exception of Dover sole, each of these species will be entrained in the order of less than a million per year; less than two million Dover sole larvae are predicted to be entrained each year.

13.6.566 Whilst intuitively the potential loss of ichthyoplankton from entrainment seems high, it is important to consider annual entrainment estimates in the context of ichthyoplankton abundances within the source water body. Densities of eggs and fish larvae predicted to be entrained represent a maximum of 32% and 20% of that recorded from coastal plankton samples during the corresponding months, respectively. The highest densities of fish larvae and eggs around the north coast of Anglesey have been found offshore and to the east, in proximity of known spawning grounds [RD24]. Inshore waters support comparatively lower abundances of ichthyoplankton.

13.6.567 It is also important to consider the life history characteristics of fish. With little or no parental care, fish eggs and larvae experience extremely high rates of natural mortality. For small, short lived species such as sprat and sand smelt, mortality following recruitment can reach 50% to 90%, whilst large, long lived fishes (e.g. bass) typically experience lower natural mortality rates, i.e. 10% per year or less [RD225]. To ensure population persistence, an individual fish will spawn thousands to millions of eggs each year on the basis that over its reproductive lifetime, only two offspring need to survive to adulthood to replace the parents within the population. Owing to natural mortality factors such as predation, starvation, disease and hydrodynamic processes, very few eggs and larvae would likely survive through to adulthood.

13.6.568 Whilst annual entrainment estimates appear high, these values represent a small fraction of ichthyoplankton abundances known to be present within the eastern Irish Sea. Furthermore, the life history strategy of fishes takes account of high natural mortality during early life stages. Mortality of

ichthyoplankton due to entrainment is therefore unlikely to have a significant effect on wider abundances and the success of adult populations.

13.6.569 To give an indication of the relevant value of early life stages to adult populations, extrapolated entrainment catches have been converted into EAVs. This approach takes into consideration species-specific reproductive and mortality rates (where available) to calculate the estimated numbers of adult fish lost from the ecosystem based on larval numbers entrained through a CWS.

13.6.570 Annual abundances of larvae predicted to be entrained and their EAV are presented in table D13-33. The predicted number of adult equivalents lost is reduced considerably compared with raw annual abundances of larvae; in most cases by up to four orders of magnitude. For example, the 14 million sandeel (*Ammodytes* sp.) larvae predicted to be entrained over the course of the year equate to less than 5,000 adult equivalents (table D13-33).

Table D13-33 Predicted annual abundance of larvae entrained and their EAVs for species where data are available (numbers over 100 to two significant figures), for an abstraction rate of 126m^3/s

Common name	Annual raw abundance	Annual EAV
Sprat	260,000	46,000
All clupeids as sprat	280,000	32,000
Goby family	24,000,000	24,000
Sandeel (*Ammodytes* sp.)	14,000,000	4,600
Dragonet	21,000,000	3,700
Plaice	84,000	1,200
Whiting	23,000	690
Solenette	2,700,000	270
Dover sole	650,000	210
Dab	9,700,000	100
Corkwing wrasse	1,100,000	100
Goldsinny wrasse	480,000	85
All clupeids as herring	280,000	36
Herring	110,761	27
Total[3]	74,000,000	81,000-110,000

[3] The reported total assumes individuals recorded as Clupeidae represent either sprat or herring.

13.6.571 Eggs experience the highest rates of natural mortality of any life stage with more than 99.9% of those predicted to be entrained annually, unlikely to survive through to adulthood. In the absence of speciation, an approximate EAV can be assigned to the annual egg entrainment estimate assuming they represent the species listed in Table D13-33. The 1.6 billion eggs predicted to be entrained annually equates to an average of 97,000 adult equivalents. The EAV-at-hatching has been assumed within the calculations and therefore this estimate represents a worst case approximation.

13.6.572 In terms of the numbers of fish larvae abstracted, the effect of entrainment has been considered from both the Existing Power Station and any subsequent station running concurrently, as having no significant adverse effect on fish populations of the species entrained [RD226]. Although the Power Station would have a larger abstraction compared with the Existing Power Station, the numbers of fish entrained are small in relation to the wider populations. Therefore, the magnitude of change is predicted to be small and there is considered to be a negligible effect on ichthyoplankton including those of conservation and/or commercial importance, from entrainment.

13.6.573 As with phytoplankton and zooplankton, evidence from previous studies suggests that a proportion of entrained ichthyoplankton are able to survive passage through circulating water systems (Table D13-34). As for phytoplankton and zooplankton, mortality and injury occurs due to mechanical damage, pressure-related effects, thermal shock, toxic antifouling agents and Total Residual Oxidant (TRO). The magnitude of each effect varies according to each individual power station's operating regime and time of year, the latter dictating the degree of thermal shock and use of biofouling control.

13.6.574 Effects on the planktonic stages of Dover sole, turbot, and bass were investigated using the EMU as described in paragraph 13.6.550 above [RD214]; [RD215]; [RD213]; [RD216]; [RD227]; [RD228]; [RD218]. Mortality through the EMU was found to vary according to the type and strength of stressors encountered.

Table D13-34 Survival rates of entrained fish from CWS passage simulation [RD218]

Species	Lifestage	Entrainment survival rate	Prime causes of mortality
Dover sole (*Solea solea*)	Eggs and post-larvae	65%	Thermal stress and chlorine toxicity
Turbot (Psetta maxima)	Eggs and post-larvae	15%–30%	Thermal, mechanical and pressure stress
Bass (Dicentrarchus labrax)	Fry	54%–60%	Thermal stress and chlorine toxicity

13.6.575 In a study of fish egg survivability, the majority of species did not seem to be affected by the rapid change in temperature. The results for Dover sole showed that as long as the maximum temperature was less than 29°C, no significant effects were noted [RD229]. The results for turbot showed that

significant effects were only noted when the absolute temperature reached 32°C, whereas for bass, at an absolute temperature of 27°C degrees, 20% egg mortality was recorded [RD229].

13.6.576 Assuming 12°C uplift, ichthyoplankton passaging the CWS will be subject to an absolute temperature of 29°C during the late summer and therefore a degree of survival is probable. Peak entrainment would occur during the late spring and early summer when ambient temperatures would be lower; survival rates are therefore likely to be higher during this period of the year.

13.6.577 In the absence of survivability data specific to the Power Station thermal and biofouling regime, the assessment has taken a precautionary approach assuming 100% mortality. However, consideration of survival rates would likely reduce the magnitude of ichthyoplankton mortality. This information provides further support to the conclusion that entrainment would have a negligible effect on ichthyoplankton.

13.6.578 The effects of entrainment on wider marine fish populations has been assessed by comparing EAV losses to commercial fish landings data or other quantifiable population data.

13.6.579 The losses to entrainment as a proportion of commercial landings are provided in table D13-35. Using information on commercial fishing efforts as presented in paragraph 13.6.505 above.

Table D13-35 Predicted equivalent adult fish entrained annually as a proportion of commercial landings

Species	Weight at 50% maturity (g)	Stock	Condition of stock	Latest landings (tonnes)	Proportion of landings
Whiting	89 [RD189]; [RD190]	Irish Sea (VIIa)	Undefined	73 (2014)	0.08%
Plaice	131 [RD191]; [RD190]	Irish Sea (VIIa)	Stock size increasing	1,005 (2015)	0.02%
Dover sole	211 [RD192]; [RD190]	Irish Sea (VIIa)	Below reproductive capacity	76 (2015)	0.06%
Sprat	7 [RD194]; [RD190]	North Irish Sea (VIIaN)	Full reproductive capacity	4,900 (2015)	0.01%
All clupeids as sprat					additional 0.01%
Herring	109 [RD193]	English Channel (VIId-e)	Undefined	3,003 (2015)	0.0001%
All clupeids as herring					additional 0.0001%

13.6.580 Other population metrics can also be used to contextualise entrainment catches for species such as dab. Using the population information presented by Selsay [RD196] (see paragraph 13.6.508), the estimated number of equivalent adult dab potentially entrained annually at the Existing Power Station represented 0.004% of the local population.

13.6.581 Of those species that are likely to be entrained and that are subject to conservation designation(s), Raitt's sandeel is the only species which would be entrained in relatively large numbers. Assuming all sandeel larvae were Raitt's sandeel (i.e. worst case), numbers would equate to a loss of 4,600 equivalent adults. Supposing each equivalent adult weighed 8g (i.e. typical weight at 50% maturity) [RD230]; [RD190], this number would represent a weight of 0.04 tonnes. Abundances of sandeel on the west coast of the United Kingdom are too low to sustain a commercial fishery and therefore no direct comparison can be made to fishing pressure. Nonetheless, a loss of this size is unlikely to affect the integrity of wider populations and therefore the magnitude of change is predicted to be negligible and the effect is negligible.

13.6.582 The plankton (including ichthyoplankton) entrained through the CWS is potentially a food source for marine fish (or their prey). Therefore, losses may cause indirect effects on this receptor in the wider population. Although it is difficult to quantify this effect, as each fish species has different prey preferences (species, size, etc.) at different life stages, it is likely that the effect would be small as the planktonic prey would still be available within the system (and may also survive entrainment), as well as be replenished via tidal exchange. Fish are also highly mobile species and are likely to have large foraging areas, and as such are unlikely to restrict their feeding to the immediate area of the CWS discharge.

13.6.583 In terms of commercial species, it is likely that sprat and herring would be entrained in the greatest numbers. Calculated as EAVs, the numbers of commercial fish potentially entrained correspond to less than 0.02% of their respective commercial catch within the northern Irish Sea and English Channel, respectively. The reduction in food resource for some marine fish species in the wider population (directly and indirectly) owing to entrainment losses, as already stated, is difficult to quantify, but is predicted to be small.

13.6.584 Although no glass eels are predicted to be entrained at the Power Station, it is acknowledged that adult life stages are present in freshwater habitats within the Wylfa Newydd Development Area; albeit in low abundance. It is therefore possible that glass eels would be vulnerable to entrainment, although the probability of this occurring is considered to be low. Entrainment of glass eel would result in small magnitude of change therefore the effect to European eel populations from entrainment is considered to be negligible.

13.6.585 The loss of all other fish species is very small in comparison to wider populations. Therefore, the magnitude of change to general fish and fisheries and all remaining fish of conservation and/or commercial importance, as a result of ichthyoplankton entrainment is small and the effect on marine fish populations is considered to be negligible.

Effects of entrainment on marine mammals

13.6.586 The entrainment of fish and invertebrates may have an indirect effect on marine mammals in the area through a reduction in their prey populations. Harbour porpoise and grey seal are the most common species present around the north coast of Anglesey and would likely be most affected. Dietary equivalents modelling (using weight composition data) has been undertaken to quantify the potential loss of food resources to these marine mammal species. Minke whale and bottlenose dolphin are also present but in much lower abundances and not all year round; entrainment is unlikely to affect the wider food resources available to these species.

13.6.587 The dominant prey of harbour porpoise in the Irish Sea are known to be gadoids (namely whiting and haddock) and clupeids (namely herring) [RD100]. Grey seal target a wide range of fish taxa within the Irish Sea; these include the majority of those predicted to be entrained [RD45]; [RD100]. Although sprat has not been identified as prey species of grey seal within the Irish Sea, this species has been included within the dietary equivalents assessment owing to the degree of uncertainty associated with dietary analysis and the possible confusion with herring larvae.

13.6.588 The approach used to assess the loss of food resources to harbour porpoise and grey seal due to entrainment is consistent with that used to assess the effects of impingement. A detailed description of this approach is outlined in paragraph 13.6.525. The only difference is that EAVs have been used rather than raw extrapolated numbers; this is considered more accurate as harbour porpoise and grey seal do not consume larval fish, preferring to target juveniles, and to a lesser extent, adults.

13.6.589 Of the fish predicted to be entrained annually, 59% and 89% are considered to represent a possible food resource to harbour porpoise and grey seal, respectively. Assuming an average adult weight of 45kg to 60kg [RD206], the estimated equivalent adult biomass of prey species potentially entrained each year equates to the annual diet of one to three harbour porpoise. The upper estimate corresponds to the smaller average adult weight and assumes that all fish recorded as clupeids were sprat which have a higher EAV at a given age compared to herring. Assuming an average adult weight of 194kg [RD100], the estimated equivalent adult biomass of known prey species potentially entrained per year equates to the annual diet of two to four grey seals.

13.6.590 Considering the loss of food resource in relation to the size of the population and availability of alternative food sources, the magnitude of change is predicted to be small and the effect on marine mammals from entrainment of food resource is negligible.

Effects of entrainment on seabirds

Target species

13.6.591 The entrainment of fish could have an indirect effect on seabirds through a loss of food resource. Dietary equivalents modelling (using bioenergetic data) has been carried out to quantify the potential loss of food resources to

terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA.

13.6.592 The approach taken is consistent with that used to assess the indirect effects of fish impingement; a detailed description can be found in paragraph 13.6.525. The only difference is that EAVs have been used rather than raw extrapolated numbers; this is considered more accurate as terns preferentially target juvenile and to a lesser extent adult fish.

13.6.593 The dietary equivalents assessment has only considered sandeel and clupeids as these are the main food resource to terns, representing between 78% and 95% of the overall diet of adults and chicks [RD207]; [RD50]; [RD208]. The estimated number of clupeid and sandeel adult equivalents entrained during the breeding season (April to July) can be examined in the context of the typical dietary intake of terns, which are a target species owing to their designation within the Anglesey Terns/Morwenoliaid Ynys Môn SPA.

13.6.594 Based on the bioenergetics information presented in paragraph 13.6.528, it is estimated that the number of clupeid and sandeel adult equivalents entrained during the breeding season would support up to 55, 62 or 57 adult Arctic, common or Sandwich terns, respectively.

13.6.595 Whilst intuitively the potential loss of food resource to these target species seems large, it is important to consider entrainment effects in the context of the SPA population. Approximately 1,290, 189 and 460 breeding pairs of Arctic, common and Sandwich terns are supported by the SPA (five year mean population size: 1992 to 1996 for Arctic and common terns and 1993 to 1997 for Sandwich terns). Multiplying per capita consumption by these population estimates, the predicted weight of equivalent adult sandeel and clupeid entrained between April and July would represent between 0.8% and 1.5% of that required to sustain the SPA population during the corresponding period (i.e. the breeding season).

13.6.596 Considering the loss of local food resource in relation to the size of the wider foraging area known to be utilised by terns, the magnitude of change is predicted to be small and the effect on target seabirds from entrainment of food resource is negligible.

Secondary species

13.6.597 In terms of secondary species, the effect of entrainment on their food source is less quantifiable (as opposed to an impingement catch where actual biomass is easily obtainable). It is difficult to obtain and apply an accurate EAV value to the potential total entrainment loss through the Power Station (or to only those species that would be targeted by seabirds).

13.6.598 To quantify the potential loss of food resources to other seabirds, dietary equivalents modelling using generic bioenergetic data [RD212] has also been used. This approach is consistent with that used to assess the indirect effects of fish impingement; a detailed description can be found in paragraph 13.6.536.

13.6.599 The estimated equivalent adult weight of whiting, plaice, dab, Dover sole, sandeel, herring and sprat entrained annually would equate to the annual

diet of between three and five seabird equivalents. Although it is recognised that this does not include all potentially targeted species, it is indicative of the magnitude as some of these species are among those potentially entrained in the highest numbers (and/or EAVs).

13.6.600 Considering the loss of food resource in relation to the size of the population and availability of alternative food sources, the magnitude of change is predicted to be small and the effect on secondary seabirds from entrainment of food resource is considered to be negligible.

Effects of entrainment on designated sites

13.6.601 The indirect loss of food resource to marine mammals and seabirds due to entrainment would have a further indirect effect on current and proposed designated sites for which they are qualifying features.

13.6.602 As described in the preceding sections on marine mammals and seabirds, the magnitude of change is predicted to be small and the effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA from entrainment, as well as the North Anglesey Marine cSAC, are considered to be negligible. It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites, from entrainment.

Impact pathway: underwater noise from AFDs during operation

General context

13.6.603 An AFD system will be installed on the front face of the intake (paragraph 13.5.70) to reduce the effect of impingement on marine fish. The AFD system is designed to emit sound signals in the frequency range of 25Hz to 400Hz at a source level of 160dB re 1µPa. The operation of the AFD system will result in a continuous noise source at the intake to deflect fish away from the area and thereby avoiding entrapment.

Effects of underwater noise generated through operation on marine mammals

13.6.604 An overview of marine mammal hearing is provided in paragraphs 13.6.318 to 13.6.321. This shows that the frequency range at which the AFD operates within the auditory range of marine mammals and pinnipeds.

13.6.605 The largest overlap is for low-frequency cetaceans which include the baleen whales such as the minke whale. Baleen whales are more commonly found offshore and in the southern Celtic and Irish Sea (appendix D13-6, Application Reference Number: 6.4.86). Baseline surveys undertaken have reported two sightings of baleen whales (possibly minke) outside of the survey area (appendix D13-6, Application Reference Number: 6.4.86).

13.6.606 Of the cetacean species likely to be within the Wylfa Newydd Development Area, the hearing ranges of the bottlenose dolphin and harbour porpoise will have some overlap with the AFD system. The underwater noise generated by the system is not of a level that would result in PTS or TTS for both species and it is highly unlikely that any disturbance would result.

13.6.607 Pinnipeds in water also have a hearing range that overlaps with the sound signal for the AFD. Like the harbour porpoise and bottlenose dolphin there is not potential for PTS or TTS in seals from the AFD and disturbance is unlikely.

13.6.608 Modelling of the AFD system has shown that the sound signal is localised to the intake and assuming a precautionary range of 500m within which disturbance could occur this would not have an effect on the species. The records of all cetaceans and pinnipeds within Porth-y-pistyll are sparse with only rare sighting of grey seal within the bay. The effect of underwater noise on marine mammals is considered to be of negligible magnitude and therefore negligible effect.

Impact pathway: discharge of Cooling Water – thermal effects

General context

13.6.609 The Cooling Water discharge for the Power Station would be located at Porth Wnal, adjacent to the outfall of the Existing Power Station. The discharge water would be approximately 12°C (98 percentile) warmer than the water being abstracted. The volume of water discharged would vary over the tidal cycle from 113m^3/s at LAT to 126m^3/s at highest astronomical tide. Hydrodynamic modelling has been based on a tidal average value with an allowance made for potential inefficiencies over the lifetime of the CWS. The modelling is therefore based on Cooling Water being discharged at a rate of 126m^3/s (tidal average plus 5%).

13.6.610 The Cooling Water outfall would be located within the Anglesey North WFD coastal water body. The discharge would also influence the adjacent Skerries WFD coastal water body.

13.6.611 Factors that influence the thermal tolerances of marine organisms include environmental aspects such as latitude, habitat, exposure and seasonality as well as biological factors such as mobility mechanisms, feeding, foraging and reproductive strategies.

13.6.612 The effect on each marine receptor from an increase in temperature would be determined by their exposure to the warmer water both spatially and temporally. As warmer water is more buoyant than cooler water, the area of the seabed that is warmed is relatively small in comparison to the surface. The effects on receptors are evaluated based on the modelling results, the characteristics of the receptor and the sensitivity of a receptor to temperature (as indicated by thresholds where data are available).

Thermal standards

13.6.613 Temperature limits are placed on Cooling Water discharges for a number of reasons, including:

- elevated water temperatures experienced during transit through a CWS can be fatal to fish and other organisms;
- aquatic organisms have thermal preferences and raising the water temperature may preclude certain species from an area;

- increased temperatures can reduce the dissolved oxygen concentration and/or promote algal blooms; and
- the potential for in-combination stresses on aquatic organisms, such as those associated with both temperature and biocide use.

13.6.614 The difference in temperature between the water abstracted and the water discharged (also referred to as the temperature rise) is a balance between the requirement to limit potential effects related to both discharge temperature and levels of entrapment of marine organisms into the CWS. For an equivalent power output, a lower discharge temperature would require a higher abstraction rate, which would increase entrapment effects, whilst reducing temperature related effects. Conversely, a lower abstraction rate would result in fewer entrapment effects but a higher temperature discharge and the associated issues of the thermal plume.

13.6.615 In the UK, thermal discharges are consented by applying temperature limits to the thermal mixing zone [RD219]. Temperature and other water quality parameters are allowed to exceed defined acceptable limits within the mixing zone, but the extent of the zone and the distance at which levels must have returned to below the limits, are set by the statutory authority based on the relevant regulations, available data and modelling output.

13.6.616 There are no legal standards for limits on thermal discharges into coastal water bodies. The most recent guidance available was developed by the British Energy Estuarine & Marine Studies Expert Panel who produced a report: Thermal standards for Cooling Water from new build nuclear power stations, which summarises existing temperature standards and provides evidence on the effects of thermal discharges [RD224]. This work was expanded by Wither *et al*., [RD231] in a review of the thermal tolerances of fish and marine biota and recommended thresholds in relation to WFD status boundaries (high, good, moderate, poor, bad, where the aim is for all water bodies to achieve good). The temperature boundaries for transitional and coastal water bodies proposed by the British Energy, Estuarine and Marine Studies [RD224] are shown in Table D13-36.

Table D13-36 Proposed temperature boundary values for all transitional and coastal waters outside the mixing zone in relation to WFD status [RD226]

Typology	Normative definition boundary positions (as annual 98 percentile) (°C)			
	High/good	Good/ moderate	Moderate/ poor	Poor/bad
Maximum allowable temperature	23	23	28	30
Maximum allowable temperature uplift	+2	+3	+3	+3

13.6.617 The assessment considers the locations of the 2°C and 3°C temperature boundaries. This provides an indication of the proportion of the WFD water bodies that are influenced by the Cooling Water discharge. It is recognised that temperature influences other WFD quality elements (e.g. benthic invertebrates) and that the effects of temperature should be assessed in relation to known thresholds of effect for these quality elements. Therefore, where appropriate, consideration has also been given to receptors which may be more sensitive to temperature rise and in respect of absolute temperature.

Modelling: simulations

13.6.618 Horizon has developed a marine hydrodynamic model and carried out simulations of the Cooling Water discharge using the excess temperature surface heat exchange sub model within Delft3D [RD106]. The modelling methodology is described in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.619 The model uses an excess temperature surface heat transfer model to simulate the heat loss from the surface. This requires some assumptions to be made about the average sea temperature, wind speed and an effective area (see appendix D13-8, Application Reference Number: 6.4.90).

13.6.620 The base case simulations used a fixed discharge condition of 126m^3/s and a temperature rise of 12°C (98 percentile). Four base case simulations were modelled covering summer, autumn, winter and spring seasons. These simulations used seasonally appropriate surface heat loss rates and TRO decay rates, and were undertaken without the influence of wind or wave stress on the water surface.

13.6.621 Sensitivity studies were then completed using the average observed wind speed from the north, east, south and west and also a variable wind case. The influence of waves and sensitivity to surface heat loss were also investigated.

13.6.622 The results of the sensitivity studies are summarised here as they provide an indication of how the thermal plume is likely to be affected in reality. For the purposes of assessment, two scenarios have been used to illustrate the effects of the Cooling Water discharge:

- a ‘worst case’ scenario using an annual base case with a continuous discharge of 126m^3/s and no wind stress; and
- a summer base case with a continuous discharge of 126m^3/s with the inclusion of a variable wind.

Modelling: results

Variation of the thermal plume over a tidal cycle

13.6.623 The Cooling Water discharge is buoyant and will form a plume at the surface, which will be advected by the tide and influenced by wind and waves, and will therefore remain in a constant state of flux. The buoyancy limits the exposure of the bed to elevated temperatures.

13.6.624 The tidal flow north of Wylfa Head is relatively simple, with an essentially east to west tidal current (see chapter D12, Application Reference Number: 6.4.12). However, the presence of the headland results in complex flow region in the bays either side, and the evolution of the plume differs on a neap and spring tide.

13.6.625 At high water on a neap tide, the plume is beginning to be advected to the west as the tide begins to ebb (figure D13-30). At mid ebb on a neap tide, the plume at the surface has been advected to the west of the outfall. Compared to the high water case the plume is smaller. At low water on a neap tide, the plume still extends to the west of the outfall. However, at mid flood, the surface temperature rise shows the plume being advected to the east past Wylfa Head (figure D13-31).

13.6.626 The trends are similar for both neap and spring tides, with the plume being advected to the west on the ebb and east on the flood tide. There is a difference between the evolution of the plume at high tide, with the plume having a greater extent at the surface on a neap tide compared to a spring tide. At mid ebb, the extent is also greater on a neap than a spring tide. At low water neap, the plume extends further than on a spring tide. These differences can be explained by the higher current magnitudes on a spring compared to a neap tide. The higher currents increase shear stress and result in greater mixing of the Cooling Water discharge.

13.6.627 To further explore the evolution of the thermal plume, a series of vertical profiles were plotted around the outfall at different states of the tide using a neap tide for the summer base case (a worst case scenario).

13.6.628 For the vertical profile along a north-south axis near the outfall at low water, there is a rise of around 9°C close to the outfall (figure D13-32). Further offshore, temperature rises of 4°C to 5°C are predicted within the upper 4m to 5m of the water column. For the other tidal states, the predicted temperature rise is similar although with less offshore penetration of the plume than at low water (figure D13-32). These plots show that the plume is limited to the upper layers of the water column, except in the vicinity of the outfall where the seabed is exposed to higher temperatures.

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Figure D13-30 Rise in surface temperature at high water on a neap tide (dotted line indicates cross section locations) [RD232]

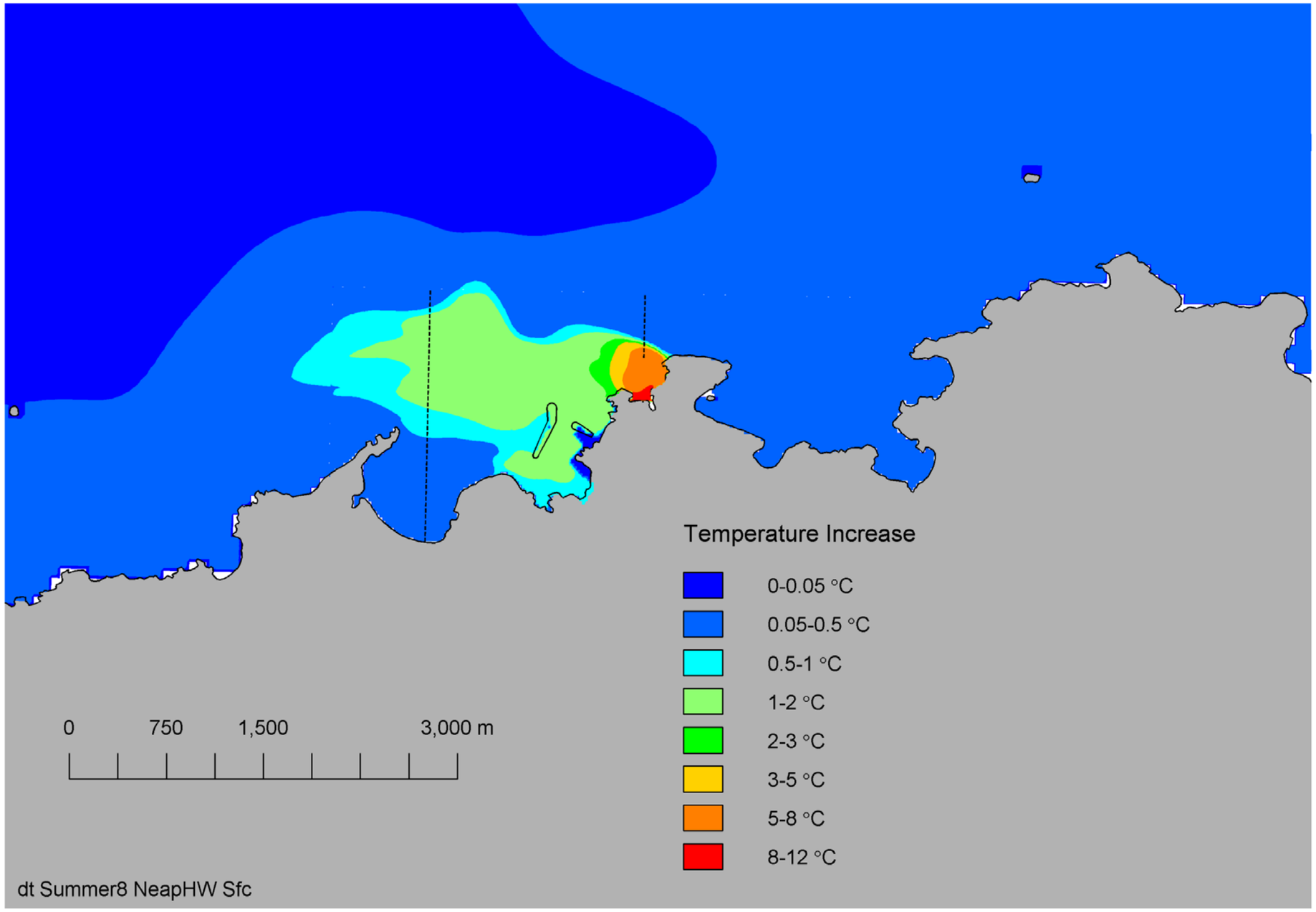


Figure D13-31 Rise in surface temperature at mid flood on a neap tide (dotted line indicates cross section locations) [RD232]

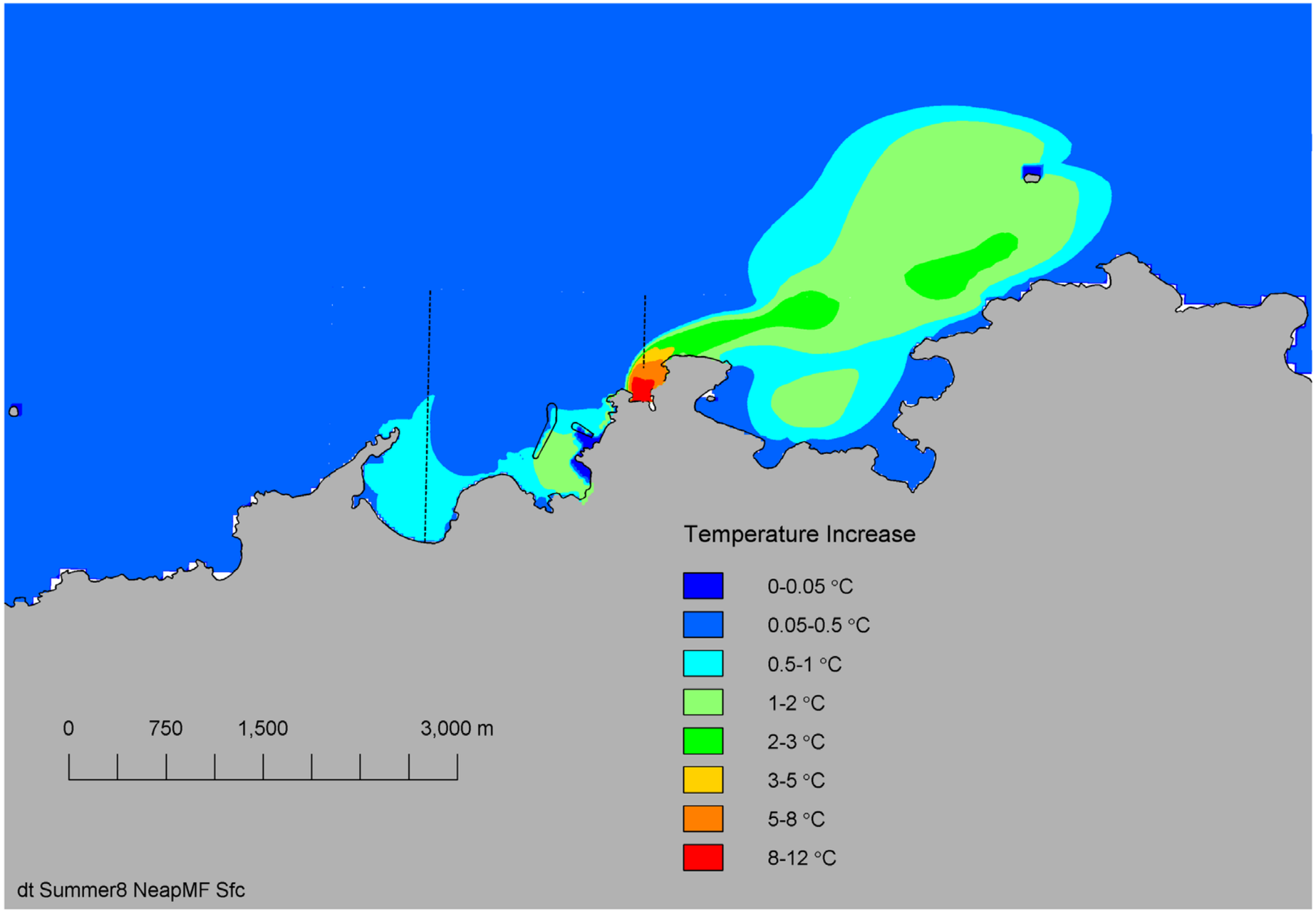
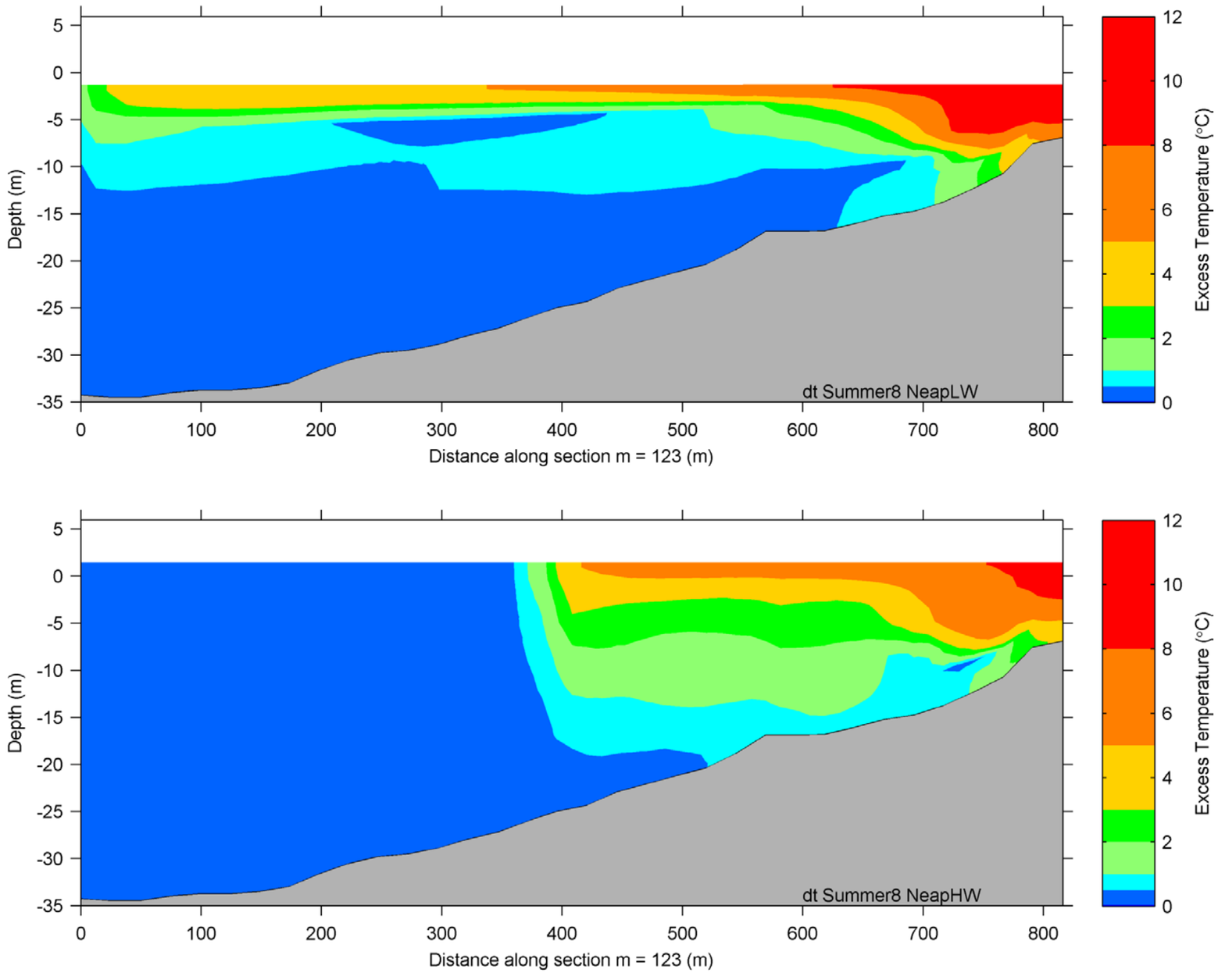


Figure D13-32 Vertical profiles at the outfall on a neap tide at low water (above) and high water (below) [RD232]; note the discharge is to the right of the figure.



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Sensitivity study: surface heat flux

13.6.629 A sensitivity study was carried out to consider the influence of the surface heat flux on mixing zones. The simulations repeated those of the summer base case but with a surface heat loss rate equal to the summer average ±10Wm^2/K. Model simulations were undertaken with both low and high surface heat exchange coefficients.

13.6.630 The difference between a low surface heat flux and the summer base case was small. In Cemlyn Bay, the mean difference between the two cases was around 0.03°C. The difference between a high surface heat flux and summer base case was also small. The small differences between the cases were considered to be indicative of the relative importance of the mixing processes compared to the surface heat loss in the waters around the Wylfa Newydd Development Area (see appendix D13-8, Application Reference Number: 6.4.90).

Sensitivity study: influence of wind

13.6.631 Both wind speed and direction have the potential to influence mixing of the Cooling Water discharge. The wind speed will influence both the stress imposed on the water and the surface heat flux. The wind stress will influence the hydrodynamics, while the surface heat flux affects the rate of heat loss and hence the mixing.

13.6.632 The base case simulations were all modelled without the influence of wind stress on the water surface. Sensitivity studies were then completed using the summer base case to explore the influence of wind from the north, south, east and west.

13.6.633 The greatest influence on the mixing zone is constant winds from the north and south. A southerly wind tended to push the plume out into the faster currents north of Wylfa Head, where mixing is greater, whilst a wind from the north tended to push the plume back towards the shore.

13.6.634 While long duration winds from any direction are relatively rare, the sensitivity studies provided confidence that excluding wind stress in the base case simulations was unlikely to have resulted in the under-prediction of the size and temperatures of the mixing zone. A no-wind stress assumption is likely to result in conservative modelling outputs. For the purposes of assessment, the summer base case with variable wind (derived from a long-term average of wind speed and direction) was used to represent a more realistic longer-term scenario.

Assessment scenarios

13.6.635 The areas of the mixing zones of the 2°C and 3°C (98 percentile) rise at the surface and seabed are presented in table D13-37 for both the annual base case and the summer base case with variable wind. The mixing zones are shown in figures D13-33 to D13-35 (Application Reference Number: 6.4.101).

Table D13-37 Area of the thermal plume in relation to 2° and 3°C (98 percentile) boundaries

Scenario	Area of the surface exceeding temperature boundaries (ha)		Area at the seabed exceeding temperature boundaries (ha)	
	>2°C	>3°C	>2°C	>3°C
Annual base case (126m^3/s at +12°C) – no wind	209	88	4.2	3.2
Summer base case (126m^3/s at +12°C) – with variable wind	97	49.8	4.1	3.1

Sensitivity study: influence of waves

13.6.636 Compared to the annual base case, the 2°C (98 percentile) mixing zone for the summer base case with waves was 29.2% smaller at the surface. The 2°C (98 percentile) mixing zone at the seabed was 5.0ha with waves compared to 5.2ha for the annual base case (19.6% larger) as a result of increased vertical mixing.

Annual base case (no wind)

13.6.637 For the annual base case the model predicted the following sea surface temperature rise:

- a greater than 3°C 98 percentile rise over a zone extending approximately 1.04km north and 1.37km from east to west; and
- a greater than 2°C 98 percentile rise over a zone extending approximately 1.52km north and 2.71km from east to west (figure D13-33, Application Reference Number: 6.4.101).

13.6.638 For the annual base case the model predicted the following temperature rise at the seabed:

- a greater than 3°C 98 percentile rise over a zone extending approximately 0.14km north and 0.38km from north-east to south-west, restricted to Port Wnal (orange zone); and
- a greater than 2°C 98 percentile rise over a zone extending approximately 0.17km north and 0.38km from north-east to south-west (figure D13-34, Application Reference Number: 6.4.101).

Summer base case with variable wind

13.6.639 For a summer base case with variable wind the model predicted the following sea surface temperature rise:

- a greater than 3°C 98 percentile rise over a zone extending approximately 0.86km north and 0.95km from east to west; and

- a greater than 2°C 98 percentile rise over a zone extending approximately 1km north and 1.86km from east to west (figure D13-35, Application Reference Number: 6.4.101).

13.6.640 A reduction in the mixing zone areas at the surface would be expected with the inclusion of wind, because the wind increases mixing and increases the surface heat flux. There is a small increase in the mixing zone at the seabed as the wind increases the vertical mixing of the thermal plume down towards the seabed, although the increases are relatively small.

Recirculation

13.6.641 A continuous supply of cool water is required for safe operation of the Power Station. The position of the intake and outfall has been carefully considered to avoid recirculation of warm water. The potential for recirculation was investigated by modelling over a range of conditions. A cell located approximately within the forebay was chosen and the depth-averaged temperature was determined over a spring neap tidal cycle under both the base case and tidally varying case. The results for the summer base case are presented in table D13-38.

Table D13-38 Temperature rise above ambient at the intake

Scenario	Temperature rise above ambient (°C)		
	Average	98 percentile	Maximum
Summer base case (126m^3/s at +12°C)	0.46	0.78	0.84

13.6.642 With a constant wind from the north, the mixing zone was slightly larger when compared to the base case. The degree of recirculation increased slightly with a constant wind from the north (an average of 0.1°C increase over the summer base case of 0.46°C). For all other directions the influence of wind either reduced or did not change the average temperature rise.

Absolute temperatures

13.6.643 The predicted maximum water temperature with the long-term operation of the Cooling Water discharge have been produced by combining the ambient temperature (maximum) with the maximum rise from the Cooling Water discharge over the year.

13.6.644 For the annual base case, the surface area with a temperature greater than 23°C (maxima) is approximately 14.6ha compared to 14.2ha in the summer base case with variable wind. In both scenarios the area of the 23°C (98 percentile) mixing zone at the seabed is limited to the immediate vicinity of the outfall in Porth Wnal.

Commissioning and non-standard operation conditions

13.6.645 During commissioning, it is possible that certain scenarios may lead to short-term temperature excursions whereby the Cooling Water discharge temperature will be elevated more than 12°C above ambient. However, the

maximum temperature rise at the point of discharge will not exceed 12°C above ambient as a 98 percentile.

13.6.646 For the majority of time the Power Station will operate under normal conditions. However, over the lifetime of the Power Station a number of scenarios may occur that differ from standard operating conditions. These include planned events such as outages which are required for maintenance, as well as unplanned events such as pump or turbine trips and turbine bypass.

13.6.647 At some point during operation, the Power Station could be required by National Grid to operate in 'frequency sensitive mode'. National Grid are responsible for balancing grid 'frequency'[4], which is achieved by controlling the outputs from large power generators to alter their output continuously to keep the frequency near 50Hz. There are a number of options that can be employed to achieve this, and the worst case scenario in terms of discharge temperature is whereby the station operates a 32% turbines bypass whilst operating at 100% reactor power. This would result in a discharge temperature uplift of up to 15°C above ambient for 100 seconds. This situation is unlikely to occur more than a few times over the lifetime of the Power Station.

13.6.648 During commissioning and non-standard operational conditions, there may be a rise in the temperature of the discharge of more than 12°C above ambient (98 percentile), but any exceedance would be balanced out over the discharge consent averaging period by varying reactor load to ensure that temperature thresholds (98 percentile) are met within the agreed mixing zone.

Effects of thermal discharge on marine water quality

13.6.649 To determine the magnitude of effect on the receiving waters, a comparison is made of the areas of mixing zones, in relation to the area of the receiving water bodies. This can be used to consider whether the mixing zones are proportionate and whether there could be any related effects on other receptors.

13.6.650 The Skerries and Anglesey North WFD water bodies are 4,723ha and 12,600ha respectively. The thermal plume would be dispersed over both water bodies. The thermal plume will be in a constant state of flux and the proportion of the plume within the water bodies will change with the tide. For the purposes of assessment, the area of the thermal plume that falls within each water body has been calculated and the proportion of the mixing zone in comparison to the water body has been derived (table D13-39).

13.6.651 The Skerries water body is achieving high status and therefore the 2°C boundary is relevant, whereas the Anglesey North water body is currently at

[4] System frequency is a continuously changing variable that is determined and controlled by the second-by-second (real time) balance between system demand and total generation. If demand is greater than generation- the frequency falls, while if generation is greater than demand the frequency rises (National Grid, 2016).

moderate status and therefore the exceedance should be considered in relation to a 3°C boundary, although the 2°C has also been considered.

13.6.652 This shows that in the worst case scenario the 2°C (98 percentile) mixing zone in the Anglesey North water body would be 0.97% of the water body area at the surface. The 2°C (98 percentile) mixing zone in The Skerries water body would be 1.69% of the water body area at the surface.

Table D13-39 Proportion of WFD water bodies exceeding 2°C and 3°C boundaries (98 percentile)

Scenario	WFD water body	Proportion of the water body exceeding boundaries (98 percentile) at the surface (%)		Proportion of the water body exceeding boundaries (98 percentile) at the seabed (%)	
		>2°C	>3°C	>2°C	>3°C
Annual base case (126m^3/s at +12°C (98 percentile)) – no wind	Anglesey North	0.97	0.27	0.03	0.02
	The Skerries	1.69	1.09	0.04	0.03
Summer base case (126m^3/s at +12°C (98 percentile)) – with variable wind	Anglesey North	0.32	0.11	0.02	0.01
	The Skerries	1.11	0.75	0.05	0.03

13.6.653 The total area of the 23°C (maximum) mixing zone at the surface is 14.6ha. The proportion of the mixing zone within the two water bodies is shown in table D13-40. The largest mixing zone occurs in The Skerries water body where, in the annual base case and the summer base case with variable wind, the 23°C (maxima) boundary would be exceeded at the surface over an area equivalent to 0.3% of the water body.

Table D13-40 Proportion of WFD water bodies exceeding the 23°C boundary

Scenario	WFD water body	Proportion of the water body exceeding the 23°C boundary (98 percentile) at the surface (%)
Annual base case (126m^3/s at +12°C (98 percentile)) – no wind	Anglesey North	0.1
	The Skerries	0.3
Summer base case (126m^3/s at +12°C (98 percentile)) – with variable wind	Anglesey North	0.1
	The Skerries	0.3

13.6.654 Given the large area of the water bodies and the comparatively small area of the thermal plume at the surface and seabed, the magnitude of change is predicted to be small and the effects on WFD water bodies from the thermal discharge is considered to be negligible.

Effects of thermal discharge on phytoplankton and zooplankton communities

13.6.655 Plankton have limited motility and their distribution is governed by external factors including the hydrodynamic regime and degree of vertical mixing. Localised effects are therefore usually hard to detect in coastal waters owing to the patchiness of plankton concentrations. Separating the effects of entrainment and temperature is difficult and therefore consideration has been given to thermal effects within the assessment of effects of entrainment (see paragraphs 13.6.547 to 13.6.559).

13.6.656 An increase in water temperature can directly affect planktonic species as metabolic rates are linked to temperature. The temperature tolerances of any organism are complex and tolerance will vary both within individuals and within the lifetime of any one individual [RD233]. All species will have an upper limit which, if exceeded, will have adverse effects ranging from a reduction in productivity to mortality [RD234]. Where a thermal discharge raises water temperature above the optimum range of plankton, this can have a negative effect on the survival and growth of plankton and thus the wider community. Such changes in community structure may lead to lower abundance of benthos and fish [RD235].

13.6.657 Effects on individual species can, in turn, potentially lead to changes in species' community composition and distribution. This results from some species being more (or less) successful at coping with environmental change, conferring competitive advantage (or disadvantage) to certain species over others. This can lead to a change in the assemblage, which currently constitutes the 'characteristic' species complement for the area.

13.6.658 Primarily, it is the degree of change in temperature from the ambient temperatures, to which the organism is adapted, which will dictate the response. Competitive advantage or disadvantage to planktonic species resulting from increased temperatures can lead to an increase in the occurrence of Lusitanian species and a decrease in the occurrence of cold boreal species. For example, Southward *et al*., [RD236] noted the observed latitudinal shifts in planktonic communities coinciding with climate shifts over the twentieth century. Additionally, an increase in water temperature may increase the possibility of the successful establishment of self-sustaining populations of exotic plankton species, and exotic species having planktonic life stages, released into the area from, for example, ballast water. However, Naylor [RD237] reported that although there were instances where introductions of 'southern' immigrant species had been recorded, there was little evidence of such establishments replacing indigenous species.

13.6.659 Phytoplankton respond rapidly to changes in environmental factors. Baseline surveys have demonstrated that seasonal patterns in abundance and community composition are driven by changes in light and nutrients.

Whilst temperature affects rates of growth and reproduction, other factors may have a greater influence on productivity including the availability of nutrients [RD235] and light [RD238].

13.6.660 A study on the effects of high temperature on marine phytoplankton undertaken by Hirayama and Hirano [RD239] reported that Cooling Water discharges from power stations rarely adversely affect marine plankton even in the immediate vicinity of the discharge. This study investigated potential harmful effects on plankton from heated effluents, focusing on direct inhibitory influences of high temperature (in conjunction with residual chlorine) on growth, and photosynthesis of marine phytoplankton. For the phytoplankton species studied, adverse effects were not apparent until significant temperatures had been reached (>35°C, a temperature rise of 15°C relative to the 'ambient' temperature of the experimental media used at 20°C), far in excess of temperatures (or temperature rise) that would be experienced at the Cooling Water outfall.

13.6.661 Zooplankton abundance was dominated by Arthropoda (specifically Copepoda) and exhibited a lag response to the seasonal peaks in phytoplankton abundance. Metabolic rates in zooplankton are dependent on temperature [RD240] as seen in the copepod (*Pseudodiaptomus hessei*) which showed exponentially increasing metabolic rates with increasing temperature [RD241].

13.6.662 In terms of zooplankton, copepods, such as *Acartia tonsa,* have been found to tolerate temperatures of between –1ºC and 32ºC [RD242]. *Temora longicornis* has been found to be able to adjust to changing environmental temperatures. This species tolerates an increase in temperature above its normal range, (with test conditions of up to 24ºC) and the response to temperature rise is an increase in swimming activity [RD243].

13.6.663 One study at a power station considered the entrainment of the planktonic stage of three crustacean species, *A.tonsa, C.crangon* and *H.gammarus*, and found that on its own, elevated temperature did not have a significant effect on these species, although it was noted that at temperatures above 8ºC *C.crangon* had a greater sensitivity to TRO [RD244].

13.6.664 The modelling shows that exposure to temperatures in excess of 2°C (98 percentile) above ambient, up to a maximum of 12°C (98 percentile), is restricted to locations in the immediate vicinity of the outfall. Within this body of water, plankton is likely to be exposed to temperatures that would affect their metabolic function and could even result in mortality.

13.6.665 Beyond the immediate vicinity of the outfall, modelling showed that in the worst case scenario, temperatures at the surface would increase by up to 2°C (98 percentile) above ambient over an area of approximately 209ha. This increase is restricted to the surface layer. At the seabed, the 2°C (98 percentile) temperature rise affects only around 4ha. In terms of absolute temperature, at the surface there would be an increase above 23°C (98 percentile) over an area of approximately 14ha.

13.6.666 Within the water column, peak phytoplankton abundance occurs within 5m or 10m of the water surface; zooplankton are also known to exhibit diel

vertical migrations to even greater depths. Therefore, the majority of the planktonic community would not be exposed to a temperature increase that would affect their metabolic rate, with the exception of the communities in the vicinity of the outfall. The effects are not considered likely to have any wider implications for the abundance and diversity of plankton communities. Therefore, the magnitude of change is predicted to be negligible and the effect on plankton communities from the thermal discharge is considered to be negligible.

Effects of thermal discharge on intertidal and subtidal habitats and communities

Thermal tolerances of habitats and species

13.6.667 In their natural environment, marine organisms, of a given species and life stage, occupy areas with water temperatures that best suit their genetic predisposition and their state of physiological adaptation, described as the thermal optima. This is the temperature condition which a species finds the most favourable for growth and reproduction. Each species has a thermal tolerance range which can be demarcated by its lower critical and upper critical limits [RD245].

13.6.668 There are three key factors relating to a thermal discharge from an outfall which determine the biota that may be exposed and the degree of physiological stress:

- the rise in mean ambient temperatures (e.g. the ΔT +°C values);
- the absolute temperature, where the maximum temperatures are sufficiently high to interfere with biological processes and approach an organism's lethal limits; and
- the warm water fronts from the discharge and plume, which shift tidally causing a localised increase in the short-term fluctuations in temperatures across the seabed [RD246]; [RD219].

Consideration of a recovered baseline

13.6.669 It is recognised that the current baseline environment in the vicinity of the outfall is likely to change following the cessation of the discharge from the Existing Power Station on 30 December 2015. Recolonisation of this area is currently at an early stage and it is likely to be some years before the habitats reach a stable state where species abundance and diversity is similar to the surrounding habitats.

13.6.670 As a precautionary approach, the assessment considers that, by the start of the operational phase, the habitats in close proximity to the outfall will have recovered and would be similar to those in the surrounding area.

Intertidal habitats and communities

13.6.671 Intertidal habitats and species are naturally exposed to a greater degree of thermal stress than subtidal species, as they are periodically exposed to elevated temperature and desiccation when immersed during low tide. For

example, on uncovered sandflats of Milford Haven (south Wales) temperature rises of 0.2°C/min were recorded in the summer and, during early autumn, temperatures ranged between 15°C and 26°C on the shore [RD247]. Beyond these seasonal fluxes in temperature are short-term diurnal and tidal shifts in temperature with organisms subjected to rapid changes in temperature. Under such fluctuating thermal conditions, behavioural responses, physiological acclimation and evolutionary adaptation of these intertidal populations will be important [RD248]; [RD249]. A review of thermal impacts from discharges [RD224] identified shifting temperature interfaces as being one of the main negative impacts on flora and fauna. The report concluded that most fauna should be able to tolerate tidal temperature shifts of up to 3°C.

13.6.672 Most intertidal macroalgae species generally live close to their upper thermal tolerance limits and have a lower ability to respond to further rising temperatures [RD250]; [RD251]. Some algal species are particularly sensitive to elevated temperature; a study by Howalls and Langford [RD252] found that *Ascophyllum* sp. and *Fucus* spp. were eliminated from a rocky shore in Maine, USA where a power station had raised the temperature to between 27°C and 30°C. These species were both replaced by *Ulva intestinalis*. The replacement of fucoids and other macroalgae by ephemeral species such as *Cladophora* and *Ulva* seems to be a typical community response to pressure.

13.6.673 Available scientific literature, the MarLIN MarESA and professional judgement has been used to determine if a community is stenothermal (able to tolerate only a small range of temperature conditions). Table D13-41 is closely derived from that provided by MarLIN for the hydrological pressure temperature increase. The criteria for this pressure are an increase in water temperature of 5°C for one month, or 2°C for one year, excluding temperature changes from global warming (climate change).

13.6.674 MarLIN has carried out a MarESA based on resistance, resilience and sensitivity to a pressure. Resistance indicates whether a receptor can absorb disturbance or stress without changing character. Resilience is the ability of a receptor to recover from a given pressure, and sensitivity is a function of the ability of the feature to tolerate or resist change (resistance) and its ability to recover from an impact (resilience) [RD253].

13.6.675 All assessment against resilience was either high (full recovery in two years) or medium (full recovery in two to 10 years). Information on the resistance, resilience and sensitivity, as well as whether a species is stenothermal, can be found in table D13-41.

Table D13-41 Resistance, resilience and sensitivity of intertidal biotopes at the outfall to an increase in temperature

Biotope complex code	Biotope description	Resistance	Resilience	Sensitivity	Stenothermal
LR.MLR.BF.PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock	Medium	Medium	Medium	No
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	High	High	Not sensitive	No
LR.MLR.BF.FspiB	*Fucus spiralis* on exposed to moderately exposed upper eulittoral rock	High	High	Not sensitive	No
LR.HLR.FR.Coff	*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock	High	High	Not sensitive	No

Note: All sensitivities listed are based on a decrease or increase in temperature of 5°C over one month, or 2°C for one year.

13.6.676 The influence of the Cooling Water discharge at the Existing Power Station on communities is described in paragraph 13.3.90. The effects recorded from the outfall surveys show similar patterns to those described in the literature and can be used to provide an indication of the distance from the outfall at which communities could be affected.

13.6.677 Both intertidal and shallow subtidal surveys from the late 1980s [RD23]; [RD254] and from the present day have shown that the existing discharge causes a gradient of impoverished fauna and flora on the rocky reef communities. Within the intertidal zone, the effects of the discharge were recorded up to 250m. The Existing Power Station operated at 70m^3/s with a temperature rise of 10.3°C. Bamber considered this impoverishment to be related to thermal stress rather than the influence of scour or the effects of antifouling agents in the Cooling Water, and discussed similar effects recorded at other power stations such as Hinkley Point, Somerset [RD255].

13.6.678 Based on modelling and on studies of the Existing Power Station Cooling Water outfall, it is predicted that within a few hundred metres there would be

very low species diversity, representing a marked change to the baseline natural composition of intertidal habitats and species.

13.6.679 The intertidal habitats that would be affected are considered to be rocky reef Annex I habitat (0.3ha) and are assigned a medium value. The effects of the thermal plume on intertidal habitats are likely to result in a reduction in abundance of some species and degradation of intertidal habitat. However, as with the Existing Power Station, this would occur over a small area of the intertidal shore and would not affect the wider integrity of this receptor. Therefore, the magnitude of change is predicted to be small and it is considered that there would be a minor adverse effect on intertidal habitats and communities (including those of conservation importance) from thermal discharge.

Subtidal habitats and communities

13.6.680 Subtidal organisms are naturally less adapted to wide fluctuations or increases in temperature than those in intertidal communities, and as a result could be more susceptible to the effects of thermal stress.

13.6.681 There is an absence of thermal tolerance data for the majority of the sessile, sublittoral reef organisms such as sponges, tunicates, cnidarians and bryozoans. However, it is expected that an increase in temperature could affect reproduction and therefore could affect an organism's ability to colonise new areas. Other potential effects from exposure to high temperatures include, for example, bleaching in cnidarians.

13.6.682 Two key macroalgae species are considered to be stenothermal, *Alaria esculenta* and *L.hyperborea.* None of the benthic invertebrate species recorded in the Wylfa Newydd Development Area are considered stenothermal.

13.6.683 The habitats (biotopes) within Porth Wnal were recorded during the outfall surveys and the MarLIN MarESA have been used to consider the effects on the subtidal communities recorded around Porth Wnal (Table D13-42). Based on scientific literature and the MarLIN MarESA, an indication has been given as to whether a community is likely to be stenothermal.

13.6.684 The outfall surveys did not record any priority habitats listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

13.6.685 The Cooling Water outfall is designed to direct the plume away from the seabed, and the buoyancy of the plume is demonstrated in the vertical profiles in figure D13-32. Modelling predicted that the area of seabed exposed to temperatures in excess of 2°C (98 percentile) above ambient would be restricted to the immediate vicinity of the outfall, over an area of 4.2ha in the worst case scenario (table D13-37). Within this area, temperatures will fluctuate, and habitat in the immediate vicinity of the outfall would be exposed to temperatures up to a maximum of 12°C above ambient (98 percentile).

Table D13-42 Resistance, resilience and sensitivity of subtidal biotopes at the outfall to an increase in temperature

Biotope complex code	Biotope description	Resistance	Resilience	Sensitivity	Stenothermal
IR.HIR.KFaR.FoR	Foliose red seaweeds on exposed lower infralittoral rock	High	High	Not sensitive	No
IR.MIR.KR.Lhyp.Ft	*Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.Lhyp.Pk	*Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.LhypT (derived from the assessment of IR.MIR.KR.LhypT.Ft and IR.MIR.KR.LhypT.Pk)	*Laminaria hyperborea* on tide-swept, infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.XFoR	Dense foliose red seaweeds on silty moderately exposed infralittoral rock	High	High	Not sensitive	No

Note: All sensitivities listed are based on a decrease or increase in temperature of 5°C over one month, or 2°C for one year.

13.6.686 At the Existing Power Station, the subtidal outfall surveys recorded a clear, acute effect on the infralittoral rocky reef communities within 100m of the outfall, with kelp notably absent from this area. There were clear shifts in the dominant taxa within 150m to 200m of the outfall and subtler effects were recorded out to 300m. Beyond 300m from the outfall there were no

significant differences in the subtidal communities observed (appendix D13-5, Application Reference Number: 6.4.87).

13.6.687 The Existing Power Station operated at 70m^3/s with a temperature rise of 10.3°C, and the observed effects cannot be directly related to the influence of temperature alone. However, it does provide some indication of the likely scale of effects on benthic communities.

13.6.688 Within a few hundred metres of the outfall, it is likely that there would be a loss of key characterising species, particularly *L.hyperborea*, that has an upper lethal limit of around 23°C (which in summer is approximately 7°C above ambient) (see appendix D13-5, Application Reference Number: 6.4.87). Diversity is likely to be affected within a few hundred metres of the outfall and the effects would extend further than those observed at the Existing Power Station. Based on the outfall surveys, it is likely that there would be a decrease in densities of brown algae and red algae close to the Cooling Water outfall, and an increase in densities of green algae.

13.6.689 An area of 4.2ha of subtidal habitats and species not considered to be of conservation importance would be exposed to temperatures up to 2°C above ambient, which includes subtidal habitat within Porth Wnal and to the west of Wylfa Head. The main effects are likely to occur within a few hundred metres of the outfall. There would be a permanent reduction in the abundances of some species and degradation of subtidal habitat, with the severity of the effect declining with increasing distance from the outfall. The subtidal habitats affected by the thermal plume are common along the coastline and the loss would not result in wider effects on the structure and function of subtidal habitats. Mobile benthic species would move away from the outfall to a location that would be more favourable for growth and reproduction.

13.6.690 Considering the extent of the effect on subtidal habitats and communities (including those of conservation importance) the magnitude of change is predicted to be medium and it is considered that there would be a minor adverse effect on subtidal habitats and communities from thermal discharge.

Invertebrates of conservation importance

13.6.691 There are no records of the spiny lobster within the vicinity of the outfall, however, if it were present, it is a mobile species and therefore has the ability to move away from warmer water. Therefore, the magnitude of change is negligible and the effect is negligible.

Effects of thermal discharge on marine fish

13.6.692 In terms of more mobile species, Magnuson *et al*., [RD256] proposed the concept of fish occupying a ‘thermal niche’, i.e. a range of temperatures in which fish prefer to live. They found that most fish spent two-thirds of their time within 2ºC of their temperature preferendum and all of their time within 5ºC. Fish choose to spend as much time as possible in their preferred temperature range but will venture into sub-optimal conditions to exploit resources such as food. However, in doing so they compromise their growth rate. The ability of fish to seek areas out of their preferred temperatures can therefore be seen as critical to their ecological performance, and explains

shifting distributions of species in response to climatic changes [RD257]; [RD258].

Ichthyoplankton

13.6.693 Ichthyoplankton distribution is largely dependent on external factors especially in earlier life stages, and populations are patchy in nature. As juveniles mature, their swimming ability increases and there will be some degree of selectivity in their location in areas of weaker currents. Separating the effects of entrainment and temperature is difficult and therefore consideration has been given to thermal effects within the assessment of effects of entrainment (see paragraphs 13.6.563 to 13.6.584). There is a paucity of data on the effects of temperature alone on fish larvae and especially on the effects on recruitment.

13.6.694 A study on the effect of water temperature on ichthyoplankton concluded that the highest temperature increase that most eggs can tolerate is 6ºC from the centre of their optimum temperature range [RD259]. Marine fish will spawn within a few degrees of the optimum temperature to produce the maximum number of viable eggs.

13.6.695 Sandeel eggs are demersal, and are spawned directly within the adult habitat where they adhere to sand grains and remain until hatching [RD260]; [RD261]. Following hatching, larvae become pelagic and enter the water column. Following metamorphosis, juveniles exhibit burrowing behaviour from September until spring (March to April) [RD262]; [RD261]; [RD263]. The hydrodynamic modelling predicts that a bed temperature rise of over 2°C (98 percentile) is restricted to Port Wnal and just west of Wylfa Head. The subtidal habitat in this location is silt overlying bedrock which is not suitable sandeel habitat and therefore no effect on sandeel eggs is predicted.

13.6.696 Once operation is established, the ichthyoplankton communities adjacent to the outfall are likely to comprise those which have been entrained within the CWS. The loss of ichthyoplankton from entrainment is assessed in paragraphs 13.6.563 to 13.6.584.

13.6.697 Fish larvae may be transported by currents from spawning grounds (plaice, Dover sole and whiting) around Anglesey to the waters in proximity to the outfall that are influenced by the thermal discharge. The modelling shows that exposure to temperatures in excess of 8°C (98 percentile) above ambient, up to a maximum of 12°C (98 percentile), is restricted to Porth Wnal and to the west of Wylfa Head. Within this body of water, ichthyoplankton are likely to be exposed to temperatures that would affect their metabolic function and could even result in mortality.

13.6.698 Beyond the immediate vicinity of the outfall, the modelling showed that in the worst case scenario, temperatures at the surface would increase by up to 2°C (98 percentile) above ambient over an area of approximately 200ha. At the seabed, the 2°C (98 percentile) temperature rise is predicted to affect 4.2ha. Ichthyoplankton are distributed throughout the water column and the highest temperature increases are restricted to the surface layer, so only a small proportion of the ichthyoplankton would be subjected to the highest temperature increases.

13.6.699 The peak in sandeel larvae occurs in February and March (see appendix D13-4, Application Reference Number: 6.4.86). With the exception of the surface waters immediately adjacent to the outfall, the increase in temperature would not expose sandeel larvae to absolute temperatures outside of their known tolerance. In addition, the highest abundances of sandeel larvae were recorded at the sites furthest offshore where the temperature rise would be reduced compared to the rise in the vicinity of the outfall.

13.6.700 The exposure of ichthyoplankton to the thermal plume is not considered likely to result in changes to communities in terms of abundance and diversity. The duration that individual larvae would be exposed to high temperatures would be short given the momentum of the Cooling Water discharge and the rapid mixing processes in the coastal waters. Therefore, the magnitude of change is predicted to be negligible and the effect on ichthyoplankton from thermal discharge is considered to be negligible.

Fish (of conservation and/or commercial importance)

13.6.701 Depending on the species, temperature may have a positive, negative or neutral effect on subtidal fish populations. Langford [RD233] examined data from power plant studies around the world and found no instance of direct fish mortalities associated with a power plant outfall. The main effects to consider are therefore sub-lethal effects such as active thermal avoidance or attraction, changes in growth rate or the modification of community structure resulting from warm-water species being favoured over cold-water species.

13.6.702 The fish species recorded in baseline surveys of conservation and/or commercial importance are listed in table D13-3. Of these, sandeel, plaice and herring were the most abundant with other notable species being mackerel, cod, Dover sole and sea trout (medium importance). Eel and river lamprey (high importance) are also considered as these species have been recorded in entrapment surveys. The thermal tolerances of the majority of these species were considered within the BEEMS [RD224] and Wither *et al*., [RD231] studies, which derived thresholds based on the most sensitive cold-water fish species.

13.6.703 Baseline surveys recorded sandeel in all seasons in both intertidal and subtidal surveys. Densities of adult sandeel were much higher at sites east of Wylfa Head which is likely to be related to the presence of suitable sandy substrate (see appendix D13-4, Application Reference Number: 6.4.86). Sandeel alternate between burrowing in sand and feeding in the water column. The subtidal habitat in the immediate vicinity of the outfall is silt overlying bedrock which is not suitable sandeel habitat, although this area may be used for feeding.

13.6.704 A spawning ground for plaice is located on the east of Anglesey and baseline surveys recorded plaice in consistently high numbers at sites east of Wylfa Head at the wide sandy beaches (see appendix D13-4, Application Reference Number: 6.4.86). However, there is an absence of suitable substrate for plaice in the vicinity of the outfall.

13.6.705 In both the intertidal and subtidal fish surveys, herring were recorded in particularly high numbers at sites on the east coast of Anglesey compared to sites on the west and north coasts. Whiting was the most abundant species in the subtidal fish surveys and again peak numbers were observed at sites on the east coast of Anglesey (appendix D13-4, Application Reference Number: 6.4.86). Sea trout were recorded in seine nets in Cemaes Bay and very occasionally in Porth-y-pistyll. European eel, river lamprey and Atlantic salmon, if present, would be migrating to or from freshwater habitat. These species navigate by following the seabed and may be exposed to higher temperatures for a short duration when navigating around Porth Wnal.

13.6.706 Some fish species currently utilise the waters around the outfall for feeding. For species where the habitat type is not suitable, fish may visit the area infrequently before returning to more favoured habitat (e.g. sandeel). During operation some species may choose not to utilise the area in the immediate vicinity of the outfall where temperatures are noticeably warmer. The area that fish may avoid would depend on the species. It is likely that there would only be a noticeable change in behaviour at temperatures of 2°C or higher for the majority of species present. The waters and habitats adjacent to the outfall are not considered to provide a vital food source or refuge for fish species of conservation and/or commercial importance. Although fish will navigate along the coastline, they are able to drop down to near the seabed for a short duration to avoid the warmer water if preferred. It is possible that some species, e.g. sandeel, may alter their feeding behaviour to avoid warmer water at the surface, although again effects are not likely to be noticeable below 2°C and would only result in localised displacement, rather than effects on fish communities.

13.6.707 A rise in water temperature is unlikely to adversely affect bass as they are known to associate with warmer water, particularly in their juvenile stages [RD264].

13.6.708 It is likely that most fish would avoid the waters with the highest temperatures in close proximity to the Cooling Water outfall. The thermal plume would not affect the breeding success of fish species of conservation and/or commercial importance and therefore would not affect wider fisheries. The magnitude of change is predicted to be negligible and the effect on fish of conservation and/or commercial importance from thermal discharge is considered to be negligible.

General fish and fisheries

13.6.709 A total of 42 fish species were recorded in the baseline surveys and, of the other species not of commercial or conservation importance, the most abundant were Gobiidae and sand smelt. Some species, such as Gobiidae, are likely to actively move away from the immediate vicinity of the outfall where the greatest fluctuations in temperature would be experienced. The optimum growth temperature of common goby, *Pomatoschistus minutus* was found to be between 17ºC and 22.6ºC with a thermal preference of 17.3ºC and an upper lethal temperature of 31ºC [RD265]. Subtidal habitats, which provide a food resource and refuge, would be altered and may no longer provide these services. However, similar habitats are abundant along the

coastline and the loss of this area for fish is not considered likely to affect recruitment or wider fish populations.

13.6.710 The thermal plume would not affect the breeding success of fish and therefore would not affect wider fisheries. The magnitude of change is predicted to be negligible and the effect on general fish and fisheries from thermal discharge is considered to be negligible.

Effects of thermal discharge on marine mammals

13.6.711 Marine mammals are physiologically adapted to regulate their body temperature. Although the increase in temperature in the vicinity of the discharge may be noticeable to marine mammals, it would be within the natural temperature range that would be experienced by these species (e.g. when diving and moving between coastal and estuarine waters or when hauling-out as in the case of grey seals). Therefore, the magnitude of change is predicted to be negligible and the effect on marine mammals from the thermal discharge is considered to be negligible.

Effects of thermal discharge on seabirds

13.6.712 There is no direct pathway from an increase in water temperature to effects on seabirds. There is a negligible effect on the fish species that provide a food source for seabirds. Baseline surveys show that terns do not significantly utilise the area around the outfall to actively feed (see appendix D13-7, Application Reference Number: 6.4.89), so the foraging in this area is not considered to be a significant resource.

13.6.713 It is possible that some fish prey species may be less available to terns if fish choose to feed deeper within the water column, potentially outside the hunting range of terns. Considering the thermal tolerances of fish, there may be a noticeable effect at temperatures above 2°C, which would equate to an area of 201.6ha where feeding may be affected.

13.6.714 In relation to the feeding grounds that are available to terns, this is a very small area and considered to be insignificant as similar habitats are abundant along the coastline.

13.6.715 The food resource is not likely to be lost, rather it would be displaced. During feeding, sandeel are likely to tolerate sub-optimal temperatures for short periods of time to utilise the food resources in the upper water column. In addition, the Irish Sea is known to support several species of sandeel, with those species preferring colder waters and those preferring warmer waters, present. It is therefore likely that should boreal species be displaced from the area to different feeding grounds, the Lusitanian species are more than likely to exploit the areas left.

13.6.716 Therefore, the magnitude of change is predicted to be negligible and the effect on seabirds from the thermal discharge is considered to be negligible.

Effects of thermal discharge on designated sites

13.6.717 The extent of the thermal plume has been considered in relation to the North Anglesey Marine/Gogledd Môn Forol cSAC, Anglesey Terns/Morwenoliaid Ynys Môn SPA), and indirect effects of thermal changes on the Cemlyn Bay SSSI via potential effects on the seabird assemblage (table D13-43).

Table D13-43 Proportion of the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA exceeding a 2°C boundary

Scenario	Designated nature conservation site	Proportion of the site exceeding 2°C (98 percentile) at the surface (%)	Proportion of the site exceeding 2°C (98 percentile) at the seabed (%)
Annual base case (126m^3/s at +12°C (98 percentile)) – no wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.06	0.001
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.21	0.004
	Cemlyn Bay SSSI	N/A	N/A
Summer base case (126m^3/s at +12°C (98 percentile)) – with variable wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.03	0.001
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.10	0.004
	Cemlyn Bay SSSI	N/A	N/A

13.6.718 There are no effects predicted on the features of the designated sites either directly or indirectly and therefore the magnitude of change is predicted to be negligible and the effect on designated sites from the thermal discharge is negligible.

Impact pathway: discharge of Cooling Water – thermal effects on spread of non-native species

General context

13.6.719 The Cooling Water discharge for the Power Station would be located at Porth Wnal, adjacent to the outfall of the Existing Power Station. The discharge water would be approximately 12°C (98 percentile) warmer than the water being abstracted. The volume of water discharged would vary over the tidal cycle from 113m^3/s at LAT to 126m^3/s at highest astronomical tide. Hydrodynamic modelling has been based on a tidal average value with an allowance made for potential inefficiencies over the lifetime of the CWS. The modelling is therefore based on Cooling Water being discharged at a rate of 126m^3/s (tidal average plus 5%).

Non-native species

13.6.720 The risk of introduction of non-native species would be very low during the operational phase as there would be limited pathways for introduction. During operation, the MOLF would only be used very infrequently for occasional deliveries.

13.6.721 Prior to operation, marine life would have become established on areas of new substrate (e.g. the breakwaters and MOLF) over a period of around six years following the completion of the Marine Works.

13.6.722 If non-native species are present in the surrounding waters, then based on evidence from the Existing Power Station it is possible that some species adapted to warmer water could become established in the Cooling Water outfall channel. The baseline for non-native species will continue to evolve during the construction phase and therefore it is not possible to accurately predict the species that could become established. The species observed in the outfall at the Existing Power Station included *C.fragile, A.armata* and *D.japonica*. It was noted that the Cooling Water outfall did not support an unusual abundance of non-native species. *A.armata* and *D.japonica* continued to be present at other sites, further afield, in comparable abundances. *C.fragile* was not recorded at survey sites outside of the outfall channel and this species is better adapted to warmer waters, with its spread limited by cooler temperatures [RD124]. It is possible that *C.fragile* would become established in the Cooling Water outfall of the Power Station, but its distribution would be confined to the area of warmer water in proximity to the outfall.

13.6.723 The risk of introduction and colonisation of non-native species during operation is considered to be low and therefore the magnitude of change is predicted to be negligible. The effect on native habitats and species (including invertebrates of conservation and commercial importance) from the establishment of non-native species linked to the thermal plume is predicted to be negligible.

Effects on zooplankton and phytoplankton

13.6.724 There is a small risk that some southern species, including harmful/toxic species, could be favoured within the vicinity of the outfall, but these communities would not be sustained beyond Porth Wnal where temperatures return close to ambient, and therefore this would not affect wider communities. The non-native diatom *C.wailesii*, which is already present in the area and has known ecological impacts (see paragraph 13.6.247), is known to grow well in a wide range of temperatures from 0°C to 20°C; therefore, it is unlikely that increased surface temperatures will favour its growth.

Impact pathway: discharge of Cooling Water – thermal effects on dissolved oxygen

General context

13.6.725 An increase in temperature decreases the solubility of gases in water and therefore could affect the dissolved oxygen concentration in the water column.

Dissolved oxygen standards

13.6.726 The standards for dissolved oxygen are outlined in the WFD (Standards and Classification) Directions (England and Wales) 2015. Salinity in the coastal waters ranged between 32.80 and 35.29. The standards for dissolved oxygen concentrations are defined in relation to salinity and the most conservative values have been used in the assessment, as outlined in Table D13-44.

Table D13-44 Dissolved oxygen standards for coastal water bodies (normalised to salinity 35)

Status	Dissolved oxygen concentration (mg/L) as 5 percentile values
High	5.7
Good	4.0
Moderate	2.4
Poor	1.6

Modelling

13.6.727 The dissolved oxygen saturation concentration, as a function of temperature and salinity, was calculated using a formula by Benson and Krause [RD266]. Based on the assumption that the water is saturated at the existing ambient temperature, the hydrodynamic model can then be used to calculate the dissolved oxygen concentration at a particular temperature.

13.6.728 The calculations assumed a constant salinity of 33.6 (the average measured at mooring S9 from February to December 2011), a temperature equal to the 95 percentile ambient plus the maximum predicted temperature rise.

Thermal effects on dissolved oxygen and the effects on marine water quality

13.6.729 The average dissolved oxygen saturation levels recorded at the two monitoring buoys closest to the outfall was 99.4% at S9 and 94.8% at S2 (further offshore) (see appendix D12-2, Sediment Regime, Application Reference Number: 6.4.81).

13.6.730 The minimum predicted dissolved oxygen concentration, assuming average salinity of 33.6 and a maximum temperature rise, is greater than the high status boundary value of 5.7mg/L. The minimum saturated dissolved oxygen concentration occurs at the discharge, where the temperature increase is greatest.

13.6.731 As the predicted dissolved oxygen concentration remains well above the concentration required to achieve high status, the magnitude of change is predicted to be negligible. It is therefore considered that there would be no effect on water quality from changes to dissolved oxygen as a result of the thermal discharge.

13.6.732 Based on the high status of the predicted dissolved oxygen concentration, it is considered that there would be no effect on biological receptors from changes to dissolved oxygen concentrations as a result of the thermal discharge.

Impact pathway: discharge of Cooling Water – thermal effects on pH and on the ratio of ionised to unionised ammonia

General context

13.6.733 Ammonia in water can exist in either an ionised or unionised form. The unionised form is typically more toxic to aquatic life. The ratio of ionised to unionised ammonia varies with temperature and pH; the concentration of unionised ammonia increases as the temperature increases. The temperature increase from the operation of the Cooling Water discharge could therefore alter the natural ratio.

Unionised ammonia standards

13.6.734 The standard for unionised ammonia is given as a long-term EQS of 21µg/L. The equilibrium of the ionised to unionised ammonia is particularly sensitive to changes in pH. At pH 8.5, the proportion of unionised ammonia is approximately 10 times that at pH 7.5 and, for every 9°C increase in temperature, the proportion of unionised ammonia approximately doubles [RD267].

Effects on marine water quality

13.6.735 Baseline data collected for the Wylfa Newydd Project indicate that the average concentration of ammonia is 0.0293mg/L as nitrogen (N) and for unionised ammonia it is 0.58µg/L as N (see appendix D13-1, Application Reference Number: 6.4.83). The average concentrations of ammonia to unionised ammonia show approximately 2% of the ammonia was in the unionised form.

13.6.736 The observed unionised ammonia ratio is similar to that calculated using the United States Environment Protection Agency [RD268] formula [RD269]. This formula has been used to calculate the unionised ammonia concentration for a range of temperature increases up to the maximum temperature rise of 12°C (Table D13-45).

Table D13-45 Predicted unionised ammonia concentration as a function of temperature at salinity 34.3 and pH 8.07

Condition	Temperature (°C)	Ratio	Unionised ammonia (µg/L)
Average ambient	11.78	0.020	0.60
Average + 12°C	23.78	0.048	1.42
Max ambient	16.00	0.028	0.81
Max ambient + 12°C	28.00	0.065	1.91

13.6.737 For all conditions considered, the unionised ammonia remains well below the EQS and therefore the magnitude of change is predicted to be negligible. It is considered that there would be no effect on water quality from changes in pH and on the ratio of ionised to unionised ammonia as a result of the thermal discharge.

13.6.738 Based on the negligible magnitude of change on water quality, it is considered that there would be a negligible effect on biological receptors from thermal effects on pH and on the ratio of ionised to unionised ammonia.

Impact pathway: discharge of Cooling Water – TRO

General context

13.6.739 Biofouling is an almost universal problem at power stations and requires operators to implement measures for its control. The exclusion of larval and juvenile fish at intakes is becoming increasingly important, necessitating finer (smaller) screen mesh. However, this is not sufficient to prevent ingress of the <1mm planktonic larval stages of most fouling organisms, nor some of the secondary settlement stages of mussels (1mm to 5mm).

13.6.740 Small ‘hard fouling’ organisms, (young mussels, tubeworms and barnacles) together with ‘soft fouling’ (hydroids and sponges) can completely cover submerged surfaces, increasing roughness and decreasing flow, particularly in smaller-diameter ancillary cooling circuits.

13.6.741 The most common method of biofouling control (antifouling) is by chlorination. It is proposed that sodium hypochlorite would be used to control biofouling and the typical dosing regime is described in paragraph 13.5.96. Any residual biocide that is discharged with the Cooling Water is referred to as the TRO. TRO is the sum of the following oxidants:

- free (available) chlorine which is that present as an equilibrium mixture of hypochlorous acid (HCIO) and hypochlorite ions (OCl-); and
- combined (available) chlorine which is available in (mainly) inorganic chloramines and in other compounds having a nitrogen-carbon link.

13.6.742 Natural waters have a ‘chlorine demand’ consisting primarily of oxidisable material – organic and non-organic, living and dead – that rapidly reduces the applied biocide concentration. Following discharge, the concentration of TRO will diminish through dilution, additional demand introduced by the receiving water and by continuing decay reactions. The biocidal potential of

discharged TRO concentrations therefore depends on the chlorine demand of the water. Decay/demand would likely be greatest in late spring and summer when productivity and water temperatures are at their highest. However, relative dilution and dispersal may be greatest during autumn and winter when the coastal waters are subject to greater mixing from wind and wave action.

13.6.743 TRO reacts with virtually any oxidisable material in the water to produce compounds referred to as chlorine (produced) by-products or chlorination by-products (CBPs). Bromoform is the principle CBP generated in saline waters owing to the prevalence of bromide which provides a rapid reaction pathway to bromoform. However, exactly what CBPs are formed depends upon what is present in the water. There are known to be a great number of brominated and chlorinated chemical species that could be formed [RD270].

13.6.744 Many CBPs are known to persist in the marine environment and have been proved or suspected to be toxic, mutagenic or carcinogenic to marine organisms when subject to long-term exposure [RD271]. CBPs can also bioaccumulate in sediments, organic detritus and biota, although this has generally been found to be restricted by the concentration of bromide in seawater.

13.6.745 As the production of CBPs is dependent on the chemical characteristics of the seawater at a given point in time (most notably the concentration of bromide), it is extremely difficult to reliably predict the speciation and concentration of CBPs that could arise in the marine environment from Cooling Water discharge. However, the concentration of TRO, a component of CBPs, at the point of discharge is known and therefore dispersion can be reliably modelled. Consequently, for the purpose of this assessment, chemical and any subsequent ecological effects of Cooling Water discharge have been considered in the context of TRO. This assessment is considered to provide a reliable indication of potential effects from CBP production.

13.6.746 Acute toxic effects (mortality) of TRO would primarily be experienced by organisms entrained through the CWS. Once discharged, TRO still has the potential to affect ecological receptors, although the extent and scale of effects are less easy to predict than for entrainment, and would likely be sub-lethal. In terms of the sub-lethal effects of TRO, these could include inhibition of growth, changes in molluscan shell deposition and changes in adenosine triphosphate. The effects of TRO on receptors have been evaluated based on published data (e.g. relating to thresholds) of representative taxa, which may have similar responses or sensitivities to those inhabiting the receiving waters of the Cooling Water discharge. These evaluations are also further guided by the TRO modelling outputs, in terms of spatial extent.

TRO standards

13.6.747 There is a statutory EQS relating to the discharge of biocide products (in this case TRO) into coastal waters. The WFD (Standards and Classification) Directions (England and Wales) 2015 (Part 2, Article 1) sets the ‘end of pipe’ EQS for TRO as 0.01mg/L, as a 95 percentile. Part 2, Article 17 of the WFD (Standards and Classification) Directions (England and Wales) 2015 allows

this standard to be exceeded within a designated area, a 'mixing zone' around the point of discharge and offers some technical guidelines for identifying a mixing zone. However, this is at the discretion of the regulator and is considered on a case-by-case basis.

13.6.748 As outlined in the WFD Directions [RD272] "The Appropriate Agency may designate mixing zones adjacent to points of discharge in surface water bodies. In mixing zones designated under sub-paragraph (1) [RD272], concentrations of one or more substances listed in table 1 may exceed the relevant EQS if those concentrations do not affect the compliance of the rest of the water body with those standards".

Modelling parameters

13.6.749 Modelling of TRO is based on a first order decay process, both as a function of water temperature and season. The simulations used a fixed discharge condition of 126m^3/s and fixed TRO discharge concentration at the point of discharge of 0.1mg/L.

13.6.750 The Cooling Water discharge is influenced by tidal conditions, and by wind and waves, and therefore as with the thermal plume, TRO concentrations in the Cooling Water discharge would remain in a constant state of flux.

13.6.751 For the purposes of assessment, two scenarios have been used to illustrate the effects of the Cooling Water discharge. These are the same scenarios as used for the assessment of the effects of temperature from the Cooling Water discharge:

- a worst case scenario using an annual base case with a continuous discharge of 126m^3/s and no wind stress; and
- a summer base case with a continuous discharge of 126m^3/s and application of a variable wind.

Modelling results

13.6.752 The areas of the 0.01mg/L mixing zones (95 percentile) rise at the surface and seabed are presented in Table D13-46 for both the annual base case and the summer base case with variable wind. The mixing zone is shown in figures D13-36 to D13-38 (Application Reference Number: 6.4.101). Compared to the annual base case, the TRO mixing zone for the summer base case with variable wind is 48% smaller at the surface and 2% larger at the seabed.

Table D13-46 Area of the 0.01mg/L TRO (95 percentile) mixing zone

Scenario	Area at the surface exceeding 0.01mg/L TRO (95 percentile) (ha)	Area at the seabed exceeding 0.01mg/L TRO (95 percentile) (ha)
Annual base case (126m^3/s at +12°C and TRO 0.1mg/L) – no wind	248	5.6
Summer base case (126m^3/s at +12°C and TRO 0.1mg/L) – with variable wind	128.5	5.7

13.6.753 For the annual base case, the model predicted the following in relation to a TRO concentration of 0.01mg/L (95 percentile):

- a mixing zone at the surface extending approximately 1.1km north and 3.5km from east to west (figure D13-36, Application Reference Number: 6.4.101); and
- a mixing zone at the seabed extending 0.4km north but limited to the Port Wnal area and along the western coast of Wylfa Head (figure D13-37, Application Reference Number: 6.4.101).

13.6.754 For a summer base case with variable wind, the model predicted the following in relation to a TRO concentration of 0.01mg/L (95 percentile):

- a mixing zone at the surface extending approximately 0.9km north and 2.3km from east to west (figure D13-38, Application Reference Number: 6.4.101); and
- a mixing zone at the seabed extending 0.4km north but limited to the Port Wnal area and along the western coast of Wylfa Head.

13.6.755 A reduction in the mixing zone at the surface would be expected with the inclusion of wind due to increased vertical mixing of the TRO down towards the seabed. However, the mixing zone at the seabed is still restricted to a similar area to that seen under the annual base case.

Effects of TRO on marine water quality

13.6.756 To determine the magnitude of change on water quality, a comparison was made between the size of the TRO mixing zones and that of the receiving water bodies. This was used to consider whether the mixing zones are proportionate and whether there could be any related effects on other receptors.

13.6.757 The Skerries and Anglesey North water bodies are 4,723ha and 12,600ha respectively. The TRO mixing zone will be dispersed over both water bodies. For the purposes of assessment, the area of the TRO mixing zone that falls within each water body has been calculated and the proportion of the mixing zone in comparison to the water body has been derived.

13.6.758 Table D13-47 compares the proportion of the mixing zone to the area of each water body. This shows that in the worst case scenario the mixing zone in The Skerries water body would be 3.4% of the water body area at the surface. The mixing zone in the Anglesey North water body would be 0.6% of the water body area at the surface.

Table D13-47 Proportion of WFD water bodies exceeding 0.01mg/L TRO (95 percentile) (ha)

Scenario	WFD water body	Proportion of the water body exceeding 0.01mg/L TRO (95 percentile) at the surface (%)	Proportion of the water body exceeding 0.01mg/L TRO (95 percentile) at the surface (%)
Annual base case (126m^3/s at +12°C) – no wind	Anglesey North	0.6	0.03
	The Skerries	3.4	0.08
Summer base case (126m^3/s at +12°C) – with variable wind	Anglesey North	0.4	0.03
	The Skerries	1.7	0.08

13.6.759 Given the large area of the water bodies and the comparatively small area of the TRO mixing zones at the surface and seabed, the magnitude of change is predicted to be small and the effects on WFD water bodies from discharge of TRO is considered to be negligible.

Effects of TRO on phytoplankton and zooplankton communities

13.6.760 Plankton have limited motility and their distribution is governed by external factors including the hydrodynamic regime. Localised effects are therefore usually difficult to detect in coastal waters owing to patchiness of plankton concentrations. It is also difficult to separate the effects of TRO on planktonic communities at power stations from the combined effects of exposure to thermal discharges and entrainment (particularly in close proximity to the outfall).

13.6.761 TRO inputs can directly affect planktonic species, and different life stages to varying extents, for example by reducing adenosine triphosphate (the molecule providing energy to cells) in phytoplankton [RD273].

13.6.762 Short-term studies on various species of phytoplankton gave a 24h EC_{50} (effective concentration) of 0.075 mg/L for the diatom *Thalassiosira pseudonana*. This was a static test system in which the exposure concentration was estimated from dilution of a concentrated stock solution [RD274]. The recent Risk Assessment Report [RD275] regarded these results as a very likely underestimate of the toxicity following a continuous exposure. The majority of the other short-term algal toxicity results are an order of magnitude higher than this value.

13.6.763 Long-term exposure to concentrations as low as 0.001mg/L to 0.01mg/L Total Residual Chlorine (which is equivalent to TRO) were reported to reduce phytoplankton cell numbers, with a 21 day EC_{50} (effective concentration)

[RD276]. Continuous (one year) exposure of mixed estuarine phytoplankton to TRO in indoor and outdoor microcosms resulted in a 13%–58% reduction in adenosine triphosphate (ATP). Chlorination appeared to have been intermittent, with additions ranging from 0.125mg/L – 1.441mg/L. However, the measured concentration in the system was continually below the detection limit of 0.01mg/L [RD273]. This is an abnormally high chlorine demand and casts doubt on the method. This information was used as supportive information for the Risk Assessment Report [RD275].

13.6.764 Phytoplankton responds rapidly to changes in environmental factors. Effects on individual species can, in turn, potentially lead to changes in species community composition and distribution. This results from some species being more (or less) successful at coping with environmental alteration, conferring competitive advantage (or disadvantage) to certain species over others. This can lead to a change in the assemblage which currently constitutes the 'characteristic' species complement for the area. The modelling results show that the long-term exposure levels of 0.001mg/L – 0.01mg/L Total Residual Chlorine from Sanders *et al*., [RD276] would be exceeded by the expected concentrations at the surface over a considerable area. However, it must be borne in mind that below the immediate surface layer, TRO concentrations would rapidly diminish to a much smaller footprint and therefore any effects would not be detectable.

13.6.765 The copepod *Acartia tonsa* has been found to exhibit 22% mortality at TRO concentrations of 0.14mg/L to 0.56mg/L [RD217]. The copepod *Eurytemora affinis* had an LC_{50} (lethal concentration) of 1mg/L TRO when exposed for five hours. These levels are higher than the concentrations proposed at the point of discharge. The zooplankton community is dominated by copepods, and whilst they may not exhibit toxicological effects over a wide area they may exhibit sub-lethal effects within the surface waters that are subject to higher concentrations (e.g. 0.08mg/L to 0.11mg/L).

13.6.766 The modelling output for the summer base case with variable wind showed that exposure to TRO concentrations (95 percentile) between 0.08mg/L and 0.1mg/L are restricted to locations in the immediate vicinity of the outfall. Within this body of water, plankton is likely to be exposed to TRO (and temperature) that would affect their metabolic function and could even result in mortality. Once operation is established, the planktonic communities adjacent to the outfall are likely to comprise those which have been entrained within the CWS (see paragraphs 13.6.548 to 13.6.562).

13.6.767 Beyond the immediate vicinity of the outfall the modelling showed that in the worst case scenario, TRO at the surface would reduce to 0.05mg/L at approximately 500m offshore. This level of TRO would be restricted to the surface layer, and there would be no detectable increase in the TRO concentration at the seabed at this distance.

13.6.768 The peak in plankton abundance occurs just below the surface and the proportion of the plankton community exposed to TRO concentrations that would affect metabolic rates is very small compared to the size of the community. The effects are not considered likely to have any wider implications for the abundance and diversity of plankton communities.

13.6.769 Only a very small proportion of the plankton community would be affected and therefore the magnitude of change is predicted to be negligible and the effects on phytoplankton and zooplankton communities from the TRO discharge are predicted to be negligible.

Effects of TRO on intertidal and subtidal habitats and communities

Tolerances of habitats and species

13.6.770 The TRO in the Cooling Water discharge has the potential to affect individual benthic species either through lethal or sub-lethal effects. Sub-lethal effects include changes in swimming and crawling behaviour of molluscan larvae and changes in shell growth rate of adults [RD277]. Sessile species are at particular risk once settled as they are unable to move away from the stressor.

13.6.771 The lowest reliable short-term data point for marine invertebrates that can be identified was a 48h LC_{50} of 0.026mg/L chlorinated polyolefin for the larvae of the American oyster *Crassostrea virginica* [RD278]. A 15 day field study on *C.virginica* (a cultured UK species) yielded an inferred no observed effect concentration of 0.007mg/L TRO for shell deposition and a lowest observed no-effect concentration of 0.014mg/L TRO [RD279]. In molluscs, effect concentrations range from approximately 0.01mg/L to 5mg/L.

13.6.772 The effects on an individual species may vary according to the life stage. Early-stage larvae of the American clam *Mercenaria mercenaria* (a cultured UK species) had a 48h LC_{50} of 0.001mg/L Total Residual Chlorine although the reliability of this study is in question and it may overestimate toxicity [RD280]. Nevertheless, *Mercenaria* larvae managed to settle and grow to maturity in the chlorinated outfall channel of the previous power station at Marchwood on Southampton Water [RD219]. The *M.mercenaria* results were used as supportive information in the Risk Assessment Report.

13.6.773 The effects of sodium hypochlorite on bivalves such as mussels *Mercenaria* and *Crassostrea* have been found to be greater in larvae compared to juveniles [RD280]; [RD277].

13.6.774 Tolerance data from literature is likely to be more useful in terms of assessing effects outside the zone closest to the outfall (e.g. 100m or further offshore), owing to the potential combined effects of temperature. However, the presentation of the effects of TRO in terms of lethal concentrations and sub-lethal physiological responses or behaviour varies and comparative assessments across the majority of species receptors are therefore not possible.

13.6.775 Lethal concentrations of TRO have been measured for a number of crustacean species with LC_{50} of 0.09mg/L recorded for *Pandalus goniurus* [RD281] and an LC_{100} of 2.5mg/L for *Melita nitida* [RD282] and [RD283] in BEEMS [RD284]. Although these are higher than, or within the upper contour range concentration close to the outfall, there could still be sub-lethal effects at the concentrations experienced in the surface waters of the wider TRO plume.

13.6.776 Other crustacean species that are also known to be present in the area include the brown shrimp (*C.crangon*) and European lobster. TRO concentrations of 0.53mg/L have caused responses in approximately 38% of *C.crangon* after 48 hours and concentrations of between 0.24mg/L and 1.0mg/L have been found to cause 2.7% mortality in European lobster [RD213]; [RD216]. Again, these responses have occurred at concentrations higher than that at point of discharge, but this does not preclude other effects occurring in waters particularly within 250m of the outfall. *Corophium volutator* has been found to exhibit lethal responses at much lower concentrations, with a LC_{10} of 0.032mg/L to 0.039mg/L [RD285]. Sensitive crustacean species such as this would likely be sub-lethally affected within approximately 200m of the outfall.

13.6.777 In terms of molluscs, TRO sensitivities have been found to cause a decrease in survival from concentration of around 0.1mg/L for *Megallina gigas* (reducing to 0% survival at 0.15mg/L) [RD214]. The LC_{50} for *C.virginica* has been found to be much lower at 0.026mg/L TRO [RD278]; [RD286]. *M.edulis* has shown similar sensitivities to *M.gigas*, with complete inactivity in larvae occurring at concentrations between 0mg/L and 0.13mg/L and 95% inactivity of larvae between 0.14 and 0.8mg/L [RD228]. Sensitivity was found to be reduced in older (spat) life stages. *Macoma balthica* was found to exhibit sub-lethal effects at 0.037mg/L and 0.124mg/L TRO with the occurrence of burial activity [RD285]. Sub-lethal effects would therefore inhibit individuals' ability to thrive in an environment through reducing feeding activities, for example.

13.6.778 The available literature indicates that most of the benthic invertebrate species would not experience lethal effects from TRO at the highest concentrations (i.e. 0.1mg/L) modelled close to the outfall.

Considerations of a recovered baseline

13.6.779 There have been no direct observations of the effects of TRO on marine invertebrates at the Existing Power Station. As with macroalgae there was a change in species composition within the area of influence of the discharge. Invertebrates appearing to be most adversely affected by the CWS discharge (at around 150m to 200m) were sponges, algae and sea squirts. As there are several environmental factors acting in combination, it is unclear the extent to which the existing TRO alone is affecting these organisms.

13.6.780 The assessment of the effects of TRO has followed the same approach as described in paragraph 13.6.669.

Intertidal habitat and communities

13.6.781 An understanding of the sensitivity of habitats has been derived from MarLIN MarESA. None of the intertidal biotopes recorded in baseline surveys were found to be sensitive to 'synthetic compound contamination', although it is noted that this may not specifically refer to TRO.

13.6.782 Intertidal habitats and species would only be exposed to TRO when inundated and therefore those highest up the shore would be least affected.

The effects from exposure to TRO may be masked by those caused by the effects of the thermal discharge.

13.6.783 At the Existing Power Station, the effects of Cooling Water discharge on intertidal habitats and species were recorded from 200m to 250m. Based on modelling and on studies at the Existing Power Station Cooling Water outfall it is predicted that the effects on intertidal habitats would result in low diversity and abundance of some species within a few hundred metres from the outfall, although it is not possible to attribute this to the effects of TRO or thermal discharge alone.

13.6.784 The effects on this intertidal habitats and communities would occur over a small area of the intertidal shore and this would not affect the wider integrity of the receptor. Therefore, the magnitude of change is predicted to be negligible and there would be a negligible effect on intertidal habitats and communities from TRO discharge.

Subtidal habitat and communities

13.6.785 Subtidal habitats and species that are continually submerged would be susceptible to the effects of TRO discharge.

13.6.786 An understanding of the sensitivity of habitats has been derived from MarLIN MarESA. None of the subtidal biotopes recorded in baseline surveys were found to be sensitive to ‘synthetic compound contamination’, although it is noted that this may not specifically refer to TRO.

13.6.787 Modelling results predicted that the area of seabed exposed to TRO in excess of 0.01mg/L (95 percentile) would be restricted to the immediate vicinity of the outfall, over an area of 5.7ha in the worst case scenario (see Table D13-46). Within this area the TRO would fluctuate and some intertidal habitat adjacent to the outfall would be exposed to concentrations up to a maximum of 0.1mg/L.

13.6.788 At the Existing Power Station, the effects of Cooling Water discharge on subtidal habitats and species were recorded up to 300m. Based on modelling and on studies at the Existing Power Station Cooling Water outfall, it is predicted that the effects on subtidal habitats would result in low diversity and abundance of some species within a few hundred metres from the outfall, although it is not possible to attribute this to the effects of TRO or thermal discharge alone. It is likely that effects would be sub-lethal in the majority of subtidal benthic species outside the immediate zone of discharge (i.e. beyond 100m from the outfall).

13.6.789 Based on the extent of subtidal habitat that would be affected, the magnitude of change is predicted to be small and there would be minor adverse effect on subtidal habitats and communities from TRO discharge.

Intertidal and subtidal habitat of conservation importance

13.6.790 Considering the presence of the Annex I rocky reef habitat in the intertidal subtidal areas and the presence of other biotopes that form Section 7 habitats and species of The Environment (Wales) Act 2016, the magnitude of change is predicted to be small. Therefore, there would be a minor

adverse effect on intertidal and subtidal habitats of conservation importance from TRO discharge.

Effects of TRO on marine fish

13.6.791 TRO in the Cooling Water discharge has the potential to affect fish in the area, with smaller benthic species inhabiting the biotopes close to the outfall (e.g. blennies) being most at risk of exposure. As all adult fish are mobile, they are able to move away from the source. However, the egg and early planktonic stages have a higher risk as they have no/limited motility.

Ichthyoplankton

13.6.792 The distribution of ichthyoplankton is patchy and it is clear that separating the effects of entrainment, temperature and TRO is difficult. Therefore, consideration has been given to TRO effects within the assessment of effects of entrainment (see paragraphs 13.6.563 to 13.6.572).

13.6.793 The larvae of several species found in the area have been studied with respect to their tolerance of TRO. In terms of flatfish larvae, the LC_{50} for plaice and Dover sole was found to be 0.028mg/L [RD287]. In another experiment using the EMU, Dover sole exhibited approximately 17% mortality after 24 hours at TRO concentrations of 0.13mg/L to 0.2mg/L [RD227]. Turbot eggs and larvae were tested at concentrations of 0.2mg/L and around three quarters of larvae were found to be damaged and the rest viable, but none suffered mortality. At the same concentrations, around 95% of turbot eggs were found to be viable and hatching, and none were dead [RD215]. In terms of other species, TRO concentrations of 0.08mg/L were found not to induce mortality in bass after 24 hours, although concentrations of 0.2mg/L to 0.32mg/L increased mortality to around 50% of larvae. The LC_{50} of herring larvae was found by McLean [RD282] to be 0.065mg/L.

13.6.794 Taking these observations into account it is considered that the larval stages of some of these species would not suffer mortality as a result of the TRO discharge. One exception may be Dover sole and herring, which may be vulnerable to effects of concentrations greater than 0.06mg/L and 0.03mg/L, respectively, although this would only affect larvae in the surface layer, up to approximately 900m from the point of discharge. However, the majority of the water column in this zone would have much lower TRO concentrations, decreasing to zero at the bed.

13.6.795 A small proportion of the ichthyoplankton community would be affected and therefore the magnitude of change is predicted to be negligible and the effect on ichthyoplankton from TRO discharge is negligible.

All fish receptors (excluding ichthyoplankton)

13.6.796 Most of the relevant data available to fish species in this area of coast are pertinent to the egg and larval stages. Langford [RD233] examined data from power plant studies around the world and found no instance of direct fish mortalities associated with a power plant outfall. As fish are mobile species and can avoid sub-optimal habitat conditions, the main effects to

consider are therefore sub-lethal. This may include change in local distribution and reduction in feeding opportunities in areas affected.

13.6.797 Bellanca and Bailey [RD288] found adult ocean spot (*Leiostomus xanthurus*) had a 96 hour LC_{50} of 0.09mg/L TRO in a through flow experiment [RD275]. Although not found in UK waters, it provides an example of an adult fish tolerance.

13.6.798 European eel elvers exposed to TRO concentrations of 0.102mg/L for seven days at 22ºC exhibited 100% mortality [RD289]. This concentration is just above that at the point of discharge, therefore if elvers remained in areas subject to maximum concentration (which is highly unlikely) then mortalities could, in theory, occur. In reality, fish would be able to avoid areas of increased TRO, therefore mortalities are unlikely.

13.6.799 Areas close to the outfall experiencing the highest TRO (and temperature) would likely be inhabited by proximo-benthic species which are able to take advantage of food resources in sub-optimal areas of habitat. Benthic species would likely be reduced in abundance compared to seabed habitats outside the influence of the plume. This effect would only be likely at a distance of up to a few hundred metres from the outfall.

13.6.800 As fish are able to move away from the source of the effect and given the extent of the effect, the magnitude of change is predicted to be negligible. Therefore, the effect on fish receptors (including those of conservation and/or commercial importance and general fish and fisheries) from TRO discharge is predicted to be negligible.

Effects of TRO on marine mammals and seabirds

13.6.801 The discharge of TRO would not affect marine mammals or seabirds directly and there is no pathway for TRO through the food chain. There would be no effect on marine mammals and seabirds from TRO discharge.

Effects of TRO on designated sites

13.6.802 The extent of the TRO mixing zone has been considered in relation to the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA.

Table D13-48 Proportion of the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA exceeding 0.01mg/L TRO (95 percentile) boundary

Scenario	Designated nature conservation site	Area (ha)at the surface exceeding 0.01mg/L TRO (95 percentile) as % proportion of the site	Area (ha) at the seabed exceeding 0.01mg/L TRO (95 percentile) as a % proportion of the site
Annual base case (126m^3/s at +12°C (98 percentile)) – no wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.08	0.002
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.24	0.005
Summer base case (126m^3/s at +12°C (98 percentile)) – with variable wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.04	0.002
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.13	0.006

13.6.803 There are no effects predicted on the features of the designated sites either directly or indirectly and therefore the magnitude of change is predicted to be negligible and the effect on designated sites from the TRO is negligible.

Impact pathway: discharge of Cooling Water – chemical changes in discharge water

General context

13.6.804 The Cooling Water will be abstracted from Porth-y-pistyll through the Cooling Water intake structure, passed through the Power Station's CWS and returned to the Irish Sea at the Cooling Water discharge structure. The conventional discharge from the Power Station is subject to H1 screening with respect to the marine environment. The H1 process enables calculation of the impact of substances likely to be released to various media. In this instance, the H1 screens out the need for detailed assessment of those discharges to liquid effluent streams described as insignificant in comparison to the relevant EQS.

13.6.805 The Environment Agency provides a methodology for the H1 process based on risk assessment of discharges to surface water. The risk assessments enable operators to demonstrate how their activities will be managed so that

the impact on their local environment is acceptable. NRW has stated its intention to accept the H1 screening process for regulated activities in Wales.

13.6.806 The effects of radionuclides to marine environment receptors (including phytoplankton and zooplankton, marine benthic habitats and species, marine fish, seabirds as well as relevant designated and candidate conservation sites) have been assessed within chapter D14 (radiological effects) (Application Reference Number: 6.4.12) of this Environmental Statement. This assessment concluded a negligible magnitude of change and effect on marine environment receptors from the release of radionuclides in the Cooling Water plume and from disturbance to marine sediments.

Modelling: parameters

13.6.807 Horizon has undertaken water quality monitoring in the vicinity of the Existing Power Station since 2010, the results of which have been used to provide ambient water quality data for this assessment.

13.6.808 The screening process compares the predicted concentrations of the discharge constituents to water quality standards. Where available, the EQS provided by the Environment Agency have been used. For those constituents for which an EQS is not available, alternative standards have been used (appendix D13-14, Application Reference Number: 6.4.96). The preference in selecting these screening criteria has been to use a predicted no-effects concentration.

13.6.809 The H1 assessment has been undertaken based on four discharge points for liquid effluent from the Power Station with both continuous and non-continuous (batch) discharges. These discharges will be to:

- sea (Cooling Water outfall), via the seal pit;
- sea (Porth-y-pistyll) – Cooling Water intake and discharge point for the fish recovery and return system;
- Welsh Water wastewater treatment works (under Dŵr Cymru Welsh Water operations); and
- surface waters.

13.6.810 The expected chemical discharges from the Power Station during operation and outage (appendix D13-11, Marine Modelling of the Operational Discharge, Application Reference Number: 6.4.93) have been considered separately as the chemical discharges will differ considerably between the two periods.

Modelling: outputs

13.6.811 Of the chemical discharges expected to arise from Wylfa Newydd Power Station (appendix D13-1, Application Reference Number: 6.4.83) that have been subject to an H1 assessment, one was not immediately screened out of the need for further assessment. This was sodium nitrite. All other chemicals were screened out as not being of potential concern.

13.6.812 Sodium nitrite is used as a corrosion inhibitor in closed loop systems. This will result in sodium nitrite being present in the maintenance batch

discharges, as a product of the drain down of the closed-loop systems. Following drain down, sodium nitrite will enter the marine environment via the main CWS outfall. The maximum concentration in the CWS effluent at the point of discharge (i.e. before any mixing taking place) will be 24.8 µg/L. Sodium nitrite concentrations would be lower at drain down than that stated in the maximum concentration, owing to degradation within the system during operation.

13.6.813 The following section presents further information on the effects of sodium nitrite in the marine environment, and assesses whether there would likely be any effects resulting from its discharge.

Sodium nitrite standards

13.6.814 There is no defined EQS for sodium nitrite therefore the predicted no-effect concentration value of 6µg/L has been used in the H1 assessment for a preliminary assessment of potential effects on the marine environment.

13.6.815 Sodium nitrite is listed in the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment [RD290].

Effects of nitrite

13.6.816 Nitrite is an intermediate product and is converted to nitrate in the aquatic environment by nitrite-oxidizing bacteria, e.g. of the genera *Nitrospira*, *Nitrospina*, *Nitrobacter*, and *Nitrococcus* [RD291].

13.6.817 Once discharged, sodium nitrite has the potential to affect ecological receptors. Given sufficient concentrations and specific conditions, nitrite is a toxic substance to aquatic organisms. Nitrite poisoning in fish, for example, manifests itself in the presence of high levels of blood methaemoglobin, whereby nitrite reacts with haemoglobin and oxidises ferrous iron into ferric iron, producing methaemoglobin, which will not bind or transport oxygen, causing tissue hypoxia [RD292]; [RD293].

13.6.818 The effects of sodium nitrite on receptors has been evaluated partly based on published data relating to 96h LC_{50} thresholds, (i.e. the concentration at which 50% of the test sample suffer mortality after 96 hours) of broadly representative taxa to those inhabiting the receiving waters of the Cooling Water discharge (e.g. fish and crustaceans).

13.6.819 Boyd [RD294] states that nitrite-nitrogen 96h LC_{50}s for marine organisms generally range from 10 mg/L to 300 mg/L for invertebrates and 100mg/L to 1,000mg/L for fish.

13.6.820 The 48h LC_{50} for penaeid shrimps was found to be 170mg/L for nitrite –N (nitrite as nitrogen) [RD295]. The 24h LC_{50} value of nitrite –N was 13.20 mg/L for (larval development stage) [RD295].

13.6.821 In terms of marine fish, red drum (*Sciaenops ocellatus*) larvae have been found to tolerate nitrite concentrations of up to 100mg/L for two weeks, with no effects on growth [RD296].

13.6.822 Lewis and Morris [RD297] collated 96h LC_{50} for nitrite information relating to various (mainly freshwater) fish species. A summary of the lowest concentration reported for each species (note environmental variables vary depending on the experiment) is presented in table D13-49.

13.6.823 Boyd [RD294] presented similar published information relating to marine species, some of which may be present in the receiving waters of the Wylfa Newydd Cooling Water discharge (i.e. sea bass (*Dicentrarchus labrax*), European eel (*Anguilla anguilla*) and sea trout) (table D13-50). Those species had 96h LC_{50}s broadly in the range of 80mg/L to 980mg/L nitrite.

Table D13-49 96h LC_{50} for fish (mainly freshwater) species (lowest concentration recorded) [RD297]

Species	Nitrite concentration (mg/L)
Rainbow trout	0.15
Chinook salmon	0.88
Cutthroat trout	0.52
Channel catfish	7.1
Black bullhead	>32
Fathead minnow	7.1
European minnow	28
Creek chub	>41
Common carp	>32
White sucker	>80
Quillback	>80
Largemouth bass	140
Bluegill	2.4
Mosquitofish	1.5
Blue tilapia	16
Logperch	<3
Brook stickleback	<3
Mottled sculpin	>67

Table D13-50 96h LC_{50} for marine species [RD294]

Species	Nitrite concentration (mg/L)
Mud crab	41.6 to 69.9
Sea bass	154.0 to 274.0
European eel	84.0 to 974.0
Pacific white shrimp	9.0 to 322.0
Black tiger prawn	13.6
Sea trout	980.0

Factors influencing nitrite toxicity

13.6.824 The presence of chloride in marine waters can reduce or inhibit the toxic effects of nitrite [RD296]. The key factor is the attenuating effect of monovalent ions such as Cl- [RD292], which is a competitive inhibitor of the uptake of nitrite [RD292]; [RD298]. As the concentration of Cl- increases, the capacity of nitrite ions to enter the blood stream decreases [RD297]; [RD298]. Fish tolerance to nitrite exposure may therefore increase in environments with greater salinity [RD292]; [RD297]; [RD299]. In terms of other monovalent ions, the presence of Br- (80mg/L) has been found to almost fully offset the presence of nitrite (at a concentration of 32mg/L) for Atlantic salmon [RD300].

13.6.825 Owing to the fact that nitrite reduces the oxygen-carrying capacity of blood, lower levels of oxygen will exacerbate the toxicological effects. A higher amount of oxygen coupled with lower metabolic rates of fish at lower temperatures might render nitrite a less potent toxin. However, lower temperatures reduce the efficiency of any detoxification mechanisms [RD297].

13.6.826 The duration of exposure is also an important factor in terms of toxicity; a 24 hour to 48-hour exposure period was found to be required for maximum accumulation of nitrite in fish [RD301]; [RD300]; [RD302].

13.6.827 Studies have shown that recovery from nitrite exposure can be rapid. Eddy *et al*., [RD300] found that most rainbow trout (*Oncorhynchus mykiss*) that had been exposed to LC_{50} concentrations for 20 hours recovered rapidly once placed in nitrite-free water.

Effects of sodium nitrite on marine receptors

13.6.828 By comparison of published data with the anticipated operational conditions at the Power Station, the maximum concentration of sodium nitrite within the Cooling Water discharge would be over six times lower than the most sensitive example of a fish species' 96h LC_{50} (Rainbow trout, table D13-49). Furthermore, the concentration would be over 500 times lower than published 24h LC_{50}s for penaeid shrimps. It is therefore concluded that toxic effects on marine organisms would be extremely unlikely.

13.6.829 Following discharge, the concentration of nitrite will diminish through dilution and additional demand introduced by the receiving water, e.g. by continuing oxidisation of nitrite to nitrate via nitrite-oxidising bacteria. The final product, nitrate, is less toxic to organisms such as fish. Demand through oxidisation would likely be greatest in late spring and summer when bacterial activity and water temperatures are at their highest.

13.6.830 In addition, both the temporary nature of the discharge (in allowing individuals to recover on cessation) and the toxicity-reducing effects of the saline receiving waters (in blocking the nitrite uptake by organisms) would ensure that sub-lethal effects on marine biota would also be unlikely. The same conclusion is drawn for potential effects of sodium nitrite on features of designated sites (i.e. terns and harbour porpoise), as there are no

pathways for this discharge component to affect the designated receptors or their prey.

13.6.831 Given the fact that sub-lethal effects on marine biota are considered unlikely, the magnitude of any change is predicted to be negligible therefore the overall effects of the sodium nitrite discharge on the marine environment would be negligible.

Impact pathway: airborne noise during operation leading to disturbance of seabirds

Context

13.6.832 Activities during operation would potentially affect target and secondary seabirds, due to an increase in airborne noise. The main sources of plant noise during operations would be from engines/generators, heating ventilation and air condition intake and exhaust fans, steam venting, pumps and transformers, alarm testing and marine vessels. In the context of the Power Station Site and the nearest receptors, it is unlikely that other noise sources such as traffic, or noise from overhead transmission lines, would be of concern.

Effect of airborne noise during operation on seabirds

13.6.833 In respect of the operation of the Power Station, tolerance of seabirds to noise disturbance is predicted to be high, as all seabird species using the marine environment adjacent to the Existing Power Station have been habituated to noise associated with its operation.

13.6.834 Based on the predicted noise contour modelling during operation with mitigation described in chapter D6 (Application Reference Number: 6.4.6), it is predicted that there would be no increase in noise levels at the tern colony at Cemlyn Lagoon, whereas at Porth-y-pistyll the maximum noise level would be 35dB(A) to 40dB(A) (see chapter D6, Application Reference Number: 6.4.6).

13.6.835 During worst case scenarios when all emergency equipment would be in operation, noise levels at the tern colony at Cemlyn Lagoon would be at less than 35dB(A), however this situation would be rare. Noise levels at Cemlyn Bay, Cemaes Bay, Porth Wnal and the gull colony are predicted to be temporarily up to 40dB. Porth-y-pistyll is predicted to experience temporary worst case noise levels of 50dB during very rare events. These noise levels would represent a negligible magnitude of change and would result in negligible effects on seabirds.

Decommissioning

13.6.836 Activities associated with decommissioning are described in chapter D1 (Application Reference Number: 6.4.1). The activities of particular relevance to the marine environment are:

- the shutdown of reactors and the reduction and eventual cessation of abstraction and discharge of Cooling Water;

- changes in the quantity and quality of liquid effluent discharge; and
- the removal of structures including the intake and outfall and MOLF.

13.6.837 Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment which would assess in detail the effects against the baseline conditions at that time. A preliminary indication of the likely effects during decommissioning is outlined below considering the current baseline.

13.6.838 A number of details relating to decommissioning are not known at this time and therefore, a number of assumptions have been made, as shown in paragraphs 13.5.115 and 13.5.116.

13.6.839 The marine receptors that would potentially be directly or indirectly affected by decommissioning are considered the same as those outlined in table D13-4 for the Wylfa Newydd Development Area.

13.6.840 A reduction in Cooling Water abstraction and discharge and eventual cessation during the decommissioning phase would represent an opportunity for the potential thermal effects identified in paragraphs 13.6.649 to 13.6.718 to be reversed. This would allow intertidal and subtidal species with lower thermal tolerances that had previously been displaced from the area around the Cooling Water outfall, to return. Species which are adapted to warmer temperatures may be affected by cessation of the Cooling Water discharge resulting in a decrease in feeding and reproduction rates, growth and potential displacement or mortality.

13.6.841 With a reduction in Cooling Water abstraction and discharge and eventual cessation, the total amount of biocide discharged would reduce and following shutdown, TRO would no longer be released into the marine environment. Habitats and species sensitive to TRO would be able to recolonise the area within the TRO footprint with potential reversal of the TRO effects identified in paragraphs 13.6.749 to 13.6.831.

13.6.842 The removal of the MOLF, and intake and outfall structures could lead to localised losses of marine habitats and species on and around the structures. The majority of structures that would be removed represent vertical surfaces which are known to support fewer marine organisms compared to surfaces with shallow gradients owing to the limited extent of habitat available within each tidal zone. Mobile species commonly found on surfaces with shallow gradients are often unable to survive on vertical slopes, especially when the effect of wave action is significant [RD303]; [RD304]. Therefore, although marine habitats present on hard structures at the time of decommissioning are likely to support fully established habitats and communities, these would probably be of lower quality (i.e. lower species diversity) than comparative communities on surfaces with shallow gradients. The intertidal and subtidal areas which will remain following removal of the MOLF, and intake and outfall structures will represent more natural rocky habitats characterised by a greater degree of structural heterogeneity. It is likely that these habitats would support a more diverse species complement in the long-term.

13.6.843 Information regarding the likely succession of intertidal and subtidal communities following the cessation of physical disturbance is outlined in

paragraphs 13.6.143 to 13.6.146. This should be borne in mind when considering the effects of decommissioning on intertidal and subtidal habitats and species.

13.6.844 During decommissioning there would be a number of vessels and marine plant entering the area which may originate from national or international destinations. This could lead to non-native species being introduced to the area. Following removal of structures and cessation of Cooling Water discharge, new substrate would also present an opportunity for non-natives to become established which may facilitate their spread and increase the risk to native species. An assessment of the effects associated with the introduction of non-native species is outlined in paragraphs 13.6.247 to 13.6.262; this is considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.845 During decommissioning there would be temporary disturbance to marine receptors (e.g. fish, marine mammals and seabirds) from an increase in underwater and airborne noise and vibration, artificial lighting and visual disturbance during removal of structures. An assessment of the effects associated with underwater and airborne noise and vibration, artificial lighting and visual disturbance is outlined in paragraphs 13.6.263 to 13.6.466; these are considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.846 Land-based and marine-based demolition works associated with decommissioning could affect marine water quality. An assessment of the effects associated with surface water and groundwater discharge is outlined in paragraphs 13.6.2 to 13.6.103; these are considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.847 It is recognised that given the duration of the operation phase (60 years), the abundance and distribution of marine species present in the vicinity of the Power Station may change owing to the effects of climate change. Legislation and conservation designations are also likely to adapt to changes in the marine environment to ensure continued protection of vulnerable species and habitats. These factors would all influence the assessment of key ecological receptors. Any future assessment should review the baseline conditions at that time and redefine key ecological receptors if necessary.

13.6.848 A more detailed indication of effects is not possible at this time; however, future assessments would be expected to consider the following beneficial changes:

- no further abstraction and therefore no further loss of plankton, ichthyoplankton, invertebrates or fish;
- cessation of the maintenance dredging programme which would allow recovery of habitats in the approach channel; and
- the ecological value of the breakwaters at the end of the operational phase.

13.7 Assessment of effects for the Disposal Site

13.7.1 This section presents the findings of the assessment of effects associated with the Disposal Site.

Construction

Impact pathway: changes to marine water quality from proposed dredging disposal (suspended sediment and release of contaminants)

General context

13.7.2 Disposal of sediment would result in an increase in SSCs at and beyond the point of disposal. Sediment dispersion will be subject to the hydrodynamic processes of the Disposal Site.

13.7.3 Increases in SSCs can lead to high turbidity in the water column, with the potential to affect phytoplankton through light reduction and thus 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 [RD305] and young fish may also be affected if suspended sediments become trapped in their gills [RD306].

13.7.4 Mobilisation of sediment at the point of disposal may also result in the release of sediment-bound contaminants into the water column with potential indirect effects on marine organisms.

13.7.5 The maximum volume of soft sediment that would be disposed is 242,000m^3 (bulked volume) with sediment disposal operations estimated to take 35 days to complete. This period assumes that disposal of sediment is continuous and without break in operations, i.e. the worst case.

Modelling

13.7.6 Plume dispersion modelling has been carried out using a range of model scenarios (see appendix D13-12, Application Reference Number: 6.4.94). The model outputs predict the fate of the disposed material in terms of increases to SSCs beyond background levels and also sediment deposition rates.

13.7.7 A number of conservative assumptions have been made including the following.

- Modelling of disposal events every 12 hours, continuously for 35 days.
- The volume of sediment disposed of will be 242,000m^3 (bulked volume).
- There are no waves during the 35-day disposal period. The model predicted that the addition of waves would result in a more rapid dispersion of dredged material; therefore, a more conservative scenario

was to model without waves (appendix D13-12, Application Reference Number: 6.4.94).

13.7.8 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) (appendix D13-12, Application Reference Number: 6.4.94). As the SSCs generated by coarse and medium sand fractions were not visible from the outputs these are not discussed further in relation to SSCs; however, these are discussed later in relation to potential effect of deposition.

13.7.9 The modelling outputs (appendix D13-12, Application Reference Number: 6.4.94) following a disposal event showed that the plume (mostly represented by SSCs that exceed typical background levels by no more than 10mg/L) disperses to baseline background SSCs (see section 13.4) after approximately three hours.

13.7.10 Figure D13-39 to figure D13-42 (Application Reference Number: 6.4.101), show the SSC outputs from the modelled surface layer (approximately 7m thick), where the highest SSCs are predicted, for fine sand and fines fractions, each after a single disposal event (+3hrs after event) and the final disposal event (+35 days after initial disposal event). The model outputs showed that the SSC of fine sands is well within the range of typical background concentrations in both outputs (+3hrs after single disposal event, +35 days after initial disposal (end of disposal programme)); therefore, the effects from fine sands are not considered further.

From the plume generated by the fines it is predicted that SSCs would disperse to typical background concentrations after approximately three hours following a single disposal event. Figure D13-43 (Application Reference Number: 6.4.101), showing the residual fines plume 48hrs after the final disposal event of the programme, indicates that SSCs will be within typical background concentrations, evidencing the highly dispersive nature of the area.

Effects on marine water quality

Changes in SSCs

13.7.11 Modelling of the SSCs from disposal events has evidenced the highly dispersive nature of the receiving water (see figure D13-39 to figure D13-42, Application Reference Number: 6.4.101). Increases in SSCs beyond typical background concentrations are highly transitory. More than three hours following a single disposal event all sediment would have dispersed to such a degree that SSCs would be within typical background concentrations (paragraphs 13.4.18 to 13.4.21). Furthermore, at 48 hours after the final disposal event it is considered that the SSCs generated by the sediment plume would not be discernible from the background environment.

Changes in water chemistry

13.7.12 Chemical analyses of sediment collected from Porth-y-pistyll and the adjacent area, recorded comparatively few exceedances of the Cefas Action

Level 1 for metals and PAHs (appendix D13-2, Application Reference Number: 6.4.84). The sum concentration of ICES-7 PCB congeners did not exceed Cefas Action Level 1. None of the determinands analysed exceeded Cefas Action Level 2 from any of the locations within or adjacent to Porth-y-pistyll.

13.7.13 The Cefas Action Level 1 has been set as criteria below which the material is unlikely to pose a significant chemical risk to the marine environment and as such disposal at sea would be considered acceptable.

13.7.14 Although there is potential for some of the sediment-bound determinands to dissolve in the water consideration is given to the large volume of water and hence considerable diluting properties, along with the high dispersive nature of the environment in this area, as evidenced in appendix D13-12 (Application Reference Number: 6.4.94).

13.7.15 In order to determine the potential for contamination of the water column as a result of sediment disturbance from dredging and excavation, an assessment was carried out to determine the effect on marine water quality from the potential mobilisation of sediment-bound contaminants (see paragraphs 13.6.86 to 13.6.96). The assessment derived the maximum dissolved concentration for each contaminant and added this to the ambient levels to derive a total dissolved concentration.

13.7.16 The assessment concluded that the maximum dissolved concentration for each contaminant resulting from dredging and excavation is several orders of magnitude below the available EQS, suggesting that the potential for dredging activity within the Wylfa Newydd Development Area to affect water quality from contaminants in sediments is minimal. Further assessment considered the potential for any small uplifts in contaminant concentrations (see paragraphs 13.6.86 to 13.6.96); however, it was found that these would not result in any AA-EQS exceedances.

13.7.17 The study is considered relevant to changes in sediment chemistry at the Disposal Site as it presents a worst case scenario based on an increase from typical background SSCs to 1000mg/L. At the point of disposal, at zero hours, an increase from typical background SSCs to 1600mg/L has been assumed for the modelling study (appendix D13-12, Application Reference Number: 6.4.94) based on the sediment density within the hopper. Although the disposal increase in SSCs is higher than that modelled for the excavation, as the dissolved concentration for each contaminant from the sediment is several orders of magnitude below the available EQS, the effect on water quality from contaminants in sediments is similarly minimal.

Effects on phytoplankton and zooplankton

Changes to SSCs

13.7.18 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101) and appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.19 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.

13.7.20 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.

Changes in water chemistry

13.7.21 The potential effect on coastal water from changes in water chemistry from the release of contaminants has been assessed as negligible (see paragraph 13.7.20). 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. The value of this receptor is low. Hence the effect on this receptor from changes to water chemistry is considered negligible.

Summary of effects on phytoplankton and zooplankton

13.7.22 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on phytoplankton and zooplankton from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to phytoplankton and zooplankton is negligible.

Effects on marine fish

Changes to SSCs

13.7.23 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101) and appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.24 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. Hence the effects on all marine fish receptors (including ichthyoplankton receptors) from changes to SSCs are considered negligible.

Changes in water chemistry

13.7.25 The potential effect on water chemistry from the release of contaminants has been assessed as negligible (paragraph 13.7.21). Consequently, it is considered that there would be no noticeable effect on larval, juvenile or adult fish populations from changes in water chemistry and the magnitude of change is predicted to be negligible on all fish and shellfish receptors.

Hence, the effect on all marine fish receptors (including ichthyoplankton receptors) from changes to water chemistry is considered negligible.

Summary of effects on marine fish

13.7.26 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on marine fish from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to all marine fish receptors (including ichthyoplankton receptors) is negligible.

Effects on marine mammals

Changes to SSCs

13.7.27 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101; appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.28 Effects on fish from changes to SSCs, some of which will be prey items for marine mammals, were assessed as negligible (see paragraph 13.7.24).

13.7.29 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. Hence, the effect on highly mobile marine mammal receptors from changes to SSCs is considered negligible.

Changes in water chemistry

13.7.30 The potential effect on water chemistry from the release of contaminants has been assessed as negligible (paragraph 13.7.21) as is the effect on fish receptors (paragraph 13.7.25). Consequently, it is considered that there would be no noticeable effect on marine mammals and the magnitude of change is predicted to be negligible. Hence, the effect on highly mobile marine mammal receptors from changes to water chemistry is considered negligible.

Summary of effects on marine mammals

13.7.31 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on marine mammals from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to marine mammals is negligible.

Effects on target and secondary seabirds

13.7.32 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on seabirds from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to target and secondary seabirds is negligible.

Effects on designated sites

13.7.33 As described in the preceding sections on seabirds and marine mammals, the magnitude of change from potential effects on marine water quality is predicted to be negligible. It is therefore considered that any effects on the terns, as the qualifying feature for the Anglesey Terns/Morwenoliaid Ynys Môn SPA and the Cemlyn Bay SSSI, or harbour porpoise as the qualifying feature for the North Anglesey Marine cSAC, would be negligible.

Impact pathway: direct footprint of the works leading to mortality of species, loss of subtidal habitat and loss of resource (food and refuge)

General context

13.7.34 Direct loss of subtidal habitats and benthic species would occur from the disposal of rock and sediment at the Disposal Site.

13.7.35 As part of the embedded mitigation, rock material will be deposited within a micro-sited area of the Disposal Site (paragraph 13.5.80). Rock will be deposited over a period of approximately 16 months following commencement of dredging in the outer harbour.

13.7.36 Based on benthic survey data (appendix D13-2, Application Reference Number: 6.4.84); [RD64] the position of the micro-sited area within the Disposal Site is such that it is >0.25km from any known Sabellariidae reef (see figure D13-20, Application Reference Number: 6.4.101).

13.7.37 Assuming that a bulked volume of rock equal to 368,000m^3 (this being a worst case volume) is disposed at the micro-sited area would result in raising the seabed by approximately 1m (less than 1.5% of the baseline depth).

13.7.38 Direct loss of subtidal habitat will also occur as a result of sediment disposal and consequent deposition of material. The effect on benthic communities and sessile species is dependent on their sensitivity to sedimentation and the level of deposition.

13.7.39 Broad partitioning of the sediment fractions divides the sediment into coarse sand, medium sand, fine sand and fines (see appendix D13-12, Application Reference Number: 6.4.94). As part of the embedded mitigation, where practicable the sediment will be disposed within the central area of the Disposal Site thus constraining the effects of sediment dispersion, specifically deposition, as much as possible, to within the Disposal Site boundary.

13.7.40 Multibeam data collected by a SEACAMS research project in 2013 and 2014 and interpreted by Potter [RD67] indicates that depths in the middle region of the Disposal Site exceed 70m. BGS data (BGS DigSBS250) records the seabed in this area as comprising a mix of sandy gravels. The general community type characterising this area is predicted as '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (SS.SMx.CMx.FluHyd) [RD8].

Modelling

13.7.41 For rock disposal, 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.

13.7.42 For sediment disposal, plume dispersion modelling looked at rates of sediment deposition at the Disposal Site following disposal of dredged sediment (see paragraphs 13.7.6 to 13.7.11).

13.7.43 Modelling outputs showed minimal deposition after seven days in a highly localised area (see appendix D13-12, Application Reference Number: 6.4.94). The model showed that deposition of sediment is restricted to certain states of the tide i.e. deposition did not occur for sustained periods in the full tidal cycle.

13.7.44 After a single disposal event the model predicted that no area of the seabed receives a deposition of 1cm or more.

13.7.45 On completion of the sediment disposal programme (after 35 days) the areal extent of 1cm or more of deposition was 180ha (appendix D13-12, Application Reference Number: 6.4.94). This was depicted by a patch of sediment extending 2.8km along its major axis and 0.9km along it minor axis in a broadly oval shape (figure D13-44, Application Reference Number: 6.4.101). Therefore, deposition of 1cm or more did not occur beyond the Disposal Site boundary.

13.7.46 By the end of the disposal programme the model outputs showed that a deposition depth of 5cm or more covered an area of 50ha; and that a deposition depth of 30cm or more covered an area of 7ha. The maximum depth predicted was 43cm, covering an area of <1.6ha.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.47 The direct footprint of the disposal activities is considered as those areas directly impacted from the disposal of rock and the disposal of sediment. These areas are geographically distinct and are discussed separately with an overall assessment based on the considerations.

Rock disposal

13.7.48 From survey work carried out around the micro-sited rock disposal area (appendix D13-2, Application Reference Number: 6.4.84) and acknowledging BGS data (BGS DigSBS250), it is considered that the seabed encompassed by the rock disposal footprint is a mix of circalittoral rock and coarse gravels, interspersed with boulders.

13.7.49 The Disposal Site benthic survey (appendix D13-2, Application Reference Number: 6.4.84) recorded the presence of the rocky biotope '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock'

(CR.MCR.EcCr.UrtScr) immediately within the footprint of the micro-sited area and the biotope 'very tide-swept faunal communities' (CR.HCR.FaT) just to the north-east. Further to the west and south were '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 it has been assumed that pockets of this Annex I feature may be present.

13.7.50 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 clearly represents part of the Annex I reef feature and are therefore assigned a medium value. As a worst case, it has been assumed that the entirety of the rock disposal footprint is represented by this Annex I reef feature and thus encompassed by the receptor group 'subtidal habitats and communities of conservation value.'

13.7.51 Consideration is given to the wider rocky reef environment. Survey data has indicated that rather than continuous bedrock it is a mix of bedrock, boulders and stony reef. These rocky reef environments are extensive within this region of the Irish Sea, covering approximately 1233ha in the Disposal Site alone. Beyond the Disposal Site, recognising the data by BGS and also HABMAP [RD8], it is acknowledged that these rocky reef features extend many kilometres to the north and east of the rock disposal footprint.

13.7.52 Owing to the rocky nature of the disposed material recolonisation by a similar community is likely within the short-term, the sessile species lost being common to the general area. Furthermore, the scale of habitat loss is very small in comparison to the availability of rocky reef in the wider region. 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. Consideration is also given to the incremental changes to the seabed within the rock disposal footprint. These would occur over the estimated 16-month duration and therefore it is considered that some recolonisation may occur soon after the first disposal event, rather than at the end of the 16 months.

13.7.53 The loss of resource would be unnoticeable when considered in terms of the extensive rocky habitat adjacent to the footprint. In the short-term the development of a similar community on the disposed rocky material will also provide resources to benthic species.

13.7.54 As with the rocky reef habitat, Sabellariidae aggregations are present throughout the wider area with crusts and, less commonly, reef being recorded at a number of sites during the benthic surveys of the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84). Sabellariidae aggregations, specifically crusts and reefs, are often representative of a regularly changing community, i.e. they are just one step in a cyclical succession, representing an ephemeral rather than particularly stable community (e.g. [RD307].

13.7.55 For the physical pressure 'habitat structure changes – removal of substratum' the MarLIN MarESA for *S.spinulosa* habitat is relevant. Since rocky seabed lost would be replaced by disposed rock, the resulting substratum would be similar. On this basis, the MarLIN MarESA concludes that the sensitivity of the Sabellaria community to this physical pressure is medium [RD308].

13.7.56 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, then recolonisation of seabed could take place in the short-term to medium-term [RD308].

13.7.57 Furthermore, considering that any pockets of Sabellariidae reef, if present within the rock disposal footprint, would not represent an isolated feature in this region, it is not thought that the short-term to medium-term loss of this habitat would have a noticeable effect on the integrity of this receptor over the wider area.

Sediment disposal

13.7.58 The model predicted that an area of 180ha will receive a deposition depth of 1cm or more over the complete sediment disposal programme (figure D13-44, Application Reference Number: 6.4.101).

13.7.59 The whole of the 180ha area lies within an area predicted by HABMAP as the community *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment [RD8]. Presence of the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx) in this region was also confirmed from some of the nearest benthic survey sampling sites (HHD_8; HHD_12; HHD_19) (appendix D13-2, Application Reference Number: 6.4.84) to the 180ha area. However, as a worst case it has been assumed that the more sensitive feature (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) dominates the 180ha area. To the north-west of the 180ha area the site HHD_16 recorded the biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (SS.SBR). PoR.SspiMx; however, applying the criteria for assessment of reefiness [RD14] this community was not considered a reef (appendix D13-2, Application Reference Number: 6.4.84).

13.7.60 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.

13.7.61 As the MarLIN MaeESA has concluded that the habitats *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment and 'Sabellaria *spinulosa* on stable circalittoral mixed sediment' are 'not sensitive' to smothering up to 5cm, it is more appropriate to consider the area affected by a sediment deposition of 5cm or more (50ha) [RD308]; [RD309]. Although many of the species would tolerate deposition of 5cm, especially since sedimentation will occur over a 35-day period, as the deposition approaches 30cm or more it is assumed that most characterising species would be buried

[RD308]; [RD309]. However, as a worst case it has been assumed that the habitat that experiences 5cm or more sediment deposition will be lost (50ha).

13.7.62 Utilising the HABMAP predictive model [RD8], it is suggested that approximately 60% of the Disposal Site (1727ha) is covered by the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (see [RD70]). This feature extends way beyond the Disposal Site, extending a number of kilometres to the north, south and east. The benthic survey (appendix D13-2, Application Reference Number: 6.4.84) also confirmed the presence of this feature at several sites in the Disposal Site along with the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx).

13.7.63 The characterising species of the *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment biotope and the habitat itself are widespread throughout this region. No benthic species of conservation designation were recorded from within the Disposal Site.

13.7.64 As discussed above (paragraphs 13.7.54 to 13.7.57) Sabellariidae crusts and, to a lesser extent, reefs are found throughout the region. From consideration of the MarLIN MarESA of physical pressure 'habitat structure changes – removal of substratum', the sensitivity of the *Sabellaria* community to this physical pressure is medium [RD308].

13.7.65 In terms of the *Flustra* community the loss of resource would be unnoticeable when considered in terms of the extent of the same or very similar habitat occurring adjacent to the footprint and far beyond this area.

13.7.66 Considering that Sabellariidae reef, if present within the sediment disposal footprint, would not represent an isolated feature in the wider region it is not thought that the short-term to medium-term loss of this habitat would have a noticeable effect on the integrity of this receptor.

13.7.67 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-term to medium-term.

Overall assessment of effect on subtidal habitats and communities (including those of conservation importance)

13.7.68 The assessment has considered loss of Annex I reef (rocky and biogenic) from the rock and sediment disposal. Loss of the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment from sediment disposal has also been considered.

13.7.69 Assuming the worst case scenario, a total area of 87.5ha will be lost during the disposal events. The directly impacted habitat will largely be made up of rocky reef (up to 37.5ha) and *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (up to 50ha). Within these areas it has been assumed that pockets of Sabellariidae reef may also exist; however, it is also recognised that *Sabellaria* communities are widespread throughout the region.

13.7.70 Acknowledging that loss of any 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 that recovery within the footprint would occur in the short-term to medium-term, the magnitude of change is predicted to be small.

13.7.71 The *Flustra* habitat falls under the receptor group subtidal habitats and communities and is assigned a low value. The magnitude of change is small and the effect on subtidal habitats and communities from direct loss under the footprint of disposal is therefore assessed as minor adverse.

13.7.72 The Annex I reef feature falls under the receptor group 'subtidal habitats and communities of conservation importance' and are assigned a medium value. Given consideration of all of the above, the magnitude of change is small and the effects on subtidal habitats of conservation importance from direct loss under the footprint of disposal is assessed as minor adverse.

Effects on marine fish

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

13.7.74 Indirectly, the loss of habitat feeding resource and refuge would result in some displacement of fish and shellfish. However, as outlined above (paragraph 13.7.52), recolonisation of rock material will occur in the short-term, taking place after each disposal event; and 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.

13.7.75 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. Hence the effect is assessed as negligible on all marine fish receptors.

Impact pathway: physical effects on subtidal habitats and communities from sand-scour and smothering (sediment disposal)

General context

13.7.76 Dredged material will be disposed as rock and as sediments. These disposals will vary temporally and spatially with the disposal of sediment taking place initially, followed by rock. It is assumed that, so far as possible, sediments be deposited approximately within the central area of the Disposal Site.

13.7.77 For the purposes of this assessment, and with consideration of a worst case effect, it has been assumed that sediment deposition of 5cm or more would effectively result in the loss of subtidal habitat (paragraphs 13.7.44 to 13.7.67). As discussed, deposition of up to 1cm in a single event is assumed to represent smothering comparable to natural events and is therefore considered to represent a negligible magnitude of change, as it is within the range of natural variability within the short-term. This assumption is based on extensive literature which contains studies relating to natural sedimentation processes and ecological effects e.g. [RD113].

13.7.78 Therefore, the effect of physical disturbance from smothering by sediment, is that which receives between 1cm and 5cm of deposition; which, from the modelling (paragraphs 13.7.41 and 13.7.46), equates to 130ha. This area is fully encompassed by the Disposal Site and is considered coincident with the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (see paragraph 13.7.59). Acknowledging that the MarLIN MarESA definition for 'light' deposition is up to 5cm of fine material added to the habitat in a single, discrete event. This is considered valid for the assessment of smothering effects from sediment at the Disposal Site.

13.7.79 Once the sedimentary material settles, it can potentially cover benthic organisms through the increase of sedimentation and result in deterioration of the benthic community. Although mobile organisms such as fish and marine mammals would not be directly impacted by the light deposition, it may affect food resource and lead to displacement.

Effects on subtidal habitats and communities

13.7.80 Within the MarLIN MarESA of light deposition to *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment, the resistance and resilience of this community is assessed as high leading to an assessment of not sensitive [RD309].

13.7.81 Acknowledgment is also given to the JNCC description of the *Flustra habitat* as 'sand-scoured', this physical factor being an important structuring component of the biotope [RD310]. The characterising species of this habitat, *F.folicacea* and *H.falcata* are both tolerant of sediment abrasion and sand-scouring [RD310]; [RD311]

13.7.82 Given the above the magnitude of change is predicted to be negligible on the group receptor subtidal habitats and communities, which represents *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (low value). Hence, the potential effect of sand-scouring and smothering is assessed as negligible.

13.7.83 Benthic surveys within the Disposal Site have recorded the presence of Sabellariidae reef, albeit infrequently, at several locations within the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84), and [RD64]. However, Sabellariidae reef has not been recorded within or adjacent to the area of seabed that is predicted to receive between 1cm and 5cm of sediment deposition as shown in figure D13-44, (Application Reference Number: 6.4.101) and appendix D13-12 (Application Reference Number: 6.4.94).

13.7.84 Acknowledged as an r-strategist (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 [RD312]. The species and associated structures are considered fairly resilient to increased sediment loads, even being able to tolerate smothering for a number of weeks [RD312].

13.7.85 On the MarLIN website, [RD312] also state how it is likely that *S.spinulosa* could tolerate sediment deposition of 5cm or more for several weeks and hence assesses *S.spinulosa* as not sensitive to smothering, increases in turbidity or suspended sediment.

13.7.86 Given the above the magnitude of change is predicted to be negligible on the group receptor subtidal habitats and communities of conservation value which represents Sabellariidae reefs (medium value). Hence, the potential effect of sand-scouring and smothering is assessed as negligible.

Effects on marine fish

13.7.87 Indirectly, the modification of habitat feeding resource and refuge through light sediment deposition may result in some displacement of fish and shellfish. However, as outlined above (paragraphs 13.7.61 to 13.7.63), the dominant habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment is assessed by MarLIN [RD309] as not sensitive to light smothering, with a high resilience to this effect.

13.7.88 Considering that the magnitude of change from light deposition is predicted to be negligible on the dominant habitat (*Flustra* community), it is considered that any effect on fish that utilise this area of seabed would not be noticeable, beyond that which would be experienced within the range of natural variability in the short-term. Light deposition of the dominant habitat, which is considered not sensitive to this physical factor [RD309], is unlikely to result in a detectable indirect effect on fish that utilise the area for foraging.

13.7.89 Given the above, the magnitude of change to all marine fish receptors (including shellfish) from disturbance of subtidal habitats and communities is predicted to be negligible, with no noticeable effects on populations of fish or fisheries. Hence the effect is assessed as negligible on all marine fish receptors.

Impact pathway: physical effects on subtidal habitats and communities from changes to hydrodynamics and bathymetry

General context

13.7.90 It is assumed that the disposal of dredged sedimentary material will be over an area represented by coarse sediments (central area of the Disposal Site) and rock material will be micro-sited in an area characterised by rocky substrata, these locations thus representing a similar substratum type to their respective disposal locations.

13.7.91 The deposit of material on the seabed has the potential to affect hydrodynamics. Within the Disposal Site, particularly at the depths of the target disposal locations, studies have shown that the bed shear stress is

dominated by tidal processes (see chapter D12, Application Reference Number: 6.4.12). Consideration was given to the potential changes that the dredge material (sediment and rock) could elicit on these processes. However, acknowledging that the deposition of the sedimentary material is dominated by a sediment thickness of 5cm or less (paragraph 13.7.46) and the material is mobile, the potential effect on marine receptors from changes to hydrodynamics as a result of sediment deposition is not considered further.

13.7.92 Assuming a bulked volume of 368,000m^3 of rock material is disposed across the entirety of the micro-sited area (paragraph 13.5.80); the seabed will 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 and will result in changes to coastal processes, which may indirectly affect subtidal communities.

13.7.93 Consideration of these changes on coastal processes was specifically addressed through modelling.

13.7.94 As the micro-site location considered for rock disposal is outside the predicted area of influence for the sediment deposition, no interaction between the rock and sediment disposal would be anticipated.

Modelling

13.7.95 A model simulation was used to understand and quantify the potential effects of the rock disposal on hydrodynamics, specifically tidal flow and therefore sediment transport.

13.7.96 This was achieved by reducing model depth locally by 1m, and locally increasing bed roughness to simulate the increased roughness of the disposal area due to the presence of the rock.

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

13.7.98 The outputs showed 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 10% 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 20% velocity deficit is apparent over a larger area, recovering within 150m from the micro-site.

13.7.99 In the context of the existing bed processes in this area these highly localised and small changes are considered minimal. The modelling showed that the changes extend to 150m from the micro-site, and then only during a short window of the tidal cycle on a spring ebb tide. However, over the course of a full tidal cycle (neap to flood) these changes would be realised by considerably smaller reductions in velocity (both in magnitude and extent) than that predicted on a spring ebb tide.

13.7.100 Acknowledging the limited and highly localised changes to the tidal regime, in addition to the unbounded area around the disposed rocks, any changes to sediment transport would be highly localised and not measurable beyond the immediate vicinity of the rock disposal area.

Effects on subtidal habitats and communities

13.7.101 Considering the comparatively small changes to tidal velocity predicted by the modelling, following rock disposal, it is acknowledged that within any given two-week period the changes to current speed would be greatest during the spring ebb and spring flood tide. These changes would extend 150m to the south-west on the spring ebb, and 50m to the north-east on the spring flood.

13.7.102 However, over the majority of the tidal cycle these changes would be experienced over a much smaller extent of the seabed.

13.7.103 The seabed adjacent to the rock disposal site is considered a mix of rocky and stony reef (paragraphs 13.7.48 and 13.7.50) with some coarse sediment. As a worst case it has been assumed that this area represents the Annex I rocky reef with no pathway to effect on subtidal habitats and communities not considered to be of conservation importance. 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 D13-2, Application Reference Number: 6.4.84).

13.7.104 The MarLIN MarESA of these two communities assesses the effect of a change in the water flow. The benchmark criteria for this change described as a change in peak mean spring bed flow velocity of between 0.1m/s and 0.2m/s for more than a year. It is considered that the benchmark criteria are broadly representative of the predicted changes from the modelling study (appendix D13-12, Application Reference Number: 6.4.94). The MarLIN MarESA for both these communities from changes to water flow, at this benchmark criteria, is not sensitive.

13.7.105 As a result, the magnitude of change is predicted to be negligible for the medium value group receptor subtidal habitats and communities of conservation value which encompasses the Annex I reef communities. Hence, the effect from changes to water flow is assessed as negligible.

Impact pathway: changes to marine water quality from proposed dredging sediment disposal (suspended sediment) if coincident with existing maintenance dredging operations

General context

13.7.106 There is one active marine licence to dispose of dredged material at the Disposal Site. This is for Stena Line Ports to dispose of up to 99,000 tonnes per year of maintenance dredged material from Holyhead Port. This material comprises fine silts which would disperse rapidly at the Disposal Site [RD63].

13.7.107 Disposal of maintenance dredgings at the Disposal Site has been ongoing for a number of years [RD67] and are therefore considered part of the baseline. There are no other active disposal licences for this site.

13.7.108 In the unlikely event that the proposed disposal of sediment could overlap with the annual maintenance dredging works, consideration is given to whether there would be any additional change to water quality from cumulative SSCs from both operations that would result in a different effect from that already assessed for the proposed capital dredging disposal (paragraphs 13.7.2 to 13.7.33).

13.7.109 Acknowledging that the annual maintenance dredging of Holyhead Port has been ongoing for many years and dredged sediments are tested on a regular basis and only permitted by NRW for disposal at sea if levels of contamination are acceptable, there would be no impact pathway for changes in water chemistry resulting from release of sediment-bound contaminants with that of the proposed capital dredging disposal. Therefore, changes in water chemistry are not considered beyond that previously assessed (paragraphs 13.7.2 to 13.7.33).

13.7.110 Acknowledging modelling work specific to predicting the increase in SSCs over the duration of the proposed capital dredged sediment disposal only (appendix D13-12, Application Reference Number: 6.4.94); the effects for all relevant marine receptors were assessed as negligible or minor adverse (paragraphs 13.7.2 to 13.7.33).

Modelling

13.7.111 To assess the potential coincidence of the proposed sediment disposal with ongoing maintenance dredging a scenario was modelled based on the proposed release of 1,568m^3 of fines per day, and the release of 15,000m^3 of fines per day (2,500m^3 per release) from the Holyhead Port maintenance dredging operation. The latter simulation was run for 21 consecutive disposal releases, all of which were modelled as occurring within the same timeframe as the proposed capital dredged sediment disposal events i.e. a worst case scenario was assumed.

13.7.112 The cumulative effect from the addition of the proposed sediment disposal was not readily discernible from that of the much larger port releases. Therefore, it is not considered that the proposed disposal of material would result in a readily detectable increase in SSCs from that already generated through baseline disposal operations (appendix D13-12, Application Reference Number: 6.4.94).

Effects on marine receptors

13.7.113 In the unlikely event that both disposal operations would be coincident, given that the increase in SSCs from the proposed sediment disposal would not result in a readily noticeable change from the increase in SSCs predicted for the baseline maintenance dredging disposal, no significant additional effect is predicted (paragraphs 13.7.2 to 13.7.33).

Impact pathway: introduction of non-native species from proposed dredging disposal (Main Construction)

General context

13.7.114 No non-native benthic species have been recorded within or adjacent to the Disposal Site (paragraphs 13.4.48 and 13.4.49).

13.7.115 The most likely pathway for non-native species to be introduced to the Disposal Site is via transport of the dredged materials from the Wylfa Newydd Development Area. Non-native species can also be introduced through biofouling on ships' hulls and in ballast waters during disposal events.

13.7.116 Disposal of materials at a location outside the range of conditions to which non-native species are adapted would reduce the risk of their transfer and establishment. The proximity of the Disposal Site to the source environment of marine non-native species already present in the Wylfa Newydd Development Area (approximately 18km from Porth-y-pistyll) but at a greater depth than that of the species range (more than 50m for the majority of the Disposal Site compared to no more than 7m in Porth-y-pistyll) would reduce the risk of transfer and establishment of non-native species.

Effects on phytoplankton and zooplankton

13.7.117 The phytoplankton and zooplankton communities present at the Disposal Site are considered to be similar to the ones recorded in and around the Wylfa Newydd Development Area during baseline surveys (paragraphs 13.3.40 to 13.3.52). *C.wailesii* and *O.sinensis* recorded from the Wylfa Newydd Development Area are also likely to be present at the Disposal Site, at equally low abundances. Both of these species are widely distributed in coastal waters therefore transfer to the Disposal Site through currents and general water movements is also likely.

13.7.118 Considering the similarities in water quality characteristics between the Disposal Site and Wylfa Newydd Development Area, there are unlikely to be any changes in conditions at the Disposal Site that would further favour the growth and establishment of these non-native diatom species.

13.7.119 By following the guidance and legislation, as detailed in chapter B13 (Application Reference Number: 6.2.13) the introduction and spread of other invasive non-native plankton species through ballast water exchange would be reduced and therefore the probability of transmission is low. Based on the likely presence of non-native plankton species in the area and their wider distribution, the magnitude of change is predicted to be negligible. Therefore, it is considered there would be a negligible effect on phytoplankton and zooplankton from the introduction and spread of INNS.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.120 The non-native benthic species already present within the Wylfa Newydd Development Area include red algae (*A.armata, A.furcellatum* and *D japonica*); a green alga (*C.fragile* sub sp. *tomentosoides*); a brown alga (*S.muticum*); and the barnacle *A.modestus* (see paragraphs 13.3.80 and

13.3.89). All of these species are classified as low or unknown impact for the purposes of WFD assessment (Application Reference Number: 8.26). *S.muticum* is listed as a strategic priority species by the NWWT.

13.7.121 The five non-native algal species listed above require sufficient light for their photosynthetic processes and as such their distribution ranges from the mid-shore to shallow subtidal areas. The deep waters found at the Disposal Site of over 50m would exclude their growth due to light limitation.

13.7.122 The barnacle *A.modestus* is most common from mid-shore to shallow subtidal areas of estuarine and sheltered marine habitats. Again, the deep waters and exposed conditions would inhibit growth of this non-native species at the Disposal Site.

13.7.123 By following the guidance and legislation, as detailed in chapter B13 (Application Reference Number: 6.2.13), the introduction and spread of INNS through ballast water exchange and biofouling would be reduced and therefore the probability of transmission is low. If species already present within the Wylfa Newydd Development Area were to be transmitted to the Disposal Site, it is unlikely they would establish due to lack of suitable habitat. Therefore, based on the potential for transfer and establishment of non-native species, the magnitude of change is predicted to be negligible. Hence, there would be a negligible effect on subtidal habitats and communities (including those of conservation importance) from the introduction and spread of INNS.

Impact pathway: underwater noise from disposal of excavated material

General context

13.7.124 Underwater noise generated during the disposal of excavated rock and soft sediments has the potential to impact upon fish and marine mammals. The following activities associated with dredge disposal are considered as sources of noise and vibration:

- dredge disposal; and
- vessels.

Dredge disposal

13.7.125 For the purposes of this assessment the maximum amount of excavated material requiring disposal would be up to 368,000m^3 of rock and 242,000m^3 of soft material (bulked volumes).

Vessels

13.7.126 There will be an increase in the number of vessels at the Disposal Site and vessel movements between the Wylfa Newydd Development Area and the Disposal Site. The underwater noise assessment has been based on large vessels and has assumed that the vessels are travelling at a speed of approximately 10 knots. It is assumed that two disposal events will occur in each 24-hour period.

13.7.127 The dredging works are predicted to last for a duration of 16 months. There will be a predicted peak of 60 vessels per month for disposal of soft sediments and a peak of 10 vessels per month for disposal of rock.

Modelling

13.7.128 Details of the underwater noise modelling undertaken for the assessment are provided in paragraph 13.6.263 above. For the purpose of assessing the potential impact of underwater noise generated through the disposal of excavated material, model outputs for vessel movements and cutter suction dredging have been used.

13.7.129 Underwater noise generated from the disposal of dredged material 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.

Effects on marine fish

13.7.130 As presented in appendix D13-6 (Application Reference Number: 6.4.88) modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots, which is considered representative of ships travelling to the Disposal Site.

13.7.131 The number of vessels moving between the Wylfa Newydd Development Area and the Disposal Site is small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Therefore, it is highly likely that fish are already habituated to noise generated from vessels.

Table D13-51 Summary of modelled impact ranges for fish with swim bladders involved in hearing for vessel movements

SPL_{RMS}	Large vessels (m)	Medium vessels (m)
Recoverable injury (48h) 170dB re 1µPa (SPL_{RMS})	<1	<1
TTS (12h) 158dB re 1µPa (SPL_{RMS})	4	<1

13.7.132 Modelling has shown that noise levels generated by vessels are low with sound pressure levels of 160dB re 1µPa (SPL_{RMS}) being limited to within 4m for large vessels and 1m for medium vessels (appendix D13-6, Application Reference Number: 6.4.88). The modelled ranges of effect generated by disposal vessels does not have the potential to result in injury to fish, with TTS in fish being limited to within 4m of the vessel itself (Table D13-51).

13.7.133 It is likely that vessel movements would result in temporary localised 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.

13.7.134 It is considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. Therefore, the effect of underwater noise from vessel movements is considered to be negligible for all fish receptors.

Effects on marine mammals

13.7.135 As presented in appendix D13-6 (Application Reference Number: 6.4.88), modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots which is considered representative of ships travelling to the Disposal Site. The Disposal Site is also located in an area of heavier shipping where the vessel density in the wider area is up to 25 vessels per week [RD183]. The number of vessels using the site for disposal would be expected to be in the range of 60 vessels per month.

13.7.136 The impact ranges based on criteria from Nehls *et al*., [RD142] and Lucke *et al*., [RD143] show that PTS and TTS from vessel movements is considered unlikely (table D13-51). The ranges to behavioural effects are limited to within 60m of large vessels and 10m of medium vessels. These ranges are localised to the vessels with at most, localised avoidance. Marine mammals are highly mobile species and baseline results have indicated that their distribution is more concentrated to the east of the Wylfa Newydd Development Area.

13.7.137 The assessment of cutter-suction dredging on cetaceans and pinnipeds is provided in paragraphs 13.6.332 to 13.6.343. The conclusion made there of no potential for injury to cetaceans and pinnipeds and only displacement of a small number of individuals is also relevant here.

13.7.138 The magnitude of effect is considered to be negligible as a result of the localised nature of any effect and the lower abundance in the area. The effect on marine mammals is therefore considered negligible.

Effects on designated sites

13.7.139 As outlined in paragraph 13.7.135, the effect of underwater noise from vessel movements is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Impact pathway: physical injury of marine mammals from vessel strikes

General context

13.7.140 Marine vessels used for the disposal of excavated rock and soft sediments could strike marine mammals, resulting in physical injury (e.g. corkscrew injuries) and, in the worst case, mortality [RD173].

13.7.141 The risk to marine mammals from vessel strikes and their response is discussed above in paragraphs 13.6.467 to 13.6.471.

Effects on marine mammals from vessel strikes

13.7.142 The number of vessels moving between the Wylfa Newydd Development Area and the Disposal Site are small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Marine mammals have been recorded in low abundance around the Disposal Site with the highest

densities observed to the east of the Wylfa Newydd Development Area. The risk of vessel strikes from marine plant and vessels transiting to and from the Disposal Site is therefore considered to be of negligible magnitude and therefore negligible effect.

Effects on designated sites due to the physical injury of marine mammals from vessel strikes

13.7.143 As outlined in paragraph 13.7.142, the effect on marine mammals from vessel strikes is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Operation

Impact pathway: changes to marine water quality from proposed maintenance dredging disposal (suspended sediment and release of contaminants) during operation of the MOLF and of the Power Station

General context

13.7.144 During the operational phase of the Power Station, and the operational phase of the MOLF there will be a limited requirement for removal of fine sediment to maintain sufficient depth in front of the Cooling Water intake and to allow continued access to the MOLF.

13.7.145 Following consideration of sediment transport mechanisms in this region and the nature of the substrata, the requirement for maintenance dredging would be minimal.

13.7.146 The volume of the material required to be removed would be considerably lower than that for the capital dredging work, possibly representing an order of magnitude less.

13.7.147 The dredged material will be predominantly fines, these being highly dispersive in nature.

Effects on marine receptors

Changes to SSCs

13.7.148 The Disposal Site (IS043) is licensed as a dispersive site, regularly receiving maintenance disposals from Holyhead Port. It is considered that the infrequent maintenance dredging disposals required during operation of the MOLF and the Power Station would represent smaller volumes than are required for Holyhead Port.

13.7.149 The volume of the maintenance disposal will also be considerably less than that assessed for the capital dredging works (242,000m^3 of bulked sediment) and will therefore be shorter in duration. Moreover, unlike the capital dredgings, which will comprise a large proportion of coarse sediment, the maintenance dredgings will be predominantly dispersive.

13.7.150 From consideration of the above and acknowledging the dispersive nature of the Disposal Site, it is predicted that the magnitude of change on all receptors previously assessed (paragraphs 13.7.2 to 13.7.33) would be the same or, more likely, less.

13.7.151 Consequently, the effects on all marine receptors from changes to SSCs would be negligible with the exception of coastal water, which is minor adverse. Although the magnitude of change from maintenance disposal is predicted to be less on coastal water than assessed for capital dredging disposal, a conservative approach has been taken and the same effect is assessed.

Changes in water chemistry

13.7.152 It is anticipated that maintenance dredging during the operations of the MOLF and the Power Station would take place between three and five years after the capital dredging programme.

13.7.153 Prior to capital dredging, analyses of sediment chemistry adjacent to the Wylfa Newydd Development Area recorded relatively few exceedances of Cefas Action Level 1 (see paragraph 13.7.12).

13.7.154 Following excavation of this material by capital dredging, there would be a three-year to five-year period before maintenance dredging is required. Therefore, the risk of a significant build-up of contaminants within the approach channel sediments during this time, or the time between subsequent maintenance dredging operations, is highly unlikely.

13.7.155 From consideration of the above and acknowledging the dispersive nature of the Disposal Site it is predicted that the magnitude of change on all receptors would be negligible, as previously assessed for capital dredging (paragraphs 13.7.2 to 13.7.33). Consequently, the effects on all marine receptors from changes in water chemistry would be negligible.

Summary of effects on marine receptors

13.7.156 The effects on all marine receptors from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to all marine receptors is negligible.

Impact pathway: introduction of non-native species from disposal events during operation of the Power Station

General context

13.7.157 The details regarding the context to the introduction of non-native species is provided in paragraphs 13.7.114 to 13.7.116.

13.7.158 It is acknowledged that the requirement for disposal during the operation phase will be considerably less than during construction (paragraph 13.5.110). It is also considered that environmental conditions within the area encompassed by the proposed harbour will have changed.

Effects on phytoplankton and zooplankton

13.7.159 Following from the considerations made in paragraphs 13.7.117 to 13.7.119, acknowledgment is also given to the reduced volume of the sediment disposal programme compared to the construction phase.

13.7.160 It is recognised that post-construction, changes in the environment within the dredged area may provide suitable habitat for establishment of non-native species; however, with adherence to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and section 13.5, and in consideration of the low level of requirement for maintenance disposal the potential effect on phytoplankton and zooplankton remains as assessed in the construction phase (paragraph 13.7.119) i.e. the effect is negligible.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.161 With consideration of paragraphs 13.7.120 to 13.7.123 and also paragraph 13.7.160, the potential effect on subtidal habitats remains as assessed in the construction phase (paragraph 13.7.123) i.e. the effect is negligible.

Decommissioning

13.7.162 See paragraph 13.6.836. At this time there is no requirement for marine disposal activities as a result of the decommissioning phase.

Transboundary effects

13.7.163 During the planning process a recommendation was made in the scoping opinion that "…consideration should be given in the Environmental Statement to any likely significant effects on the environment of another Member State of the European Economic Area. In particular, the [IPC] recommends consideration should be given to discharges to the air and sea and to potential impacts on migratory species. This is particularly relevant in terms of the likely impacts on the Irish Sea."

13.7.164 With respect to the marine environment, the pathway for transboundary effects would be through potential effects to the following receptors:

- marine mammals (cetaceans and pinnipeds);
- European eel, river lamprey, Atlantic salmon;
- fish of commercial importance; and
- seabirds.

Marine mammals

13.7.165 Marine mammals are very mobile with large home ranges and can travel large distances for feeding and foraging. Owing to the mobility of marine mammals it is possible that individuals associated with populations from international waters could potentially be affected by the construction, operation and decommissioning of the Wylfa Newydd Project.

13.7.166 Effects from construction have largely been assessed as negligible with localised effects from loss of food resource, habitat and airborne noise disturbance. There is the potential for minor adverse effects from underwater noise generated through marine construction. These effects will likely result in temporary displacement of species from the immediate vicinity of the works therefore it is not considered that these have the potential to result in significant transboundary effects on other EEA states.

European eel, river lamprey, Atlantic salmon

13.7.167 European eel, river lamprey and Atlantic salmon are migratory fish that move between the freshwater and marine environment as part of their life-cycles. The construction and operation of the Power Station poses potential risks to migratory life stages of these species. European eel, river lamprey, Atlantic salmon and sea trout are common to European waters and effects on individuals could potentially affect wider populations.

13.7.168 The numbers of European eel, river lamprey, Atlantic salmon and sea trout that are expected to be impinged annually at the Power Station during the operational phase are very low and impingement effects have been assessed as negligible. Entrainment would present a risk only to the glass eel stages of European eel (owing to this life stage being present in coastal waters), although again the magnitude of any effect is expected to be negligible. Further operational effects such as from thermal and TRO inputs are all assessed as negligible to fish. As a result, it is considered that there is no potential to result in significant transboundary effects on other European Economic Area (EEA) states.

Fish of commercial importance

13.7.169 Some marine fish species undertake migrations from deep water offshore to shallow waters near shore with the migrations being both species-specific and seasonally dependent. The construction and operation of the Power Station poses potential risks to fish of commercial importance.

13.7.170 Embedded and good practice mitigation would reduce any construction effects on these species, e.g. from noise and visual disturbance during construction, placement of temporary structures and habitat loss, to negligible.

13.7.171 The numbers of individuals of commercial species that are expected to be impinged and entrained annually at the Power Station during the operational phase have been assessed in terms of their adult equivalents and are not expected to have a detectable effect on wider populations of fish or marine birds and mammals. Furthermore, they constitute a very small fraction (<0.1%) of commercial landings in the Irish Sea. Subsequently the operational effects of entrapment on commercial fish species have been assessed as negligible. Further operational effects such as from thermal and TRO inputs are all assessed as negligible to fish. As a result, there are not expected to be any significant transboundary effects on other EEA states.

Seabirds

13.7.172 Elements of the Wylfa Newydd Project have the potential to cause disturbance to seabirds through direct effects such as airborne noise. Some seabird species are designated under EU legislation and undertake international migrations (e.g. terns), and therefore effects on seabirds as a result of the Wylfa Newydd Project could have wider implications for populations.

13.7.173 During the construction and operation of the Power Station, there are predicted to be negligible effects to breeding seabirds through the loss of habitat, physical disturbance, loss of food resource or disturbance from changes in airborne noise or visual stimuli. The majority of seabird species recorded in Porth-y-pistyll during winter use the bay for roosting and loafing due to the sheltered location and protection. Although some individuals are likely to be displaced from Porth-y-pistyll, many would become habituated to the disturbance. Furthermore, extensive similar habitats exist along the north coast of Anglesey and it is considered likely that adequate resource is available for any displaced individuals. It is therefore considered that with mitigation in place, there are not expected to be any significant transboundary effects on other EEA states.

13.8 Additional mitigation

13.8.1 In accordance with chapter B1 (introduction to the assessment process) (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to the marine environment were taken into account when determining the ‘pre-mitigation’ significance of effects. These are detailed in the design basis and activities section of this chapter.

13.8.2 Additional mitigation measures would be implemented to address potential significant effects and some of the minor effects identified in the assessment of effects section.

Construction

13.8.3 Additional mitigation measures for construction are summarised in table D13-52. Further information is provided below.

Wylfa Newydd Development Area

13.8.4 Two significant adverse effects were identified in the Wylfa Newydd Development Area from the assessment of the construction phase which includes embedded and good practice mitigation; both comprised a potentially moderate adverse effect.

13.8.5 The first significant effect related to the introduction and spread of INNS and the potential effect on subtidal and intertidal habitats of conservation importance and invertebrates of conservation and commercial importance.

13.8.6 Good practice mitigation for the production of a biosecurity risk assessment and method statement is presented in paragraph 13.5.92. As additional mitigation a monitoring programme for non-native species would be implemented (as outlined in the Marine Works sub-CoCP, Application

Reference Number 8.8) to include observational surveys on structures that may provide substrate for non-native species. Surveys would record presence/abundance of non-native species with reporting in agreement with NRW. An initial pre-construction survey would be undertaken and regular surveys would begin once construction of the breakwaters and MOLF is completed. The frequency and extent of monitoring would reduce over time, particularly once the MOLF is no longer operational. The ongoing requirement for monitoring would be regularly reviewed and agreed with NRW.

13.8.7 This additional mitigation is likely to significantly increase the probability of detecting the introduction and/or spread of non-native species which has potentially occurred as a result of construction, allowing time and opportunity for additional action to be taken if necessary. This additional mitigation is considered to reduce the magnitude of change from medium to small and therefore the significance of effect on subtidal and intertidal habitats and communities (including those of conservation importance) and invertebrates (of conservation and commercial importance), from the introduction and spread of non-native species would be reduced from moderate to minor adverse.

13.8.8 The second significant effect relates to the direct loss of subtidal and intertidal habitats of conservation importance under the footprint of the Marine Works. Embedded mitigation has been considered through the presence of the breakwater structures potentially having the capacity to function as an artificial rocky reef (paragraph 13.5.83). As additional mitigation (stated in the Marine works sub-CoCP), it is proposed that marine ecological enhancement measures will also be provided in suitable locations by engineering design and functionality, to include pre-cast ecological units (e.g. features similar to bio-blocks) and modification of the permanent artificial structures (e.g. construction material, surface roughness or the addition of surface features). The purpose of marine ecological enhancement measures would be to increase surface and structural heterogeneity, encouraging the colonisation by native marine species and the establishment of diverse and productive intertidal and subtidal habitats within the footprint of the Marine Works.

13.8.9 Horizon will implement a monitoring programme (as stated in the Wylfa Newydd CoOP, Application Reference Number: 8.13) for the marine ecological enhancement measures and permanent structures, developed in consultation with NRW. The aim will be to determine the success of habitat enhancement by monitoring the colonisation of new structures, allowing adaptive management. The monitoring data will be used to inform the decision to implement further ecological enhancement if necessary.

13.8.10 The details relating to marine ecological enhancement have been developed in consultation with NRW. With inclusion of this additional mitigation, the magnitude of change would be reduced to small and the significance of effect on subtidal and intertidal habitats of conservation importance from direct loss under the footprint of the Marine Works would be reduced from moderate to minor adverse.

13.8.11 A number of minor adverse effects to marine receptors in the Wylfa Newydd Development Area were identified during the assessment of the construction phase. Whilst these are not significant effects, additional mitigation relevant to some of these effects has been proposed.

13.8.12 Initial dewatering inside the cofferdams during the construction phase would potentially result in the direct mortality of marine fish drawn into the dewatering pumps; this has been assessed as a minor adverse effect on all fish receptors.

13.8.13 As additional mitigation (as set out in the Marine Works sub-CoCP, Application Reference Number: 8.8), 'fish-friendly' pumps would be used for dewatering. Eel and Fish Transfer Pumps are used by contractors who have to dewater assets/structures that might contain eels or live fish. The purpose is to transfer/ pump fish into other waters without causing damage to the fish.

13.8.14 Use of fish-friendly pumps is likely to significantly reduce direct loss (i.e. mortality) of marine fish (and possibly other marine organisms) enclosed inside the cofferdams. The magnitude of change and significance of effect on European eel and river lamprey from dewatering would therefore be reduced from small and minor adverse, respectively to negligible.

13.8.15 Airborne noise and vibrations generated from blasting activities has been assessed as having a potentially minor adverse effect on the tern colony in Cemlyn Lagoon. Additional mitigation is set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) and is shown below.

13.8.16 As additional mitigation, between 15 April and 15 August, Horizon would commit to undertake regular monitoring of terns throughout the nesting period. If the colony exhibits fly-up disturbance reactions [to be quantified] as a direct result of attributable noise events or shows a measurable increase in the incidence of disturbance events above those recorded during baseline observation works, then alternative methods of working or additional constraint would be applied. Details of the monitoring and controls are detailed in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and in the Marine Works sub-CoCP (Application Reference Number: 8.8).

13.8.17 As additional mitigation, in order to allow for additional sensitivities of terns arriving and establishing their nesting colony, additional construction controls would be applied during the 'establishment period', for the remaining period of the tern nesting season post establishment and in all subsequent tern nesting seasons. The details of these construction controls are provided in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and in the Marine Works sub-CoCP (Application Reference Number: 8.8).

13.8.18 Considering the dynamic nature of this approach, the magnitude of the effects on the terns in Cemlyn Lagoon from airborne noise and vibrations due to blasting would be reduced to small. This additional mitigation would therefore reduce the effect on the terns in Cemlyn Lagoon to negligible.

13.8.19 Underwater noise has been assessed as being not significant for marine mammals and fish, however in undertaking piling activities, best practice will be followed including Joint Nature Conservation Committee, 2010, Statutory

nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (as stated in the Marine Works sub-CoCP, Application Reference Number: 8.8).

Disposal Site

13.8.20 No significant effects at the Disposal Site have been identified from the assessment of the construction phase and therefore no additional mitigation is proposed.

Table D13-52 Mitigation during the construction phase relevant to the marine environment

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
Implementation of a monitoring programme for non-native species.	To record the introduction and spread of non-native species to allow an opportunity to take corrective action if necessary.	Monitoring of new substrate. Record presence/abundance of non-native species. Reporting in agreement with NRW.
Provision of marine ecological habitat enhancements in suitable locations, to include ecological units.	To enhance the development of biodiversity and biomass on artificial structures.	The assessment criteria have been developed in agreement with NRW.
Use of fish-friendly pumps for dewatering	To reduce loss and damage to fish during dewatering activities.	The assessment criteria would be to reduce fish mortality as far as practicable.
Between 15 April and 15 August, Horizon would commit to undertake regular monitoring of terns throughout the nesting period. If the colony exhibits fly-up disturbance reactions [to be quantified] as a direct result of attributable noise events or shows a measurable increase in the incidence of disturbance events above those recorded during baseline observation works, then alternative methods of working or additional constraint would be applied.	To reduce disturbance on the terns in Cemlyn Lagoon from airborne noise and vibrations due to blasting.	Only undertaking blasting that conforms with model predictions. Appointing of qualified observers for the tern colony.

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
In order to allow for additional sensitivities of terns arriving and establishing their nesting colony, additional construction controls would be applied during the 'establishment period', for the remaining period of the tern nesting season post establishment and in all subsequent tern nesting seasons.	To reduce disturbance on the nesting terns in Cemlyn Lagoon from construction plant.	Establishment of buffer zones during the nest establishment season.

Operation

13.8.21 Additional mitigation measures for the operational phase are summarised in table D13-53. Further information is provided below.

Wylfa Newydd Development Area

13.8.22 No significant effects in the Wylfa Newydd Development Area have been identified from the assessment of the operation phase however; a number of minor adverse effects to marine receptors were identified. Whilst these are not significant effects, additional mitigation relevant to some of these effects have been proposed.

13.8.23 Impingement within the Cooling Water intake system is assessed as having a potentially minor adverse effect on river lamprey, European eel and Atlantic salmon. This assessment is primarily driven by the high value of these receptors, although the magnitude of impingement is predicted to be small. In addition, entrainment within the CWS may also have a minor adverse effect on ichthyoplankton of conservation and commercial importance.

13.8.24 No additional mitigation has been identified to directly reduce the effects of entrapment (impingement and entrainment), although as a form of additional mitigation, (as stated in the Wylfa Newydd CoOP, Application Reference Number: 8.13) Horizon will implement a monitoring programme for entrapment (impingement and entrainment) associated with the cooling water intake system. This will assess the effectiveness of fish protection measures embedded in the system during the operation of the Power Station, through a programme agreed with NRW, and enable any improvements to mitigation measures to be made where necessary. This additional mitigation is not considered to reduce the magnitude of change or significance of effect on river lamprey, European eel and Atlantic salmon however; further mitigating actions can be considered, in consultation with NRW, should monitoring identify potential issues.

Disposal Site

13.8.25 No significant effects at the Disposal Site have been identified from the assessment of the operation phase and therefore no additional mitigation is proposed.

Table D13-53 Mitigation during the operational phase relevant to the marine environment

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
Implementation of an entrapment monitoring programme	To monitor fish protection measures.	Monitoring and reporting in agreement with NRW.

Decommissioning

13.8.26 No additional mitigation is proposed for marine environment receptors during decommissioning. Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment which would assess in detail the effects against the baseline conditions at that time.

13.9 Residual effects

13.9.1 This section describes the residual effects on the marine environment having taken into account the embedded, good practice and additional mitigation described above. Table D13-54 provides a summary of significant residual effects identified either prior to or post application of additional mitigation for the construction phase.

13.9.2 No significant adverse effects were identified for the operational and decommissioning phases.

13.9.3 Additional minor residual effects identified in the assessment of effects section are summarised in appendix I3-1 (master residual effects table) (Application Reference Number: 6.9.8).

13.9.4 Combined topic effects (also known as intra-development effects), occur when a single receptor is affected by more than one way by the same development. These has been assessed within chapter D16 (combined topic effects) (Application Reference Number: 6.4.16). Intra-project (resulting from the various developments that comprise the Wylfa Newydd Development Project) and inter-project (resulting from the Wylfa Newydd Project together with external projects) effects have been assessed within volume I of the Environmental Statement.

Table D13-54 Summary of residual effects at the Wylfa Newydd Development Area during construction

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect(s)	Nature of effect(s)	Magnitude of change	Significance of potential effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effects
Subtidal and intertidal habitats of conservation importance	Medium	Direct loss of habitat under the footprint of the Marine Works.	Adverse Local Permanent Long-term	Medium	Moderate adverse	Provision of marine ecological habitat enhancements in suitable locations, to include ecological units.	Small	Minor adverse
		The risks posed by the introduction of non-native species (outcompeting native species).	Adverse Regional Permanent Long-term	Medium	Moderate adverse	Implementation of a monitoring programme for non-native species.	Small	Minor adverse
Invertebrates (of conservation and/or commercial importance)	Medium	The risks posed by the introduction of non-native species (outcompeting native species).	Adverse Regional Permanent Long-term	Medium	Moderate adverse	Implementation of a monitoring programme for non-native species.	Small	Minor adverse

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13.10 References

Table D13-55 Schedule of references

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RD15	Hiscock, K. (ed.). 1996. *Marine Nature Conservation Review: rationale and methods. Coasts and seas of the United Kingdom. MNCR series.* Peterborough: JNCC.
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HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.14 ES Volume D - WNDA Development D14 - Radiological effects

PINS Reference Number: EN010007

Application Reference Number: 6.4.14

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00046

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Contents

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14 Radiological effects

14.1 Introduction

14.1.1 This chapter describes the assessment of potential radiological effects resulting from the construction, operation and decommissioning of the Power Station.

14.1.2 Please refer to chapter B14 (radiological effects) (Application Reference Number: 6.2.14) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the radiological effects assessment; and assessment methodologies and criteria.

14.1.3 The *National Policy Statement for Nuclear Power Generation (EN-6)* [RD1] recognises that "*The UK has robust legislative and regulatory systems in place for the management (including interim storage, disposal and transport) of all forms of radioactive waste that will be produced by new nuclear power stations*".

14.1.4 Much of the information presented here is taken from the permit submission made as part of the application under the Environmental Permitting (Radioactive Substances Regulation) (EP-RSR). It is not the intention in this chapter to replicate that work entirely, but sufficient information has been presented to enable the assessment to be meaningfully described as part of this Environmental Statement. More detailed information is available within the EP-RSR submission [RD2]. Many of the assumptions made in this assessment are those used in the EP-RSR and are referenced accordingly.

14.1.5 The management of radioactive wastes at the Power Station during operation and decommissioning is described in appendix D14-1 (radioactive waste) (Application Reference Number: 6.4.97).

14.1.6 The assessment of effects from potential accidental release scenarios is described in appendix D14-2 (analysis of accidental releases) (Application Reference Number: 6.4.98). All of the scenarios are assessed as having negligible environmental impact using the methodology described in the appendix, even the identified severe accident scenario.

14.2 Study area

14.2.1 This section describes the study area(s) relevant to this radiological effects assessment.

14.2.2 The approach used to define the study area for radiological effects is different to other technical sections. This is because doses to exposure groups are defined by habit data, which may not always be associated with specific geographic locations. In addition, collective doses are evaluated as population doses from exposures in large geographic areas: the UK, Europe and the world (see chapter B14, Application Reference Number: 6.2.14, and paragraph 14.2.44). Because of this, this section describes the habit data and modelling assumptions used to define exposure via these pathways:

- radiation exposures to individuals and populations arising from authorised gaseous and aqueous discharges of radioactivity;
- radiation exposures arising from direct irradiation from the turbine buildings and from the storage of radioactive wastes and spent fuel in engineered facilities on the Power Station Site (doses from other sources have been found to be negligible, see [RD2]);
- radiation exposures arising from transport of radioactive materials to and from the Power Station Site; and
- radiation exposures to non-human species arising from the authorised discharge of radioactivity to air and the marine environment.

14.2.3 The basis of assessing the potential effects arising from exposure to radiological discharges is the identification of groups of individuals and non-human species whose behaviour and habits are likely to mean they would receive the highest individual radiological doses.

14.2.4 The study area for human and non-human species is defined by a combination of the locations with the highest predicted concentrations of radioactivity in environmental media and foodstuffs, combined with the habits and consumption rates of those groups.

14.2.5 As it is not practicable to assess doses to each individual member of the public, the 'most exposed individual' and 'Representative Person(s)' approach [RD3] was used where:

- the most exposed individual is the person receiving the highest dose from a single discharge pathway, for example an individual who receives a dose from aqueous discharges only or an individual who receives a dose from gaseous discharges only; and
- the Representative Person is an individual receiving a dose that is representative of the more highly exposed individuals in the population due to both aqueous and gaseous discharges and also direct radiation.

Assessment of doses to humans from discharges

14.2.6 Radiation effects due to radioactive discharges into the environment may result in the exposure of members of the public from a number of pathways. Doses are calculated to three age groups; infant (one year old), child (10 years old) and adult (18 years old or greater). Doses to the foetus are also considered.

14.2.7 Assessments are required for the impacts of discharges of gaseous and aqueous radioactive emissions. Computer modelling is used to predict the dispersion of discharged radioactivity in the environment and the resulting concentrations of radioactivity in environmental media and foodstuffs. PC-CREAM 08® [RD4] enables the assessment of individual and collective doses due to gaseous and aqueous discharges via:

- inhalation of material in the plume;
- external irradiation from material in the plume;

- external irradiation from ground-deposited material and absorbed on sediments;
- inhalation of re-suspended material including sea spray; and
- ingestion of contaminated foodstuffs grown or reared locally.

14.2.8 An assessment was made of doses to representative members of the public to enable identification of the Representative Person in the vicinity of the Power Station resulting from the following radioactive discharges, with all assumed to occur continuously:

- gaseous discharges from the Unit 1 and Unit 2 reactor building stacks at the proposed annual discharge limits (see table D14-15); and
- aqueous discharges from the main cooling water outfall, also at the proposed annual discharge limits (table D14-16).

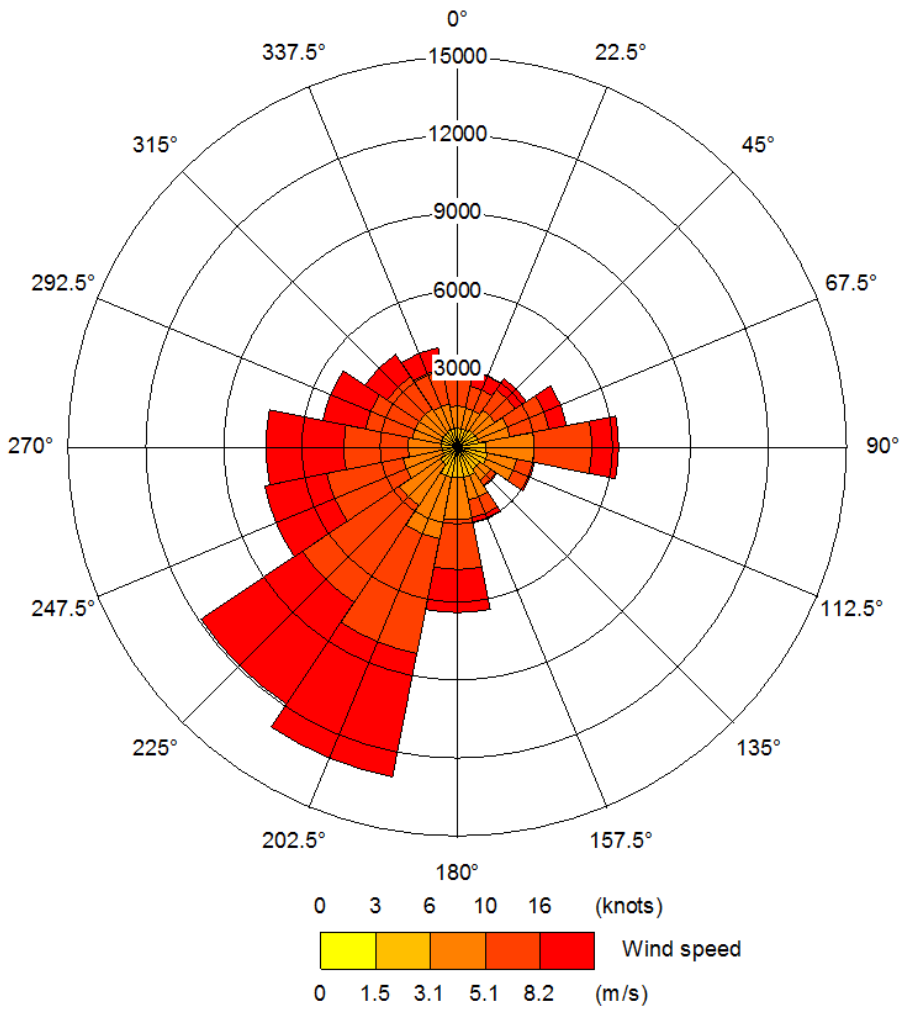
Model parameters

14.2.9 The following data inputs relate to this radiological assessment undertaken with PC-CREAM 08®.

Site-specific meteorological data

14.2.10 Ten years of site-specific weather data (2007-2016) based on the Numerical Weather Prediction model were procured from the UK Meteorological Office. The weather data files were formatted into PC-CREAM 08® compatible files, and used for the atmospheric dispersion model for gaseous discharges. The associated windrose is shown in figure D14-1. The yellow, orange and red shaded areas on the windrose indicate the prevailing direction of the wind (predominantly from the south-west).

Figure D14-1 Windrose for the Power Station Site (2007-2016 average)



Surface roughness

14.2.11 A surface roughness of 0.3 was used in the radiological assessment for gaseous releases. The factor of 0.3 is representative of agricultural land, which is the dominant land use of the areas surrounding the Power Station Site.

Ground deposition and resuspension rates

14.2.12 Default PC-CREAM 08® ground deposition factors and resuspension rates were used in the assessments.

Model parameters defining the marine environment

14.2.13 The model calculates the dispersion of material between different regions of the marine environment, with defined volumes and flows, which are conventionally called “Compartments”. A variety of parameters were used to specify the marine environment. Some, such as the local compartment coastline length, sediment density and diffusion rate, were PC-CREAM 08®

default values. Others, such as the local compartment volume, depth and volumetric exchange rate, were user-specified, based upon values recommended by the Environment Agency [RD5]. Parameters defining the marine environment considered for the dispersion of aqueous discharges are outlined in table D14-1.

Table D14-1 Model parameters for the marine environment

Parameter	Value used for assessment	Origin
Regional compartment	Irish Sea West	PC-CREAM 08® default
Local compartment volume (m^3)	2.7E+09	Parameters for Cemaes coast [RD5].
Local compartment depth (m)	2.7E+01	Parameters for Cemaes coast [RD5].
Local compartment coastline length (m)	1.0E+04	PC-CREAM 08® default
Local compartment volumetric exchange rate (m^3/y)	3.2E+10	Parameters for Cemaes coast [RD5].
Local compartment suspended sediment load (t/m^3)	4.9E-06	Parameters for Cemaes coast [RD5].
Local compartment sedimentation rate (t/m^2/y)	1.0E-04	Parameters for Cemaes coast [RD5].
Local compartment sediment density (t/m^3)	2.6E+00	PC-CREAM 08® default
Local compartment diffusion rate (m^2/y)	3.15E-02	PC-CREAM 08® default

14.2.14 In addition, PC-CREAM 08® recommends specific values to be used for coastal sediment distribution coefficients (Kd, which describe the affinity of sediment material to bind each element) for all Irish Sea compartments for cobalt, ruthenium, caesium and americium. These values are presented in table D14-2. For other elements, the PC-CREAM 08® default values are used.

Table D14-2 Non-default element specific coastal sediment distribution coefficients

Parameter	Coastal Kd (Bq/t per Bq/m^3)
Cobalt	2.5E+03
Ruthenium	7.1E+02
Caesium	2.3E+02
Americium	1.0E+05

Habits data and assumptions

14.2.15 A number of assumptions were made in order to ensure that predicted doses are bounding (i.e. are unlikely to be greater than those presented). These assumptions are described below.

14.2.16 The Centre for Environment, Fisheries and Aquaculture Science (Cefas) has performed three recent habits surveys for the Existing Power Station (referred to as Wylfa in the Cefas reports) ([RD6], [RD7], [RD8]). These cover the areas that are most likely to be impacted by discharges to the marine environment, discharges to air and from direct radiation emanating from the Existing Power Station. The Power Station Site is situated immediately adjacent to the Existing Power Station site, and so the habits data presented in the Cefas habits survey reports for the Existing Power Station are considered to be directly applicable to the Power Station.

Most exposed members of the public for gaseous discharges

14.2.17 The most exposed members of the public for gaseous discharges were assumed to be a farming family who live at a nearby dwelling and consume 100% locally produced terrestrial food. The dwelling is assumed to be located at the receptor point which corresponds to the most restrictive residential location (i.e. the location with the highest deposition rate). Adults, children and infants are assumed to spend some time outdoors.

14.2.18 Adult ingestion rates are based on the two foodstuffs with the highest consumption rates (root vegetables and milk) being consumed at 97.5th percentile rates. Other foods are assumed to be consumed at mean rates. Consumption rates for children and infants were derived from the adult values using Cefas scaling factors in Annex 4 of the habits survey [RD6].

14.2.19 Cefas habit data extend to a radius of 5km from the Existing Power Station. Following a review of the data from the last three habits surveys, consumption of milk products made from locally produced milk was not identified and so was not considered in this assessment. Grain was also not considered as only one of the three Cefas surveys identified a farmer who sold barley nationally for human consumption. Grain produced for human consumption is normally mixed with other grain obtained over a wide geographical area before processing and distribution, and therefore it is unlikely that an individual or group of individuals would consume grain produced by a single producer.

14.2.20 Products from pigs and poultry were not included due to these livestock normally being supplied with feed from a number of sources, most of which would be located at some distance from the Power Station Site [RD9]. Cow's milk, beef and sheep meat were all assumed to be produced at a local farm location whilst green vegetables, root vegetables and fruit were assumed to be grown in a garden or allotment adjacent to the residential location.

14.2.21 Occupancy was taken as the highest occupancy of residency recorded in the last three habit surveys. The fraction of time spent outdoors was taken to be 50% for adults, 20% for children and 10% for infants [RD2]. Inhalation rates

for the farming family were derived from data published by the National Radiological Protection Board (NRPB) [RD10].

14.2.22 While indoors, there is some shielding of external dose by building materials. The resulting reduction in external dose from material in the plume or deposited on the ground is shown as the cloud shine or ground shine factor respectively in the following tables.

14.2.23 The habit data and other assessment parameters used to estimate the radiological dose to the farming family are summarised in table D14-3.

Table D14-3 Assessment parameters for the farming family (gaseous discharges)

Parameter	Adult	Child	Infant
Cow's milk* (kg/y)	193.1	193.1	257.4
Root vegetables* (kg/y)	172.4	110.5	54.9
Green vegetables (kg/y)	47.4	22.2	10.1
Fruit and wild food** (kg/y)	34.2	21.7	13.8
Beef (kg/y)	31.5	21.0	7.0
Sheep meat (kg/y)	12.2	4.9	1.5
Occupancy (hr/y)	8,656	8,656	8,656
Fraction of time indoors (-)	0.5	0.8	0.9
Cloud shine factor (-)	0.2	0.2	0.2
Ground shine factor (-)	0.1	0.1	0.1
Inhalation rates (m^3/hr)	1.12	0.64	0.22

* Top two foodstuffs, 97.5th percentile consumption rates

** The values presented for fruit are the sum of the consumption rates of domestic fruit and wild/free foods, which is comprised of blackberries, sloes, crab apples and damsons.

Most exposed members of the public for aqueous discharges

14.2.24 The most exposed members of the public for aqueous discharges were assumed to be a fishing family who consume seafood at the highest critical rates [RD2]. The adults go fishing near to the coast and the children and infants spend time playing on the beach. All ingestion rates and occupancies were assumed to be at the 97.5th percentile, using the median value of the 97.5th percentile values from the three Cefas reports ([RD6], [RD7] and [RD8]).

14.2.25 For marine foodstuffs, 100% of crustaceans and molluscs were assumed to be caught in the local marine waters adjacent to the Power Station Site, whereas 50% of the fish consumed were assumed to be caught in the local compartment with the remaining 50% caught from regional waters further offshore from the coast of north Wales [RD2]. Consumption of seaweed was not considered as no observations of seaweed consumption were reported [RD6].

14.2.26 The activities that were assumed to be carried out in intertidal areas are boat maintenance, dog walking, beach warden and nature reserve duties, walking and angling [RD2]. For the purposes of the assessment, the combination of these activities undertaken on sand, sand and stone, and mud and sand, was utilised to establish the number of hours spent per year in the intertidal zone and the median of the 97.5th percentile values was used. As the activities are located in the intertidal zone, they have been conservatively assumed to occur at a distance of 1m from the sea and so lead to exposure to sea spray.

14.2.27 Adult members of the fishing family were considered to handle fishing gear in the intertidal area in addition to the time spent on the beach.

14.2.28 The habit data used to estimate the radiological dose to the fishing family are summarised in table D14-4. Inhalation rates are derived from NRPB data [RD10].

Table D14-4 Habit data for the fishing family (aqueous discharges)

Parameter	Adult	Child	Infant
Fish (kg/y)	35.4	7.1	1.8
Crustaceans (kg/y)	9.9	2.5	0.5
Molluscs (kg/y)	4.5	1.1	0.2
Intertidal activities (hr/y)	1,207	604	36
Handling fishing gear, catch and sediment (hr/y)	1,679	20	0
Inhalation rates (m^3/hr)	1.69	0.64	0.22

Candidates for the Representative Person from exposure to gaseous and aqueous discharges

14.2.29 In order to determine the exposure of the candidates for the Representative Person (CRPs) from both aqueous and gaseous discharges, three cases were considered:

- the most exposed member of the public for gaseous discharges (the farming family) also consumes locally sourced seafood at mean rates, and spends time at a local beach;
- the most exposed member of the public for aqueous discharges (the fishing family) also consumes locally produced terrestrial foodstuffs at mean rates, and lives in close proximity to the Power Station Site; and
- a worker at the Existing Power Station.

14.2.30 CRPs were selected on the basis of regulatory guidance [RD3]. Section 6.6 of the guidance advocates the determination of CRPs from consideration of realistic combinations of habits and a full range of exposure pathways; and suggests that habit survey reports are a basis for such determination.

14.2.31 A dose contribution from the direct radiation pathway is also included in the final assessment total, as calculated by the methods described in paragraphs 14.2.47 to 14.2.53.

Farming family

14.2.32 In the case of the farming family the following combined exposure pathways were assessed:

- external exposure to beach sediments;
- inhalation of sea spray when on the coast;
- consumption of sea fish, crustaceans and molluscs caught locally;
- internal irradiation from inhalation of radionuclides in the plume and re-suspended following deposition;
- external irradiation from radionuclides in the plume;
- external irradiation from radionuclides deposited on the ground;
- consumption of contaminated terrestrial foodstuffs following deposition on the ground; and
- direct radiation from Power station buildings.

14.2.33 The consumption rates of seafood were assumed to be at mean rates, using the median of the mean values from the last three Cefas reports. It was, however, assumed that the farming family would spend the same amount of time in a year in the intertidal zone as the fishing family, and so the median of the 97.5th percentile values have each been used for intertidal occupancy [RD2]. The habit data used to estimate the radiological impact to the farming family CRPs are provided in table D14-5.

Table D14-5 Farming family habit data (gaseous and aqueous discharges)

Parameter	Adult	Child	Infant
Gaseous discharge exposure			
Cow's milk* (kg/y)	193.1	193.1	257.4
Root vegetables* (kg/y)	172.4	110.5	54.9
Green vegetables (kg/y)	47.4	22.2	10.1
Fruit and wild food** (kg/y)	34.2	21.7	13.8
Beef (kg/y)	31.5	21.0	7.0
Sheep meat (kg/y)	12.2	4.9	1.5
Occupancy (hr/y)	8,656	8,656	8,656
Fraction of time indoors	0.5	0.8	0.9
Cloud shine factor (-)	0.2	0.2	0.2
Ground shine factor (-)	0.1	0.1	0.1
Inhalation rates (m^3/hr)	1.12	0.64	0.22
Aqueous discharge exposure			

Parameter	Adult	Child	Infant
Fish (kg/y)	29.0	5.8	1.5
Crustaceans (kg/y)	7.9	2.0	0.4
Molluscs (kg/y)	1.8	0.5	0.1
Intertidal activities (hr/y)	1,207	604	36

* Top two foodstuffs, 97.5th percentile consumption rates.

** The values presented for fruit are the sum of the consumption rates of domestic fruit and wild/free foods, which is comprised of blackberries, sloes, crab apples and damsons.

(-) denotes unit-less parameters.

Fishing family

14.2.34 In the case of the fishing family the following combined exposure pathways were assessed:

- external exposure to beach sediments;
- inhalation of sea spray when on the coast;
- consumption of sea fish, crustaceans and molluscs caught locally;
- internal irradiation from inhalation of radionuclides in the plume and re-suspended following deposition;
- external irradiation from radionuclides in the plume;
- external irradiation from radionuclides deposited on the ground;
- consumption of contaminated terrestrial foodstuffs following deposition on the ground; and
- direct radiation from Power Station buildings.

14.2.35 This family was assumed to live in close proximity to the Power Station Site, and be exposed to the same pathways as the farming family, i.e. the plume (inhalation and external exposure) and deposited radionuclides (including the consumption of terrestrial foodstuffs) from gaseous discharges [RD2]. However, the consumption rates of terrestrial foodstuffs were assumed to be at mean rates, using the median of the mean values from the three latest Cefas reports.

14.2.36 The occupancy rates for the fishing family at its residence were not captured in the Cefas habits survey. Therefore, a conservative assumption was made that the family has 100% occupancy at the residence when not at work (fishing at sea) or spending time at the beach (including handling fishing gear). The fraction of time spent outdoors was assumed to be 50% for adults, 20% for children and 10% for infants [RD2]. The habit data used to estimate the radiological impact to the fishing family CRPs are provided in table D14-6.

Table D14-6 Fishing family habit (aqueous and gaseous discharges)

Parameter	Adult	Child	Infant
Aqueous discharge exposure			
Fish (kg/y)	35.4	7.1	1.8
Crustaceans (kg/y)	9.9	2.5	0.5
Molluscs (kg/y)	4.5	1.1	0.2
Intertidal activities (hr/y)	1,207	604	36
Handling fishing gear, catch and sediment (hr/y)	1,679	20	0
Inhalation rates (m^3/hr)	1.69	0.64	0.22
Gaseous discharge exposure			
Cow's milk* (kg/y)	140.3	140.3	187.0
Root vegetables* (kg/y)	141.3	91.5	44.7
Green vegetables (kg/y)	47.4	22.2	10.1
Fruit and wild food** (kg/y)	34.2	21.7	13.8
Beef (kg/y)	31.5	21.0	7.0
Sheep meat (kg/y)	12.2	4.9	1.5
Occupancy (hr/y)	5,874	8,136	8,724
Fraction of time indoors (-)	0.5	0.8	0.9
Cloud shine factor (-)	0.2	0.2	0.2
Ground shine factor (-)	0.1	0.1	0.1

* Top two foodstuffs, mean consumption rates.

** The values presented for fruit are the sum of the consumption rates of domestic fruit and wild/free foods, which is comprised of blackberries, sloes, crab apples and damsons.

(-) denotes unit-less parameters.

Existing Power Station workers

14.2.37 An additional CRP for gaseous discharges is a worker at the Existing Power Station. This individual is assumed to live outside of the local area and only be exposed to gaseous discharges during the working day.

14.2.38 As decommissioning of the Existing Power Station progresses, workers from non-nuclear sectors (e.g. construction and demolition firms) could be contracted to support the effort and could potentially be exposed to radioactivity from the Power Station. These contractors are generally more likely to live away from the immediate local area. It was also considered that food pathways would be excluded from the assessment, i.e. that the Existing Power Station worker(s) would only be exposed to direct radiation and non-ingestion pathways relating to gaseous discharges during their hours of work at the Existing Power Station.

14.2.39 It has been assumed that the Existing Power Station worker(s) are always outdoors and work at ground level, at a receptor location that is 480m and 34° from the Power Station's reference stack [RD2]. The Existing Power Station worker dose assessment is for an adult only. Habit data for the Existing Power Station worker are presented in table D14-7.

Table D14-7 Habit data for the Existing Power Station worker (gaseous discharges)

Parameter	Adult
Time at location (hr/y)	2,000
Fraction of time indoors (-)	0
Inhalation rate (m^3/hr)	1.12

(-) denotes unit-less parameters.

Assessment of doses to the foetus and breast-fed infants

14.2.40 Guidance from Public Health England [RD11] suggests that doses to the foetus need only be considered for four radionuclides (i.e. phosphorus-32, phosphorus-33, calcium-45 and strontium-89) in assessments where these radionuclides form a significant part of any release to the environment. Only strontium-89 has been identified as a constituent of the radioactive inventory to be discharged from the Power Station, and it is expected that this radionuclide would form only a very small part (very much less than 0.1%) of the release to the environment.

14.2.41 Assessment results show that foetal exposure is lower than that to one-year-old infants. Assessments of foetal impacts would therefore not be explicitly reported.

Assessment of collective dose to populations

14.2.42 Collective doses have been estimated using PC-CREAM 08®. Population and agricultural production distribution within Europe is provided by the in-built database for each site on the PC-CREAM 08® database, as is the regional marine compartment that the discharge is released into. The Existing Power Station is in the database and is a suitable model representation for the Power Station.

14.2.43 The collective dose methodology [RD4] makes the assumption that the magnitude of the population of the European Union remains constant over all time, that habits remain the same and that the whole population are adults. The models, food production and population data provided in that document have been integrated into PC-CREAM 08®.

14.2.44 Collective doses were determined for the UK, European and world populations for both first pass (doses from the initial release) and global circulation scenarios, truncated at 500 years in accordance with statutory guidance. In addition, average individual doses have been calculated based on the population data for UK, EU12, EU25 and the world assumed in PC-CREAM 08® to be 59.6 million, 360 million, 456 million and 10 billion respectively [RD4].

14.2.45 For clarity, EU12 is the population representing the 12 European countries that were member states when the European Union was first established in 1993. EU25 is the number of member states (25) that were included in the European Union when PC-CREAM 08® was developed (recognising that this number has since risen again).

14.2.46 The first pass collective dose is the collective dose due to the initial dispersion of the discharge, whereas the global circulation collective dose is that due to circulation of mobile, longer-lived radionuclides in the oceans and in the atmosphere, i.e. carbon-14, tritium and krypton-85.

Assessment of doses from direct radiation exposure

Direct radiation sources

14.2.47 Doses from direct radiation exposure are calculated on the basis of computer modelling of the external doses resulting from operations at the Power Station. There are two potential radiation sources likely to result in off-site doses: the turbine buildings and the spent fuel storage facility. Off-site external doses from the Intermediate Level Waste (ILW) storage and the lower activity waste management facilities have been assessed as negligible. The dose rates due to direct radiation from radioactive sources on the Power Station Site were calculated using the software package MCNP5 (see section 14.4 in chapter B14, Application Reference Number: 6.2.14).

Most exposed members of the public for direct radiation

14.2.48 The locations at which receptor external doses were evaluated in the assessment were as follows.

- Residential location – a representative location for a family who lives near to the Power Station Site (who also happens to eat food grown and produced locally).
- Existing Power Station worker – a worker on the Existing Power Station site which lies to the north of the Power Station Site.
- Tregele – a settlement located approximately 600m from the Power Station Site.
- Cemaes – a settlement located approximately 1.2km from the Power Station Site.
- Walkers – three scenarios for walkers on paths around the Power Station Site.

14.2.49 The following scenarios are outlined for walkers on the paths around the Power Station Site (i.e. existing footpaths around the Power Station Site or paths that have been rerouted) shown on the illustrative layout in figure D14-2 (Application Reference Number: 6.4.101).

- Walker 1 – someone who parks to the south-east of the Power Station site and walks their dog every day, starting in a north-westerly direction

(see location 1 in figure D14-2, Application Reference Number: 6.4.101).

- Walker 2 – someone who parks to the south-east of the Power Station site and walks their dog every day, starting in a north-easterly direction (see location 2 in figure D14-2, Application Reference Number: 6.4.101).
- Walker 3 – assumes that, once per week, Walker 2 spends 20 minutes on the hill to the east of the Power Station Site (see figure D14-2, Application Reference Number: 6.4.101).

14.2.50 It is assumed that each walker walks at a constant speed of 1.3m/s every day of the year and performs a round trip along the appropriate length of path identified as important for the dose rate assessments [RD2].

14.2.51 In order to model the paths shown in figure D14-2 (Application Reference Number: 6.4.101) explicitly, each path was split into three sections with an associated length and time for walking. The walker was assumed to travel the length of the relevant path two times per day, i.e. an outward and a return journey. These individual sections of path were input into the MCNP models to allow the average dose rate over each section to be calculated.

14.2.52 It is highlighted that changes to the layout of paths shown on the illustrative layout figure D14-2 (Application Reference Number: 6.4.101) within the parameters sought (as described in chapter D1 (proposed development) (Application Reference Number: 6.4.1)) would not affect the assessment of doses from direct radiation for walkers.

Habit data and assumptions

14.2.53 The modelling for the direct dose rates assumed that both of the proposed reactors were in place and operating at full power. All waste storage facilities were assumed to contain the total inventory expected after 60 years of operation. This scenario is considered to be the most conservative of all scenarios in the operational lifetime of the Power Station.

14.2.54 For each of the receptors (except the walkers) the following are assumed [RD2]:

- 2,000 hours occupancy per year for a worker on the adjacent Existing Power Station site; and
- for the residential location plus the nearest points to the Power Station Site of the villages of Tregele and Cemaes:
  - occupancy of 24 hours per day for 365 days (i.e. 8,760 hours); and
  - fractions of time assumed indoors: adult 0.5, child 0.8, infant 0.9.

Assessment of doses from the transport of radioactive materials

14.2.55 This section presents the input data for the assessment of the radiological effects to a member of the public due to the transport of radioactive materials to and from the Power Station Site under normal conditions of operation

(movements of material on the Power Station Site itself are not included). The approach taken is similar to that used in a review of doses from transport of radioactive materials in the UK [RD12]. The approach is judged to be reasonably conservative and it should be noted that actual operational transports would be subject to strict regulatory control.

14.2.56 The method requires data for:

- radioactive materials to be transported and vehicle numbers;
- likely routes of travel; and
- exposure assumptions (durations, locations etc.).

14.2.57 Assumptions on vehicle movements involved with the transport of radioactive material to and from the Power Station Site are design information and are described in section 14.4.

Individual exposure parameters and assumptions

14.2.58 The transport from the Power Station Site could take two different routes within the local area (the Isle of Anglesey), and these routes have been considered in the assessment.

14.2.59 Both routes begin or end using the A5025, which would pass through or close to the villages of Tregele, Llanrhuddlad, Llanynghenedl and Valley. Between the Power Station Site and Valley (detailed below), there are no traffic signals or roundabouts, so any extended exposure to the villages listed above would be due to traffic congestion. The route of the existing A5025 has been modelled, which leads to a more conservative assessment (since there is more potential for delays due to traffic conditions).

14.2.60 If the shipments begin or end at the port or railhead in Holyhead, the route is via the A55 between Junction 1 and Junction 3, where vehicles would be forced to stop at several pinch-points such as roundabouts and traffic signals, some of which are near shops and residential areas.

14.2.61 The other route would be via the A55 Junction 3 and the M6. If the material is heading to Lancashire or Cumbria, the route would be north on the M6. If the material is heading south to Southampton or Northamptonshire, the route would be south on the M6 then the M1 (for Northamptonshire) or M1, A43, M40 and A34 past Oxford and Newbury (for Southampton). For incoming materials, the route is reversed.

14.2.62 The route toward the Holyhead railhead has several areas where a transport vehicle would have to stop, for either traffic lights or a give way junction, as described below.

Junction of A55 and A5, London Road, Valley

14.2.63 There is a supermarket, two public houses, a takeaway restaurant and several houses near to the junction. Time spent at the junction would be dependent on traffic conditions.

Junction of Kingsland Road and London Road

14.2.64 There are several houses, a hotel and several small businesses on the other side of a low wall, dividing the A55 from lower residential streets. Time spent at the junction would depend upon traffic conditions.

A55 Junction 1 roundabout

14.2.65 On the west-bound approach to the roundabout is a fast-food restaurant and a supermarket. On the roundabout, there is a fire station and several businesses. Times spent adjacent to these businesses would be dependent upon congestion at the roundabout and is expected to be longer during the weekday rush hour.

A55 Junction 3 roundabout

14.2.66 There are no businesses or residences around this roundabout, so the only people to be considered for dose exposure would be other motorists.

Junction of Holyhead Road and A5025, Valley crossroads

14.2.67 There are several businesses located around the junction, including a petrol station, barber's shop and public house. There are also several houses located on the south-bound A5025, approaching the traffic lights. The proposed improvements to the A5025 would mean that transport traffic is unlikely to pass this crossroads, but the receptors are included within this assessment to give a conservative estimate of effects.

14.2.68 The route for material leaving the Power Station Site by road towards the rest of the UK would be via the A55 towards the M6. The identified pinch-points for these routes are detailed below.

Britannia Bridge, A55

14.2.69 Congestion is expected on Britannia Bridge during peak hours on weekdays and possibly Saturday mornings and Sunday evenings during summer and Bank Holidays. There are no residences or businesses near the bridge and buildings along the congestion tailback are protected by raised concrete barriers; therefore, only other motorists would be affected.

A55 Junction 15A roundabout, between Llanfairfechan and Penmaenmawr

14.2.70 Part-time traffic signals are in place at this roundabout, so there is potential for exposure to the buildings nearby, which include several residences situated adjacent to the roundabout.

14.2.71 Where houses are close to junctions, it is reasonable to assume full-time occupancy during the transport of radioactive materials and that the same person is in the house and, therefore, potentially exposed to radioactive material transports for 52 weeks in a year.

14.2.72 Table D14-8 presents the scenarios to be considered in the assessment of transport effects, providing a matrix of radioactive sources and target

locations where members of the public could be exposed to a radiological dose.

Table D14-8 Scenarios considered for probable dose exposure to members of the public

Location	New fuel	Low Level Waste (LLW)	Very Low Level Waste (VLLW)	Spent fuel
Shops and public house near Valley crossroads	Yes	Yes	Yes	Yes
Shops near A55 Junction 1 roundabout	No	No	No	Yes
Shops and residences near Kingsland Road and London Road junction	No	No	No	Yes
Shops, public house and residences near A5 and A55 junction	No	No	No	Yes
Residences near A55 Junction 15A roundabout	Yes	Yes	Yes	No

14.2.73 Table D14-8 shows that the Valley crossroads has the potential for the highest exposure to the public, as all the transports to and from the Power Station must pass through this junction. It is assumed that each transported package spends one minute stopped at the traffic signals.

Assessment of doses to non-human species from discharges

Local area habitat designations

14.2.74 European Designated Sites within the vicinity of the Power Station have been identified (see figure D9-2, Application Reference Number: 6.4.101). Figure A3-2 (Application Reference Number: 6.1.10) shows the identified ecologically sensitive locations in the area.

14.2.75 The most notable of the sites subject to ecological conservation designations include Cemlyn Bay Site of Special Scientific Interest (SSSI), which forms part of the Anglesey Terns Special Protection Area, and the Cemlyn Bay Special Area of Conservation (SAC) to the west of the Power Station Site. The Wylfa Newydd Development Area is also located within the North Anglesey Marine candidate SAC (proposed for harbour porpoise, *Phocoena phocoena*) which covers area of approximately 325,000 hectares around the northern half of Anglesey [RD13].

14.2.76 Three distinct habitat types, representative of the designated sites (European Designated Sites or otherwise), have been identified as being

potentially sensitive to gaseous and aqueous radioactive effluent released from the Power Station on account of their ecological significance and their proximity. These are the closest habitats of these types to the Power Station which would result in the highest calculated environmental concentrations and doses to species at these locations (see chapter B14, Application Reference Number: 6.2.14). These habitat types are set out below.

- A terrestrial habitat, which lies on the Power Station Site boundary immediately to the east of the Power Station Site, just outside the Power Station fence. This habitat is the area where deposited activity from gaseous releases to the atmosphere is predicted to be greatest. It is considered that this approach would result in a realistic but conservative assessment of the effects on non-human species and so would provide conservative assessments for any designated terrestrial conservation sites near the Power Station.
- A marine habitat, in the coastal waters to the north and west of the Power Station Site. This habitat is analogous to the 100km^2 local (Wylfa) marine compartment within the DORIS marine dispersion module of PC-CREAM 08® and represents the Anglesey Terns Special Protection Area, and the candidate SAC Gogledd Môn Forol/North Anglesey Marine.
- A freshwater habitat, assumed to consist of a small lake at Tre'r Gof SSSI to the north-east of the Power Station. Tre'r Gof SSSI is situated in the predominant wind direction and its catchment includes the area receiving the highest deposition rates for gaseous radionuclides released from the Power Station. The SSSI is therefore considered to be more limiting than the other important freshwater habitat Cae Gwyn, which is situated to the south of the Power Station Site. For the purposes of this assessment, the location of the freshwater habitat is based on the food production area used in the human dose assessment.

14.2.77 Llanbadrig – Dinas Gynfor has been designated as a SSSI because of its geological significance. As such, it is not relevant to the assessment of radiation impact on non-human species.

14.2.78 A fourth important habitat, a brackish lagoon designated as the Cemlyn Bay SAC was also considered. However, current assessment methodologies do not facilitate direct assessment of radiological impacts to brackish habitats. In addition, given that the Cemlyn Bay SAC is fed by seawater (from the marine habitat identified above) and freshwater from local watercourses, it is considered that activity concentration in the brackish water and sediment within this habitat would be less than, and therefore bounded by, the activity concentrations in the marine habitat.

Calculation of radionuclide concentrations in the environment

14.2.79 The assessment of radiological impacts on non-human species was based on the ERICA Integrated Approach [RD14] (also see chapter B14,

Application Reference Number: 6.2.14). In order to carry out an assessment of impacts on non-human species, it is necessary to determine the activity concentrations of discharged radionuclides in water and soil. The concentrations are used as an input to ERICA.

14.2.80 The dispersion and resulting concentrations in environmental media of radionuclides originating from effluents discharged from the Power Station were modelled using the dispersion modules of PC-CREAM 08®. The methods for determination of concentrations of radionuclides in the terrestrial and marine environment due to gaseous and aqueous discharges are the same as those described earlier in this section.

14.2.81 The accumulation of radionuclides in a representative freshwater lake habitat based on Tre'r Gof SSSI dimensions from deposition of gaseous releases was calculated using the International Atomic Energy Agency (IAEA) SRS-19 model for a small lake [RD15].

14.2.82 The SRS-19 model takes account of both direct deposition of radionuclides into the lake and indirect contribution due to runoff and washout of radionuclides deposited within the lake catchment. The model assumes that the catchment is 100 times the lake surface area, and that 2% of radionuclides deposited on to the catchment reach the water body.

14.2.83 The SSSI has an area of 10.1 hectares [RD16], so the default modelled catchment area is likely to be conservative.

14.2.84 The deposition rates derived for the terrestrial habitat were conservatively adopted for assessing the radiological impacts to the freshwater habitat.

14.2.85 Table D14-9 presents the parameter values used to model the concentration of radionuclides in the Tre'r Gof freshwater habitat.

Table D14-9 Model parameter values for a small lake

Parameter	Value
Catchment area	0.92km^2
Lake surface area	9,200m^2
Flow rate	0.0125m^3/s
Lake depth	0.3m
Lake volume	2,760m^3
Discharge duration	60 years

14.3 Baseline environment

14.3.1 This section provides a summary of the baseline conditions for radiological effects within the study area described in section 14.2.

UK annual radiation exposure

14.3.2 The Centre for Radiation, Chemical and Environmental Hazards, a department of Public Health England, has calculated that the average annual dose to people in the UK from ionising radiation is about 2,700µSv/y (micro

sieverts per year) [RD17]. The sources of radiation giving rise to these doses can be grouped into two broad categories; exposures to artificial and to natural sources. Figure D14-3 illustrates the contribution from natural and artificial sources.

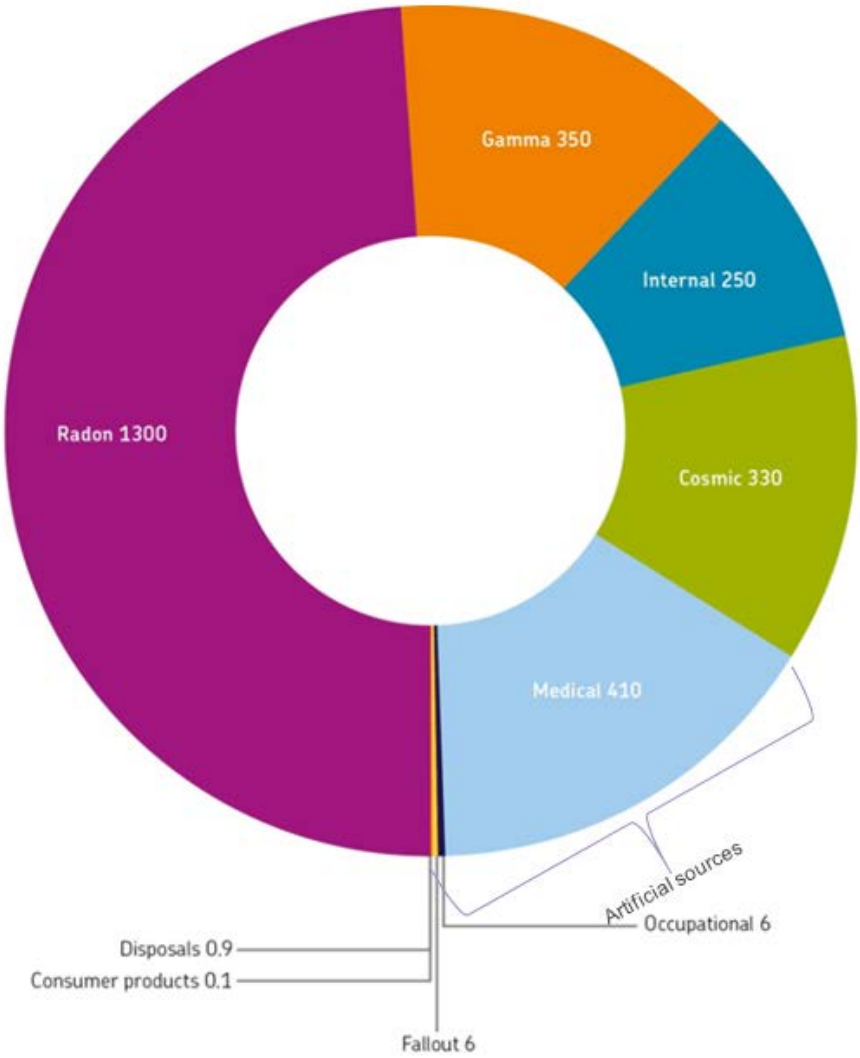
14.3.3 The main contribution to exposure to radiation from artificial sources is from medical procedures (410µSv/y). Smaller doses are received due to occupational exposure, exposure to historic radioactive contamination from nuclear accidents and weapons testing, and a small exposure from consumer products. The dose resulting from exposure to disposals of radioactive material indicated in figure D14-3 is 0.9µSv/y. The total dose from artificial sources is 423µSv/y.

14.3.4 Exposures to natural sources of radiation are due to the presence of naturally occurring radioactive minerals found in the environment (including building materials) which lead to exposure via gamma rays and also via radon inhalation, in food and drink (described as 'internal' in figure D14-3), and to cosmic radiation from outer space. Natural radiation accounts for about 85% (2,230µSv/y) of the average exposure of UK individuals.

14.3.5 The main factor contributing to variation in UK natural background radiation doses is differences in radon concentrations from the underlying rock composition. This leads to a variation in dose from radon inhalation across the UK.

14.3.6 With regards to the variation in natural radiation local to the Wylfa Newydd Development Area, measurements on Anglesey show that radon concentrations are relatively low (compared to the UK average) over the majority of the island, but with a band of higher radon concentrations observed towards the east of the island. Annual average radiation doses around the Wylfa Newydd Development Area would typically be lower than the national average as a result of lower radon concentrations in the environment [RD18].

Figure D14-3 Contributions to the average UK annual radiation dose (µSv/y)



Radioactivity concentrations in the local environment

14.3.7 Routine monitoring of the local environment around the Existing Power Station has been carried out for many years by a number of bodies (e.g. the operators of the Existing Power Station and UK regulatory bodies), and a substantial body of data on radioactivity in various environmental media exists [RD19]. The UK environment agencies and the Food Standards Agency publish an annual summary of the independent radioactivity monitoring programmes in the UK, known as Radioactivity in Food and the Environment (RIFE) ([RD20], [RD21], [RD22], [RD23], [RD24], [RD25], [RD26], [RD27]), including data from around the Existing Power Station. The distribution of radionuclide concentrations in the Irish Sea has been reviewed and reported by the Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) [RD28].

14.3.8 The radioactivity levels in the Eastern Irish Sea are influenced mainly by discharges from the reprocessing plant at Sellafield in Cumbria, and to a lesser extent the fuel fabrication plant at Springfields in Salwick, Lancashire,

the nuclear power station at Heysham in Lancashire, and the Existing Power Station.

14.3.9 It should be noted that the objectives of the various sampling programmes reviewed are different and, as such, would focus on different radionuclides and sampling media. In addition, because discharges from the Existing Power Station are low and, hence, local anthropogenic radioactivity levels are low, many of the sample results return values below the minimum detectable amount (sometimes reported as “less-than” values). The following sections have been extracted from the literature and present the significant features of the underlying data relevant to developing an understanding of the current radiological conditions of the region.

Gamma monitoring

14.3.10 For the assessment of background radiation, an estimate of baseline ambient radiation dose in the study area is required. The operator of the Existing Power Station undertakes terrestrial gamma monitoring in the local area around the Existing Power Station [RD19]. The measurements are of dose rate (nanograys per hour – nGy/hr) in the environment and this comprises components due to natural terrestrial radioactivity, cosmic contribution, inherent instrument background and man-made sources. Quarterly dose rate measurements are carried out at nine or more inner locations (4km from the Existing Power Station), and nine or more outer locations (10km from the Existing Power Station), together with five or more beach sites.

14.3.11 In 2013, the annual mean data for the inner ring locations had a lower net dose rate than the outer ring locations (34.3nGy/hr compared to 43.9nGy/hr).

14.3.12 Power generation ceased at the Existing Power Station at the end of 2015, which would result in a reduced contribution from anthropogenic sources to external gamma doses.

Soil radioactivity concentrations

14.3.13 Horizon has conducted a baseline survey of soil radioactivity concentrations in trial pits in the Wylfa Newydd Development Area ([RD29], [RD30]). All surface soils were found to be within normal background concentration ranges.

14.3.14 Horizon also undertook a rock and soil sampling survey of the Wylfa Newydd Development Area [RD29]. The results of the survey found no samples with elevated concentrations of naturally occurring radioactive material. In addition, no artificial radionuclides were detected other than trace amounts of caesium-137, which is a common component from weapons testing and fallout from past accidents (such as Chernobyl). Caesium-137 is present at low concentrations across the Power Station Site, with no indication of variation with distance from the Existing Power Station, suggesting no historic contamination has resulted from releases of radioactive material from local sources.

14.3.15 Caesium-137 was detected in 57% of near-surface samples from the Wylfa Newydd Development Area, with a maximum recorded activity of 6.43Bq/kg. The median caesium-137 activity of near-surface samples was 1.23Bq/kg. These values are lower than the assumed background caesium-137 activity based on results from annual Existing Power Station district survey soil cores (quoted in [RD29]) collected between 2006 and 2013 (maximum 36.1Bq/kg, median 17.8Bq/kg). Results indicate that caesium-137 activity is restricted to the surface, with generally reduced activity at 0.5m and no caesium-137 detected in any of the deeper samples. Measurements of caesium-137 above the Limit of Detection were found in samples from six areas. The mean caesium-137 concentration in these areas ranged from 0.9Bq/kg to 2.8Bq/kg.

14.3.16 These soil concentrations are at the lower end of the range of measurements of caesium-137 in soil, made on Anglesey as part of a wider study in north Wales [RD31]. In that study, measurements of between 2Bq/kg and 20Bq/kg were measured.

14.3.17 It is concluded that levels of caesium-137 in soil from the Wylfa Newydd Development Area reflect the typical background for Anglesey.

14.3.18 Radioactivity concentrations measured in the baseline surveys of soils were found to be below the out of scope radioactive material definition for caesium-137 from the Environmental Permitting (England and Wales) Regulations 2016 of 1000Bq/kg and the IAEA clearance and exemption value of 100Bq/kg [RD32].

Sediment radioactivity levels in marine construction areas

14.3.19 As part of the Power Station Site investigation and characterisation programme, Horizon has undertaken an extensive environmental sampling programme in the marine construction areas. As part of this programme, measurements of radioactivity were made in marine rock and sediment samples taken from the vicinity of proposed location of the Marine Off-Loading Facility [RD30].

14.3.20 The only anthropogenic radionuclides measured above the Limits of Detection were americium-241 and caesium-137. These were only detected in surface sediments and had mean concentrations of 1.1Bq/kg of americium-241 (three samples) and 3.3Bq/kg of caesium-137 (four samples). These low levels are similar to those observed in the routine monitoring programme around the Existing Power Station (see below and in table D14-10).

14.3.21 Radioactivity concentrations measured in sediments were found to be below the out of scope radioactive material definition for caesium-137 from the Environmental Permitting (England and Wales) Regulations 2016 of 1,000Bq/kg and for americium-241 of 100Bq/kg, as well as being below the IAEA clearance and exemption value of 100Bq/kg [RD32].

Local marine monitoring

14.3.22 A summary of the measured radioactivity concentrations in local marine samples from the 2016 RIFE report [RD27] is shown in table D14-10. These radioactivity concentrations would all contribute to the assessed Representative Person doses presented in RIFE and comprise the baseline for anthropogenic sources (even if they may not be significant components of the Power Station discharge inventory).

14.3.23 Even though power generation at the Existing Power Station ceased at the end of 2015, it is assumed that marine discharges would not change significantly as defueling commences, since liquid wastes would continue to be generated. Hence, the reported radioactivity levels are assumed to be typical of those likely to be observed over the next few years.

Table D14-10 Concentrations of radionuclides in food and the marine environment near the Existing Power Station, 2016

Material	Mean radioactivity concentration (fresh), Bq/kg											
	No. of sampling locations	H3 (organic)	H3	C14	Tc99	Cs137	Pu238	Pu239 + Pu240	Pu241	Am241	Gross alpha	Gross beta
Plaice	1	<25	<25	40		0.60				<0.13		
Crabs	1	<25	<25	39		<0.08				<0.09		
Lobsters	1	28	33	61	18	0.37	0.0033	0.021	0.30	0.12		110
Winkles	1	<25	<25	42	9.4	0.28	0.025	0.16	0.53	0.24		72
Seaweed	2				15	<0.44				<0.44		
Sediment	2					2.9				1.3		
Sediment	2					2.2				<0.78		
Seawater	2		<3.2			<0.20				<0.28	<3.7	13

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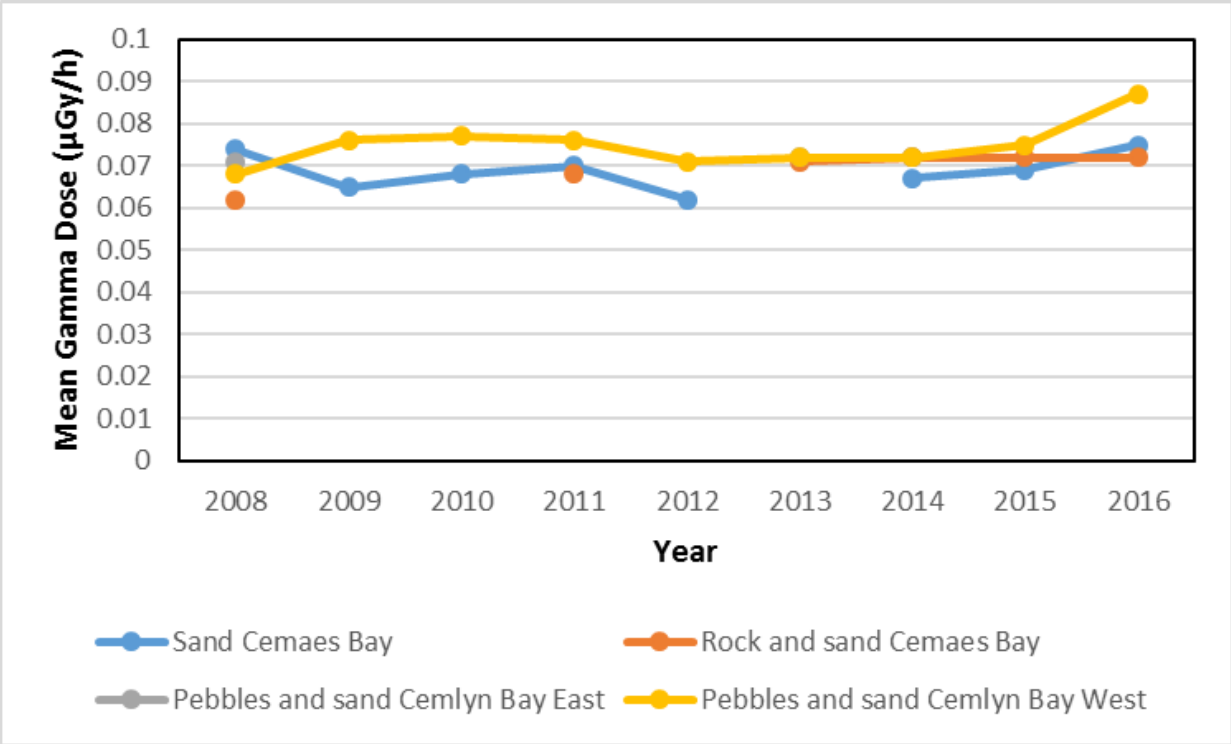
14.3.24 RIFE reports also indicate trends based on radioactivity measurements in environmental media from previous years. Of the radionuclides reported for the local area, the only significant trend is a reduction in concentrations of technetium-99 in environmental media. This is consistent with an observed reduction in technetium-99 discharges from Sellafield.

14.3.25 Gamma dose rates over beach and sediments are also measured by the nuclear regulators and reported in RIFE for local intertidal areas. The measurements over the previous nine years in different locations are shown in figure D14-4. No trends in the data are evident.

Figure D14-4 Trends in mean gamma dose rates over beach and sediments



Local terrestrial monitoring

14.3.26 Gaseous discharges from the Existing Power Station have now reduced following the cessation of power generation at the end of 2015.

14.3.27 Radioactivity measurements in terrestrial foodstuffs for 2013 [RD24] from the RIFE programme are summarised in table D14-11. The results reported from sampling programmes are dependent on particular crops being grown or available in the local district in any given year. As this is not always the case, trends in the data are harder to identify.

14.3.28 Milk is an important indicator of local exposures and has the most sampling locations. In table D14-11 and table D14-12, the first line of milk results reports the mean concentration observed in all samples and locations and the second line reports the highest observed concentration in all samples.

14.3.29 Once again, these radioactivity concentrations would all contribute to the assessed Representative Person doses presented in RIFE and comprise the

baseline for anthropogenic sources (even if they may not be significant components of the Power Station discharge inventory). However, for the local terrestrial environment, annual average concentrations in these media are more sensitive to discharges in a given year (unlike concentrations in the marine environment) particularly for tritium, carbon-14 and sulphur-35. Therefore, the baseline in the future would be much more dependent on gaseous discharges defined in the decommissioning strategy of the Existing Power Station.

Table D14-11 Concentrations of radionuclides in food near the Existing Power Station, 2013

Material	No. of sampling locations	Radioactivity concentration (fresh), Bq/kg					
		H3	C14	S35	Cs137	Gross alpha	Gross beta
Milk	5	<2.4	26	<0.57	<0.07		
Milk	Max obs.	<2.7	29	1.1	<0.08		
Apples	1	<2.2	8.5	0.50	<0.06		
Barley	1	<5.4	110	0.50	<0.13		
Beetroot	1	<2.3	15	<0.20	<0.10		
Blackberries	1	<2.2	23	1.4	<0.06		
Broad beans	1	<2.5	29	2.0	<0.06		
Cauliflower	1	<2.0	6.9	0.80	<0.08		
Potatoes	1	<2.4	18	0.30	<0.06		
Squash	1	<2.3	10	0.60	<0.05		
Fresh water (public supply)	1	<3.0		<0.19	<0.20	<0.03	0.16

14.3.30 As radioactivity concentrations of most radionuclides have fallen below Limits of Detection, the sampling programme was reviewed and the number of results reported was reduced. Data from the most recent RIFE programme [RD27] are shown in table D14-12.

Table D14-12 Concentrations of radionuclides in food near the Existing Power Station, 2016

Material	No. of sampling locations	Radioactivity concentration (fresh), Bq/kg			
		H3	C14	S35	Cs137
Milk	2	<3.8	24	<0.36	<0.06
Milk	Max obs.	<5.2		<0.38	
Potatoes	1	<2.2	15	0.50	<0.07
Freshwater (public supply) (2015 results. Sampling not undertaken in 2016)	1	<3.2		<0.98	<0.18

Summary of current local radiation exposure

14.3.31 In the most recent RIFE report [RD27], an assessment is made of doses to the public near nuclear licensed sites using the results of monitoring of radioactivity in food and the environment, supplemented by modelling where appropriate. The assessments use radionuclide concentrations, gamma dose rates and information on the habits of people living near the sites.

14.3.32 Changes in the doses received by people can occur from year to year and are mostly caused by variations in radionuclide concentrations and external dose rates. However, in some years, doses are affected by changes in habits of individuals, particularly the food they eat, as reported in habits surveys.

14.3.33 The dose presented in the report is made up of contributions from all sources of radioactivity from man-made processes. The range of human radiation doses resulting from different pathways around the Existing Power Station is summarised in table D14-13.

Table D14-13 Baseline doses around the Existing Power Station

Component	Source	Dose (µSv/y)
Radon	Uranium in rocks	120 – 3,600
Other components of natural background	Gamma, internal, cosmic	930
Background artificial components	Medical, occupational, fallout, others	420
Existing Power Station discharges – specific pathway	Adult spending time in intertidal areas	7
	Seafood consumer	<5
	Infant inhabitant and consumer of locally	5

Component	Source	Dose (µSv/y)
doses	grown food	

14.3.34 The assessment of radiological effects from the Wylfa Newydd Project contained in this chapter is based on predictive modelling undertaken in support of the EP-RSR, and a comparison of the modelled results with regulatory criteria. To assess the cumulative contribution to public radiation doses from man-made sources, the assessed contribution from the Existing Power Station is required along with baseline data from other nuclear facilities discharging into the Irish Sea.

14.3.35 Baseline data on discharges from other nuclear facilities are defined in RIFE reports. The current assessed overall public dose close to the Existing Power Station resulting from discharges to the Irish Sea is approximately 10µSv/y.

14.3.36 The variation in the total dose from all pathways to the Representative Person from the RIFE reports and the main contributing pathways, are shown in table D14-14. Total doses remained broadly similar from year to year, and are generally very low. Habit data for the RIFE assessment is based on the same survey data described in section 14.2.

Table D14-14 Trends in all pathways dose near the Existing Power Station

Year	Dose(µSv/y)	Main pathways
2010	7	Direct radiation
2011	8	Direct radiation
2012	6	Direct radiation, milk
2013	<5	Fish, gamma dose rate over sediment
2014	7	Fish, gamma dose rate over sediment
2015	13	Direct radiation
2016	8	Direct radiation

Evolution of the baseline

14.3.37 As indicated in the RIFE reports, there has been a progressive reduction in discharges to the Irish Sea from existing nuclear facilities. This is in part due to a regulatory requirement (under the OSPAR treaty) for an ongoing reduction in the discharge of man-made radioactive material into the north-east Atlantic region. This requirement, along with a cessation of operation of some existing nuclear facilities, would result in a continuation of this current downward trend in future years.

14.3.38 Following the cessation of power generation by the Existing Power Station at the end of 2015, there has been an overall reduction in external dose rates close to the Existing Power Station site, but this may vary as active items are removed and stored as waste ready for disposal. Future trends in gaseous and aqueous discharges from the Existing Power Station would depend upon the decommissioning strategy adopted.

14.4 Design basis and activities

14.4.1 This section sets out the design basis for the assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that will be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

14.4.2 As described in chapter D1 (Application Reference Number: 6.4.1), the application for development consent is based on a parameter approach. The assessment described within this chapter has taken into consideration the flexibility afforded within the parameters sought. A worst case scenario has been assessed from a radiological effects perspective based on the information presented in the EP-RSR submission [RD2] which is consistent with the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction

14.4.3 During construction, the following activities have the potential to result in inadvertent radiation exposure to workers in construction areas:

- geophysics and radiography would use radioactive sources in a controlled manner; and
- the potential for the discovery of previously contaminated land or of radiation sources used during the time of construction of the Existing Power Station.

Basis of assessment and assumptions

14.4.4 The activities described in paragraph 14.4.3 would be well controlled by the mitigation measures described in paragraphs 14.4.7 to 14.4.12 below.

14.4.5 Exposure to existing baseline radioactivity in soils and sediments during excavation-related works would be based on the existing data from soils and sediments in construction areas (see section 14.3).

Embedded mitigation

14.4.6 No embedded mitigation has been identified for construction.

Good practice mitigation

14.4.7 The hazards associated with the construction activities as described above are primarily related to the control of radioactive sources for geophysics and radiography and the potential to discover radioactive contamination from previous activities on the Power Station Site. There are a number of mitigations in place to prevent or minimise the effect of radioactive sources or radiologically contaminated land, as detailed in the waste and materials management strategy section of the Wylfa Newydd Code of Construction Practice (Application Reference Number: 8.6). Compliance with the Wylfa

Newydd Code of Construction Practice would be secured through a DCO requirement.

14.4.8 Control of radioactive sources is achieved through a combination of stringent management arrangements and supervision of the use of the sources to ensure all the requirements of the Ionising Radiations Regulations 2017 are met. Horizon would ensure it understands at all times what sources are on the Power Station Site and where they are being used. When sources are not in use, they would be kept in secure source stores to prevent loss or damage. Contingency plans for foreseeable incidents would be in place and the response to these plans would be rehearsed. It should be noted that radiography sources are commonly and safely used at major construction sites, and Horizon would adopt good practice with regard to managing these sources of radioactivity.

14.4.9 There is a potential for radiological land contamination to be discovered during construction. Horizon has assessed the construction area through a comprehensive sampling programme to determine the radiological conditions. Horizon has also worked closely with the operators of the Existing Power Station to gather current and historical environmental monitoring data. All information gained to date indicates that there is no radiological land contamination in the construction area [RD29].

14.4.10 Although risks are currently believed to be low, Horizon would adopt a precautionary approach to radiation and environmental protection. Horizon has carried out an assessment process to identify areas of potential risk. Prior to work in the identified areas, additional sampling and monitoring may be carried out. During work in these areas, radiation protection experts would be available with radiological monitoring equipment to provide reassurance monitoring.

14.4.11 Should radioactively contaminated land or radioactive items be discovered, Horizon would have arrangements in place to make the area safe, protect the workforce, prevent the spread of radioactive contamination and manage the radioactive material in consultation with the regulators. Horizon would utilise Radioactive Waste Advisors and other trained staff to implement these arrangements.

14.4.12 Radiological conditions will remain under constant assessment by Horizon's Radiation Protection Advisors (appointed in compliance with the Ionising Radiations Regulations 2017) to ensure control at all times.

Operation

14.4.13 This section describes features of the design relevant to the assessment of radiological effects during operation. These are as follows:

- the design and assumed heights associated with the main reactor stacks;
- the radioactive discharge inventories for routine releases from the stacks and to the marine outfall;

- the site layout of the turbine buildings and radioactive waste stores and inventories (to inform the direct external dose assessment); and
- the number of vehicle journeys required for transport of radioactive materials to and from the Power Station Site.

Basis of assessment and assumptions

Design of the reactor stacks

14.4.14 A stack height sensitivity study has been performed using Atmospheric Dispersion Modelling Software (ADMS) to determine the optimum height of the reactor stacks based on the dispersion of gaseous radioactive discharges [RD33].

14.4.15 This study predicted the deposition rates and ground level activity concentrations for a range of stack heights between 50m and 100m, and demonstrated that benefits diminished above a stack height of 75m, in terms of dispersion.

14.4.16 This study provided an input in to the Best Available Techniques (BAT) assessment for the reactor stack height, the output of which was that the optimum reactor stack height for the Power Station is 75m [RD33].

14.4.17 However, it is recognised that there are differences between ADMS 5 and the radiological impact assessment software PC-CREAM 08®, in that ADMS takes into account plume rise, building wake and local topography in the dispersion calculations whereas PC-CREAM 08® does not. As a result, the use of a 75m stack height within PC-CREAM 08® for the near-field assessment would potentially result in an under-prediction of concentrations close to the release point.

14.4.18 The atmospheric dispersion model employed within PC-CREAM 08® is based on a Gaussian plume model [RD34]. Gaussian plume models calculate downwind concentrations resulting from advection and dispersion processes on an unobstructed ideal flat plane. To include the effects of plume rise, terrain and building entrainment in these calculations, the concept of “effective stack height” was introduced, which represents the theoretical height of the stack under study that would result in the observed downwind dispersion curves taking into account all of the aforementioned factors.

14.4.19 When calculations of concentrations resulting from a release from the stack are undertaken within PC-CREAM 08®, the effective release height is used as a model input parameter, rather than the actual physical height of the stack.

14.4.20 Effective stack heights have been derived in a number of ways: by use of wind tunnel models, by the use of actual release experiments and by derivation from the results obtained using more complex dispersion models (such as ADMS). To assist users of the standard R91 model [RD34], the UK working group on atmospheric dispersion provided guidance on the derivation of effective stack heights for a site [RD35]. This states that, for a

site where entrainment may be an issue, the effective height can be approximated as one-third of the height of the tallest building at the site.

14.4.21 The radiological effects assessment was carried out on the basis of a reactor building height of 45m. One-third of the building height is therefore 15m, and this has been set as the effective discharge height. This value provides a high level of conservatism for the assessment, such that the calculated doses can be considered as conservative. The maximum parameter height for a reactor building (see chapter D1, Application Reference Number: 6.4.1) is 49m. The increase in reactor building height to the maximum of 49m allowed by the parameters would not affect the outcome of this assessment of radiological effects, which as stated above has been carried out on the basis of a reactor building height of 49m.

Discharges

14.4.22 Routine discharge estimates during normal operation have been developed during plant design. Site-specific routine discharges for the Power Station have been estimated as part of the EP-RSR application process.

14.4.23 The methods for deriving the proposed site-specific annual gaseous and aqueous emission limits are detailed in the EP-RSR application [RD2]. The resulting gaseous and aqueous discharge data have been used for the dose assessments and are provided in table D14-15 and table D14-16. These are the proposed discharge limits; operational discharge levels would be lower than these.

14.4.24 Gaseous discharges are the given for each stack (stack 1 includes discharges from the radioactive waste building). The aqueous discharges are mixed with the cooling water outflow.

Table D14-15 Annual gaseous radioactive discharges used in the dose assessment

Radionuclide	Stack 1 (Bq/y)	Stack 2 (Bq/y)
Ag-110m	4.6E+01	3.4E+01
Am-241	7.1E-04	5.6E-04
Ar-41	5.2E+12	5.2E+12
Ba-140	3.6E+04	3.5E+04
C-14	1.7E+12	1.7E+12
Ce-141	4.9E+04	4.8E+04
Ce-144	4.7E+04	4.5E+04
Cm-242	5.4E-01	4.7E-01
Cm-243	5.6E-05	4.4E-05
Cm-244	7.0E-03	5.6E-03
Co-58	1.6E+05	1.4E+05
Co-60	1.8E+05	1.3E+05

Radionuclide	Stack 1 (Bq/y)	Stack 2 (Bq/y)
Cr-51	1.4E+05	1.2E+05
Cs-134	9.6E+03	9.1E+03
Cs-137	6.0E+03	5.5E+03
Fe-59	2.6E+04	2.2E+04
H-3	1.1E+13	9.5E+12
I-131	4.6E+08	2.0E+08
I-132	1.1E+08	1.0E+08
I-133	9.5E+07	4.9E+07
I-135	5.0E+07	3.5E+07
Kr-85	1.3E+09	1.3E+09
Kr-85m	1.0E+10	1.0E+10
Kr-87	9.8E+03	9.8E+03
Kr-88	9.3E+08	9.3E+08
Kr-89	0.0+00	0.0E+00
La-140	4.1E+04	4.1E+04
Mn-54	1.0E+05	7.9E+04
Nb-95	1.2E+05	1.1E+05
Pu-238	1.0E-02	8.1E-03
Pu-239	1.3E-03	1.1E-03
Pu-240	2.1E-03	1.7E-03
Sb-122	4.8E+02	4.8E+02
Sb-124	4.8E+04	4.8E+04
Sb-125	1.0E+04	1.0E+04
Sr-89	4.1E+04	4.0E+04
Sr-90	2.7E+03	2.5E+03
Tc-99	2.7E+00	0.0E+00
Xe-131m	2.9E+09	2.9E+09
Xe-133	2.0E+11	2.0E+11
Xe-133m	1.8E+07	1.8E+07
Xe-135	6.6E-11	6.6E-11
Xe-135m	0.0+00	0.0+00
Xe-137	0.0+00	0.0+00
Xe-138	0.0+00	0.0+00

Radionuclide	Stack 1 (Bq/y)	Stack 2 (Bq/y)
Zn-65	4.5E+04	3.6E+04
Zr-95	5.3E+04	5.1E+04

Table D14-16 Annual aqueous radioactive discharges used in the dose assessment

Radionuclide	Bq/y	Radionuclide	Bq/y
Ag-110m	9.4E+00	I-134	0.0E+00
Am-241	8.9E-02	I-135	0.0E+00
Ba-140	1.2E+04	La-140	1.4E+04
C-14	0.0E+00	Mn-54	3.7E+05
Ce-141	4.8E+04	Nb-95	1.9E+05
Ce-144	2.2E+05	Ni-63	7.2E+05
Cm-242	2.0E+00	Pu-238	2.9E+00
Cm-243	4.2E-03	Pu-239	4.7E-01
Cm-244	3.9E-01	Pu-240	7.4E-01
Co-58	1.2E+05	Ru-103	2.8E+04
Co-60	8.6E+05	Ru-106	1.8E+04
Cr-51	7.2E+04	Sb-122	1.4E+02
Cs-134	1.2E+04	Sb-124	4.7E+04
Cs-137	1.3E+04	Sb-125	6.9E+04
Fe-55	8.0E+06	Sr-89	1.7E+04
Fe-59	2.1E+04	Sr-90	8.5E+03
H-3	1.5E+12	Tc-99	0.0E+00
I-131	1.2E+05	Te-123m	5.3E+01
I-132	0.0E+00	Zn-65	1.3E+05
I-133	0.0E+00	Zr-95	8.3E+04

Design of radioactive waste stores relevant to direct radiation dose assessments

14.4.25 A general description of the radioactive waste facilities at the Power Station Site is described in appendix D14-1 (Application Reference Number: 6.4.97).

14.4.26 Normal nuclear safety design considerations would optimise the amount of shielding required for operational purposes and which reduces the off-site external radiation dose. The requirements of the EP-RSR Permit would require the utilisation of BAT to reduce the impact on the public and environment.

14.4.27 The main plant components within the Power Station Site would be in the twin Units, which includes two reactor buildings, two turbine buildings, two control buildings and a shared services building.

14.4.28 Some of the Cooling Water System elements are common to both Units (namely the Cooling Water System intake, pumping plant, seal pit, discharge tunnel and outfall, and the reserve ultimate heat sink). An indicative layout of the Power Station Site, identifying the positions of the turbine buildings and the position of the spent fuel storage facility, is shown in figure D14-2 (Application Reference Number: 6.4.101).

14.4.29 The present design intent is to have a maximum of 301 spent fuel casks in the spent fuel storage facility at 60 years of operation. Each cask is assumed to contain up to 68 spent fuel assemblies stored dry, and a total of 19,200 spent fuel assemblies are assumed to be generated over the 60-year operational lifetime of the Power Station.

14.4.30 Twenty-two casks would be stored in the dry High Level Waste decay storage facility at the end of the Power Station's operational life, each assumed to contain 50 control rods.

Design assumptions relevant to transport dose assessments

14.4.31 The radioactive material consignments considered are:

- new fuel;
- neutron sources;
- Low Level Waste (LLW);
- ILW; and
- spent fuel.

Vehicle movement assumptions – new fuel

14.4.32 The largest shipment of new fuel would occur prior to first start-up of the reactors. Each UK Advanced Boiling Water Reactor (UK ABWR) would have a maximum fuel capacity of 872 fuel assemblies, giving a total of 1,744 assemblies across both Units [RD36]. This translates to approximately 44 heavy goods vehicles (HGVs) delivering new fuel to the Power Station Site over the initial fuelling period with a capacity of 40 fuel assemblies per HGV.

14.4.33 Each Unit would require a re-fuelling outage every 18 months. Approximately 12 HGVs per Unit would be required over each outage (see chapter D1, Application Reference Number: 6.4.1).

14.4.34 Fuel is transported in packages, containing two assemblies per package and hence 20 packages per HGV. Manufacturers' data (pers. comm) for boiling water reactor fuel packages, suggest they have a Transport Index (TI) of 0.2 to 0.5, which equates to a dose rate of 5µSv/hr at 1m from the outside of the package. The higher TI value (0.5) has been used in this assessment.

14.4.35 Paragraph 524 in the IAEA transport regulations [RD37] states that the TI of each conveyance can be determined as the sum of the TIs of all the packages contained within. Therefore, the TI of each HGV can be

calculated as 10, with a dose rate of 100µSv/hr at 1m from the outer surface of the conveyance.

Vehicle movement assumptions – neutron sources

14.4.36 Neutron sources are required for reactor start-up and other sources are used for the calibration and monitoring of various fuel route systems and processes. There is no firm strategy for the purchase and management of these items, so a bounding assumption of one delivery per outage (every 18 months) per Unit for transporting these materials onto site is used (included within the new fuel outage totals). As the origin of the source is unknown, it would be assumed that the source would make the final leg of its journey to the Power Station Site via the M6, A55 and A5025, as the most direct route.

14.4.37 A Generic Design Assessment topic report [RD38] details the gamma and neutron dose rates, at 0.5m from the surface of the source shipping container, as 240µSv/hr and 40µSv/hr respectively.

Vehicle movement assumptions - Low Level Waste

14.4.38 It is anticipated that there would be 14 third-height ISO containers (THISO) of cement-encapsulated, wet solid LLW disposed of per year (see appendix D14-1, Application Reference Number: 6.4.97). The destination for this would be the Low Level Waste Repository (LLWR) near Drigg, Cumbria; therefore, the route for these shipments would be via the A5025, A55 and M6.

14.4.39 There are also anticipated to be nine half-height ISO containers (HHISO) and six full-height ISO containers (FHISO) of dry solid LLW and Very Low Level Waste (VLLW) disposed of per year, with different destinations depending on disposal route. Estimates of LLW and VLLW transports are very conservative at this stage of design development. None of the disposal routes are expected to be local to the Power Station Site, so all transports would initially follow the same route as the wet LLW, with the final leg of the journey along the M6 being dependent on the destination, as detailed below.

- 6 x FHISOs for compaction prior to disposal – provider yet to be selected.
- 5 x HHISOs for incineration – multiple locations in the south of England.
- 1 x HHISO for metal recycling – Lillyhall, Cumbria or Tradebe Inutec, Winfrith, Dorset.
- 1 x HHISO of VLLW – multiple landfill locations in the east and north of England.
- 2 x HHISOs for direct disposal – LLWR, Cumbria.

14.4.40 The dose rates for LLW containers and VLLW containers are assumed to be the maximum allowable, according to LLWR guidelines [RD39]; [RD40].

Vehicle movement assumptions – Intermediate Level Waste

14.4.41 Current estimates of amounts of ILW produced in both operations and decommissioning phases is available from the Generic Design Assessment

disposability assessment [RD41]. Operational wastes are broken down into "crud" and resins, control rods and operational metals. Decommissioning ILW wastes principally comprise the reactor pressure vessel (RPV) and RPV internal components.

14.4.42 The number of "Cruds and resins" packages generated over the Power Station's lifetime would be 531. The peak dose rate at 1m from the package surface is estimated as 9µSv/hr.

14.4.43 The number of "control rods and mixed metal" packages generated over the Power Station's lifetime would be 21. The peak dose rate at 1m from the package surface is assumed to be 100µSv/hr.

14.4.44 The number of "RPV and RPV internals" packages generated over the Power Station lifetime would be 165. The peak dose rate at 1m from the package surface is estimated to be 12µSv/hr.

14.4.45 It has been assumed that it would take five years for disposal of these ILW materials to the Geological Disposal Facility (GDF), though this would be subject to variation by the national disposal strategy to be developed once the GDF becomes available.

Vehicle movement assumptions – spent nuclear fuel

14.4.46 Spent fuel would be discharged from the reactors every 18 months and placed into a spent fuel pool. It would be stored in the pool for a period of 10 years, to allow the decay heat to reduce to acceptable levels, after which time it is intended to remove the spent fuel to the spent fuel storage facility.

14.4.47 Final disposal of the spent fuel would be to the national GDF. Horizon's strategy is to store the spent fuel until the GDF is made available.

14.4.48 Due to uncertainty in the timings associated with the availability of a GDF, the Power Station Site would have the capability to store spent fuel and ILW for an extended period within facilities such as the spent fuel storage and ILW storage facilities. The storage facilities would be sufficient to accommodate arisings from a 60-year operational lifespan, until a GDF is available.

14.4.49 Once the GDF becomes available, it is assumed transport of spent fuel for storage at the GDF would commence, based on GDF acceptance criteria. Typical spent fuel transport practices for existing UK reactors are one to two fuel flasks per week [RD12]. For the assessment, a despatch rate of 100 flasks per year is assumed.

14.4.50 Dose rates from spent fuel flasks are taken from the Generic Design Assessment disposability assessment [RD41].

14.4.51 Table D14-17 presents the estimated frequency of radioactive packages transported to and from the Power Station Site. These transports would occur at different phases of the Power Station's lifetime.

14.4.52 Prior to start-up, there would be a relatively large number of fuel transports as each Unit is fuelled to capacity. During the operational phase, relative low numbers of transports occur, carrying new fuel for outage fuel

replacement, and low number of LLW and VLLW operational radioactive wastes. The relatively large numbers of ILW and spent fuel transports would only occur after the GDF becomes available, and the spent fuel and ILW storage facilities are decommissioned. The annual rate of transports would be dependent on the planned operational timescale for the overall management of UK ILW and spent fuel disposals at the GDF.

Table D14-17 Radioactive packages consigned annually to and from the Power Station

Package contents	Package description	Packages per year
New fuel (start-up)	HGV	44
New fuel (outage)	HGV	16
Wet solid LLW	THISO	14
Incineration LLW	HHISO	5
Metal for recycling	HHISO	1
VLLW	HHISO	1
LLW for LLWR	HHISO	2
LLW for compaction	FHISO	6
ILW packages	ILW transport package	144
Spent fuel	Fuel flask	100

Dose from start-up fuel would only apply during the initial fuelling period.
Outages occur every 18 months, so deliveries are averaged per year – i.e. 24 HGVs every 18 months equates to 16 per year.

14.4.53 Table D14-18 shows the typical dose rates associated with the various containers and conveyances that would be used to transport radioactive material to and from the Power Station Site.

Table D14-18 Dose rates for consignments for the Power Station

Packages	Contents	Typical dose rate at 1m (µSv/hr)
New fuel delivery	New fuel assemblies	100
14 HHISO and FHISO	LLW for incineration, metal for recycling, dry solid LLW for direct disposal	400
14 THISO	Wet solid encapsulated LLW for direct disposal	400
1 HHISO	VLLW for landfill disposal	2.5
106 ILW packages	ILW crud/resin	9
5 ILW packages	ILW control rod/metals	100
33 ILW packages	ILW RPV/internals	12
100 fuel flasks	Spent fuel	76.6

Embedded mitigation

14.4.54 The key mechanism for minimising discharges and disposals and the resulting impact from release of radioactive material to the environment is through demonstration of the application of BAT to the management of radioactive wastes.

14.4.55 BAT covers more than abatement and other end-of-pipe discharge controls. It applies across the whole lifecycle of the plant from design through procurement, construction, commissioning, operation and decommissioning. BAT also applies to operation and maintenance of relevant plant systems and equipment, and to procedures and management systems that may impact on environmental performance.

14.4.56 Demonstration of the application of BAT is a key requirement of the Environmental Permitting (England and Wales) Regulations 2016, and more details can be found in the EP-RSR application [RD2].

14.4.57 Intrinsic to the application of BAT is the minimisation of waste generation and discharges. This could include:

- minimisation at source;
- recycling and reuse of materials (where practicable);
- partitioning of radionuclides (where practicable) for disposal in a manner which causes the least environmental impact; and
- treatment of discharges whether by filtering, by binding onto compounds such as charcoal adsorption plant or ion-exchange resin, or evaporation.

14.4.58 For aqueous discharges, the application of BAT to the generation and disposal of radioactivity to the marine environment would include the following.

- Minimisation of radioactive discharges at source.
- Partitioning of radionuclides for disposal in a manner which causes the least environmental effect.
- Optimisation of dispersion once discharged (e.g. by timing of releases with tide cycle).
- Treatment of discharges whether by filtering, by binding onto compounds such as ion-exchange resin or evaporation.
- Optimisation of the operational regime of the liquid waste management system to minimise the volume and activity of secondary solid radioactive waste arisings (i.e. filters and resins). Integral to the Power Station design is the re-use and recycling of liquid effluent within the reactors, minimising the generation and subsequent discharge of radioactive waste.
- Abatement of the radioactive content of the waste stream as far as reasonably practicable, concentrating and containing the radioactivity in a solid form.

- Monitoring the aqueous effluent prior to discharge.
- Optimisation of the use of storage systems on-site to maximise potential for decay of radioactivity prior to discharge of the effluent.

14.4.59 For gaseous discharges, the application of BAT to the generation and disposal of radioactivity to air would include the following:

- minimisation of radioactive discharges at source;
- partitioning of radionuclides for disposal in a manner which causes the least environmental effect;
- treatment of discharges whether by filtering or by binding onto compounds such as charcoal adsorption plant;
- abatement of the radioactive content of the waste stream as far as reasonably practicable using carbon delay beds and high efficiency particulate filters;
- monitoring of gaseous wastes prior to discharge; and
- optimisation of dispersion once discharged (e.g. by the design of discharge stacks including optimisation of the stack height and location).

14.4.60 For the generation of solid radioactive wastes, the application of BAT would include the following:

- application of the waste management hierarchy;
- waste management strategies including selection of optimal disposal routes to minimise impact on people and the environment;
- minimisation of accumulated radioactive waste on-site (recognising cases where storage is required for decay purposes), and design of the waste storage systems to:
  - minimise release to the environment in normal operation, fault and accident conditions;
  - prevent the spread of contamination from leakage; and
  - incorporate leak detection and alarm capability for liquid and gaseous residues where appropriate.

Good practice mitigation

14.4.61 The use of robust transport containers to transport radioactive materials and waste, in accordance with the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, would minimise impacts from transport activities, as outlined in the traffic and transport strategy section of the Wylfa Newydd Code of Operational Practice (Application Reference Number: 8.13). Compliance with the Wylfa Newydd Code of Operational Practice would be secured through a Development Consent Order (DCO) requirement.

Decommissioning

14.4.62 As the Power Station enters the decommissioning phase, there would be an immediate reduction in doses via gaseous pathways, as fission and activation products would no longer be produced since the reactor would have ceased power generation. There would also be a reduction in dose resulting from the removal of the direct radiation pathway due to cessation of reactor activities. As decommissioning progresses, it is anticipated that doses from permitted discharges would be reduced overall, but there may be occasional temporary increases as specific projects are executed. Small direct radiation doses would still result from the shielded waste and spent fuel stores. The doses would progressively reduce during treatment and disposal of radioactive material. Direct radiation doses from material in the spent fuel and ILW storage facilities would remain until the spent fuel is removed to the GDF.

Basis of assessment and assumptions

14.4.63 The assessment of decommissioning activities presented here is based on the conservative assumption that, during the initial phases of decommissioning, discharges would be bounded by, and similar to, operational levels. BAT would be used in the management of discharges from the Power Station Site, though it is recognised that adoption of BAT to the management of some wastes may result in short-term increases in discharges of some radionuclides [RD42].

Embedded mitigation

14.4.64 Embedded mitigation during decommissioning would be identical to that described for the operation of the Power Station. This is because discharges of radioactive waste during decommissioning are also regulated by the Environmental Permitting (England and Wales) Regulations 2016, and so the same requirements for the demonstration of BAT would apply.

Good practice mitigation

14.4.65 The use of robust transport containers to transport radioactive materials and waste, in accordance with the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, would minimise impacts from transport activities, as outlined in the traffic and transport strategy section of the Wylfa Newydd Code of Operational Practice (Application Reference Number: 8.13). Compliance with the Wylfa Newydd Code of Operational Practice would be secured through a DCO requirement.

14.5 Assessment of effects

14.5.1 This section presents the findings of the assessment of effects associated with the construction, operation and decommissioning of the Power Station Site.

Construction

14.5.2 Exposures from geophysics sources and from discovery of contaminated material are well controlled by good practice mitigation required by the Ionising Radiations Regulations 2017, and are judged to have negligible impact and significance.

14.5.3 Construction activities may remobilise soil for onshore activities, and sediments during marine works. Any radionuclide content associated with this material during these movements has the potential to result in radiological effects via resuspension and inhalation of dust or incorporation into the marine food chain for marine sediments.

14.5.4 It is not anticipated that residual radioactive materials from the Existing Power Station would be encountered in soils and sediments excavated during clearance and excavation activities, beyond those already reported in routine monitoring programmes. A rock and soil sampling survey across the Power Station Site found that there was no evidence of elevated radionuclide concentrations above typical backgrounds for Anglesey and north Wales [RD29] (see section 14.3).

14.5.5 Measurements of radioactivity in marine rock and sediment samples taken from the proposed location of the Marine Off-Loading Facility show low levels similar to those observed in the routine monitoring programme around the Existing Power Station (see section 14.3).

14.5.6 The levels of anthropogenic radioactivity in soils and sediments are similar to levels measured across the region as a whole. There is no risk of enhanced exposures above those seen at other construction sites in the area. Construction activities would not lead to redistribution of this material, since the radioactivity levels in the region are relatively homogenous.

14.5.7 The Existing Power Station is designed to minimise the potential for ground contamination. The desk study of potential contamination on the Existing Power Station site (quoted in [RD29]) identified no sources of radioactive ground contamination. It was concluded that the migration of water or liquid contamination on that site would be relatively slow both laterally and vertically within the unsaturated zone (i.e. above the water table), such that, if contamination was present, then it would be likely to remain close to the source. It was stated that contamination which reached groundwater would migrate very slowly towards the coast. Significant contamination migration onto the Power Station Site via groundwater is therefore unlikely.

14.5.8 The only measurements of anthropogenic activity in soil and sediment above Limits of Detection are of caesium-137 and americium-241. Measured concentrations of americium-241 and caesium-137 in recent soil and sediment samples from the construction areas range from 1–7Bq/kg.

14.5.9 The maximum caesium-137 concentration recorded was 6.43Bq/kg, which is substantially below the out of scope radioactive material definition for caesium-137 from the Environmental Permitting (England and Wales) Regulations 2016 of 1000Bq/kg, as well as being below the IAEA clearance and exemption value of 100Bq/kg [RD32].

14.5.10 These levels are below those identified as representing “no danger” on the basis of guidance [RD43]. Exposures to concentrations at these levels result in assessed doses to operators and the public of 10µSv/y or less and risk levels of less than one in a million.

14.5.11 On the basis of the above, it is assessed that doses to construction workers are less than 1µSv/y and therefore as having negligible impact and significance.

14.5.12 The disposal of marine sediments would require an assessment as part of the disposal licensing process. However, the material is taken from the local environment which is already subject to an extensive monitoring programme (see paragraph 14.3.19 onwards in section 14.3), and resulting doses are likely to be bounded by the results from those surveys. In addition, the concentrations are shown to be below out of scope radioactive definition levels. Thus, the disposal of such low radioactivity concentrations can also be assessed as having negligible impact and significance.

Operation

14.5.13 The computer models described in section 14.4 of chapter B14 (Application Reference Number: 6.2.14) were configured with the input parameters described in section 14.2. The environmental radioactivity concentrations at the three non-human species receptor locations were calculated and were used as inputs to the non-human species models.

14.5.14 Doses from exposure to radioactive discharges are assessed assuming all discharges are considered to be planned, continuous and routine, continuing over the operational lifetime of the Power Station.

14.5.15 Detailed model results to the most exposed members of the public and CRPs in each age group are presented in the EP-RSR submission document [RD2].

14.5.16 Doses from the transport of nuclear materials to and from the Power Station Site are calculated at the location with the highest potential exposure: the Valley crossroads. Assuming that each transported package spends one minute stopped at the traffic signals (a typical duration for such a junction), table D14-19 shows the exposure parameters at these locations, and the calculated dose during transport for each package type.

Table D14-19 Annual radioactive material consignments for the Power Station passing Valley crossroads and resulting doses

Package	Location of members of public	Distance between vehicle and member of public	Exposure time per movement (minutes)	Number of movements exposed to per year	Typical dose rate at 1m (µSv/hr)	Annual dose (µSv/y)
Spent fuel	Commercial property	10	1	100	77	1.28
Spent fuel	Petrol	20	1	100	77	0.32

Package	Location of members of public	Distance between vehicle and member of public	Exposure time per movement (minutes)	Number of movements exposed to per year	Typical dose rate at 1m (µSv/hr)	Annual dose (µSv/y)
	station					
Spent fuel	Public house	30	1	100	77	0.14
LLW	Commercial property	10	1	28	400	1.87
LLW	Petrol station	20	1	28	400	0.47
LLW	Public house	30	1	28	400	0.21
VLLW	Commercial property	10	1	1	2.5	4.2E-04
VLLW	Petrol station	20	1	1	2.5	1.0E-04
VLLW	Public house	30	1	1	2.5	4.6E-05
New fuel (start-up)	Commercial property	10	1	44	100	0.73
New fuel (start-up)	Petrol station	20	1	44	100	0.18
New fuel (start-up)	Public house	30	1	44	100	0.08
New fuel (outage)	Commercial property	10	1	16	100	0.27
New fuel (outage)	Petrol station	20	1	16	100	0.07
New fuel (outage)	Public house	30	1	16	100	0.03
ILW Crud/Resin	Commercial property	10	1	107	9	0.16
ILW Crud/Resin	Petrol station	20	1	107	9	0.04
ILW Crud/Resin	Public house	30	1	107	9	0.02
ILW control rod/metal	Commercial property	10	1	5	100	0.08
ILW	Petrol	20	1	5	100	0.02

Package	Location of members of public	Distance between vehicle and member of public	Exposure time per movement (minutes)	Number of movements exposed to per year	Typical dose rate at 1m (µSv/hr)	Annual dose (µSv/y)
control rod/metal	station					
ILW control rod/metal	Public house	30	1	5	100	0.01
ILW RPV	Commercial property	10	1	33	12	0.07
ILW RPV	Petrol station	20	1	33	12	0.02
ILW RPV	Public house	30	1	33	12	0.01

Summary of doses to receptors

14.5.17 The highest doses for the most exposed members of the public via separate pathways and to CRPs are summarised in table D14-20, and these are then assessed using the methodology described in chapter B14 (Application Reference Number: 6.2.14).

Table D14-20 Doses via exposure pathways and to CRPs

CRP or exposure pathway	Dose (µSv/y)	EIA Magnitude
Gaseous discharges CRP – Farming family with contribution from aqueous discharges and external irradiation	37.7 (infant), 20.6 (child), 19.7 (adult)	Small
Aqueous discharges CRP – Fishing family with contribution from gaseous discharges (which dominate the total) and external irradiation	29.1 (infant), 17.0 (child), 16.4 (adult)	Small
Existing Power Station worker	2.66 (adult), including 0.43 external irradiation	Negligible
External irradiation at residential location	0.022 (infant), 0.032 (child), 0.063 (adult)	Negligible
External doses whilst walking at the Power Station Site perimeter	1.78 (Walker 1), 0.004 (Walker 2), 0.008 (Walker 3) (for Walker 1, 90% of the dose	Negligible

CRP or exposure pathway	Dose (µSv/y)	EIA Magnitude
	is due to exposure from the spent fuel storage facility)	
External doses from transport (commercial property) – initial fuel loading	0.73	Negligible
External doses from transport (commercial property) – operations	2.1 (LLW + VLLW + outage refuelling)	Negligible
External doses from transport (commercial property) – ILW disposals	0.31	Negligible
External doses from transport (commercial property) – Spent fuel disposals	1.28	Negligible

14.5.18 Doses from gaseous discharges give the highest contribution to the most exposed members of the public, and the selected Representative Person is for the infant of the farming family who also have exposure to aqueous discharges via their consumption of local seafood and coast occupancy. The major radionuclide contribution to gaseous doses is from carbon-14 and for aqueous discharges is from cobalt-60 and tritium.

14.5.19 Only the most exposed members of the public and CRPs receiving doses resulting from gaseous discharges are judged to have greater than negligible magnitude. It should be noted that the selection of a conservative effective release height as described in section 14.4 would have a large impact on the dose arising from gaseous discharges. The selection of a release height based upon a more detailed analysis of stack dispersion performance is likely to result in a much-reduced estimate of doses to the Representative Person from gaseous discharges.

14.5.20 Doses to Existing Power Station workers on the Existing Power Station site are 2.23µSv/y from gaseous discharge pathways and 0.43µSv/y from external irradiation.

14.5.21 For the external irradiation pathways, the most exposed member of the public who is likely to receive the highest annual dose due to walking in the vicinity of the Power Station Site is 'Walker 1', who incurs an annual dose of 1.78µSv/y (of which 90% is attributable to the spent fuel and ILW storage facilities). The highest external dose at a residential location is 0.063µSv/y for an adult.

14.5.22 The most exposed members of the public likely to receive the highest dose due to the transport of radioactive material to and from the Power Station are located inside the commercial building closest to the Valley crossroads (see table D14-19). It is assumed that such a person is the owner or a worker at this location and would be present for all transports. The member of the

public in this location is assumed to receive a total annual dose of 2.1µSv during operational transports to and from the Power Station Site. During the initial fuelling period of the reactors, the member of the public at this location would receive 0.73µSv due to new fuel transports. Annual doses from ILW and spent fuel disposals are 0.31µSv and 1.28µSv respectively, although these doses would only be occurred once the GDF is available.

Uncertainty in assessment

14.5.23 Guidance [RD3] indicates that a semi-quantitative evaluation of uncertainty and variability should be performed, such that:

"…an appropriate level of caution has been applied to the assessment. The review [of uncertainty and variability] will ensure that sufficient caution has been retained such that the dose limit is unlikely to be exceeded on the basis of a retrospective assessment…but balancing this against ensuring that there has not been an undue level of caution applied in the assessment".

14.5.24 Undertaking any assessment of prospective doses necessarily involves the application of models and the making of assumptions regarding future transfers, activities and human behaviour. As a result, varying degrees of uncertainty are present in the assessments presented in this report. The key uncertainties in the assessment process are as follows:

- the estimate of the radioactive discharge to the environment;
- the dispersion of radioactivity following aqueous and gaseous discharges to the environment;
- the transfer of radioactivity in the environment;
- assumed habits; and
- dose coefficients for the inhalation or ingestion of radioactive species.

14.5.25 Uncertainty and sensitivity analyses related to these topics are reported within the EP-RSR application [RD2]. It is concluded that the uncertainties present do not have a significant impact on the magnitude of the radiological effects presented here.

Summary of doses to most affected non-human species in each habitat type

14.5.26 The maximum assessed doses to non-human species in all three habitat types are listed in table D14-21. The table shows the species in which the maximum dose in each habitat is observed. The terrestrial assessment includes results from the ERICA assessment, and results from the R&D128 assessment (see chapter B14, Application Reference Number: 6.2.14) are presented to account for the noble gas component. All magnitudes are assessed as negligible as they are below the ERICA screening level of 10µGy/hr. This is lower than the statutory screening level of 40µGy/hr.

Table D14-21 Peak dose rates in all habitats types

Habitat / Organism	ERICA results (µGy/hr)	R&D128 results (µGy/hr)	Total dose rate per organism (µGy/hr)
Terrestrial			
All mammals, reptiles, birds	6.17E-01	2.76E-04	6.17E-01
Marine			
Mammals	5.01E-05	-	5.01E-05
Freshwater			
Insect larvae	3.90E-02	-	3.90E-02

Summary of effects from operational activities

14.5.27 The assessment of radiological effects due to operational activities is summarised in table D14-25. Only effects relating to the Representative Person for gaseous and aqueous discharges have an impact magnitude of 'small', with all other magnitudes assessed as negligible. As described in chapter B14 (Application Reference Number: 6.2.14), small magnitude impacts are judged to be of negligible significance (see table B14-11 in chapter B14, Application Reference Number: 6.2.14), as doses are well below regulatory limits.

14.5.28 There is an extensive body of knowledge on the operation of nuclear plants, likely radioactive discharges and their environmental effects. There are uncertainties associated with model assumptions and input parameters. The dose assessment for the EP-RSR application is based on realistic but conservative assumptions, and the resulting assessment meets regulatory constraint levels. The doses are at the lower end of the magnitude of impact criteria (see table B14-11 in chapter B14, Application Reference Number: 6.2.14), and as such, the certainty attached to this assessment of effects is judged to be high.

14.5.29 In addition, there is an ongoing requirement as part of EP-RSR to review continuously the application of BAT to minimise the production of waste, discharges and the impact on the environment and the public.

Decommissioning

14.5.30 The decommissioning of nuclear power plants is covered by specific regulation, the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999, for which a separate environmental statement would be produced to support an application for decommissioning consent.

14.5.31 A qualitative assessment of decommissioning activities is based on the conservative assumption that, during the initial phases of decommissioning, discharges would be similar to operational levels. It is judged that doses to the public arising from these discharges would be bounded by those during

operations and are assumed to be identical to those described in table D14-20.

14.5.32 Doses from transport of spent fuel and other wastes are included within the assessment described in sections 14.2 and 14.4. Thus the doses presented in table D14-20 can be used to estimate doses during the decommissioning phase, as contributions from transport of spent fuel and ILW for final disposal at the GDF are also detailed.

Transboundary effects

14.5.33 As noted in the *National Policy Statement for Nuclear Power Generation (EN-6)* [RD1] (para 1.74), "*Due to the robustness of the regulatory regime there is a very low probability of an unintended release of radiation, and routine radioactive discharges will be within legally authorised limits. Significant trans-boundary effects arising from the construction of new nuclear power stations are not considered likely.*" Authorised discharge limits for the Power Station to be set under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016 would be set such that the resulting doses to the local population would be below legal dose constraints.

14.5.34 In terms of radiological effects from routine releases (table D14-20 and table D14-21), it can be seen there would be no significant effects resulting from discharges of radioactive waste from the Power Station. As these effects are assessed for receptors to Representative Persons and habitats in the immediate vicinity of the Power Station, it can be assumed that they are bounding, and that equivalent receptors in neighbouring countries would incur much lower doses due to the exponential decreases in radioactivity concentrations seen with distance from release.

14.5.35 It follows there would be no significant transboundary radiological effects from routine releases.

Collective dose results

14.5.36 Collective doses also present an indication of UK national and transboundary doses to European and world populations. Following the methodology described in section 14.2 of chapter B14 (Application Reference Number: 6.2.14), the following results have been calculated for this assessment.

14.5.37 Table D14-22 summarises the collective dose per year of discharge to UK, EU12, EU25 and world populations due to gaseous discharges truncated to 500 years.

Table D14-22 Collective dose per year of discharge due to gaseous discharges

Population	First pass (manSv)	Global circulation (manSv)	Total (manSv)	Average individual dose (Sv)
UK	1.95E-01	3.63E-01	5.58E-01	9.36E-09

Population	First pass (manSv)	Global circulation (manSv)	Total (manSv)	Average individual dose (Sv)
EU	9.63E-01	-	-	-
EU12	-	2.19E+00	3.15E+00	8.75E-09
EU25	-	2.78E+00	3.74E+00	8.20E-09
World	-	6.09E+01	6.09E+01	6.09E-09

14.5.38 UK first pass collective doses (see paragraph 14.2.46) due to gaseous discharges are primarily associated with ingestion of root vegetables (23%) and cow's milk (49%). EU first pass collective doses show a similar distribution, with consumption of root vegetables (24%) and cow's milk products (50%) being the dominant pathways. For both first pass and global circulation, the principal radionuclide was carbon-14, which contributed 94% to UK first pass, 97% to EU first pass and 100% to global circulation doses.

14.5.39 Table D14-23 summarises the collective dose per year of discharge to UK, EU12 and world populations due to aqueous discharges truncated to 500 years.

14.5.40 The first pass collective dose due to aqueous discharges was estimated by summation of fish, crustacean, mollusc and beach sediment gamma contributions.

Table D14-23 Collective dose per year due to aqueous discharges

Population	First pass (manSv)	Global circulation (manSv)	Total (manSv)	Average individual dose (nSv)
UK	4.99E-07	3.03E-07	8.02E-07	1.35E-05
EU12	1.30E-06	1.83E-06	3.12E-06	8.66E-06
World	1.92E-06	5.07E-05	5.26E-05	5.26E-06

14.5.41 The consumption of marine foodstuffs contributes 62% to the UK collective dose, 42% to the EU12 collective dose and only 4% to the world collective dose. For UK, EU12 and the world the contribution from beach sediment is zero.

14.5.42 First pass doses are the most significant for the UK population (62% compared to 38% for global circulation). The EU12 collective dose is more evenly split between first pass and global circulation (42% and 58% respectively), with world collective doses being dominated by global circulation (4% first pass and 96% global circulation). The dominant radionuclide is tritium for UK (84%), EU12 (89%) and the world (99%).

14.5.43 Average individual doses from aqueous discharges from the Power Station are 1.35E-05, 8.66E-06 and 5.26E-06nSv/y for populations of the UK, Europe (assumed to be EU12) and the world, respectively.

14.5.44 Average individual doses from atmospheric discharges from the Power Station are equal to 9.4E-09, 8.8E-09, 8.2E-09 and 6.1E-09Sv/y for populations of the UK, EU12, EU25 and the world respectively.

14.5.45 The IAEA states that discharges giving rise to calculated average annual individual doses for a population group in the nanosievert per year range or below should be ignored in the decision-making process as the associated risks are minuscule [RD32]. The risks presented by the average individual doses presented in this section are therefore of negligible significance.

14.5.46 Within the EU, every time a Member State plans to alter the way it disposes of radioactive waste or proposes a new facility that may increase emissions, it must make a submission to the European Commission as part of the Euratom Treaty, known as an Article 37 submission. This submission must include enough data to determine whether such plans are liable to result in the radioactive contamination of the water, soil or airspace of another Member State. This requires a full assessment of the effects at these locations of gaseous and aqueous discharges and solid waste disposals of radioactive waste from the Wylfa Newydd Project. The Article 37 assessment includes the effects from routine operations and a consideration of potential accident scenarios (also see appendix D14-2, Application Reference Number: 6.4.98).

Treatment of cumulative effects

14.5.47 The methodology for treatment of cumulative effects is described in chapter I3 (methodology) (Application Reference Number: 6.9.3). However, the assessment of cumulative effects is only undertaken for those effects with residual impacts of minor significance or above.

14.5.48 As can be seen in table D14-25, all residual radiological effects are judged to have negligible significance. However, the cumulative effects are presented here for information, and also as presentation of some of these cumulative impacts was requested during recent consultation exercises.

14.5.49 The only other project that could impact the receptors defined for radiological effects from the Power Station is the decommissioning of the Existing Power Station. The projects are both nuclear licensed sites in close proximity to each other. Both would have permits to discharge radioactive material to air and sea. They would both store radioactive material on-site which would result in direct external doses. They would both require the transport of radioactive material either to or from the two sites. Due to the proximity of the two power stations to receptor locations, it is assumed that all receptors identified in this radiological effects chapter would be affected to some extent by activities during decommissioning of the Existing Power Station.

14.5.50 The human receptors identified in section 14.2 are summarised in table D14-20, which also includes the calculated doses for each receptor from the proposed Power Station operation. Non-human species receptors are assumed to exist at the point of maximum local radioactivity concentration in the relevant medium (terrestrial, freshwater or marine).

14.5.51 As a conservative measure, it is assumed that the Representative Persons for the Existing Power Station are identical to those for the Power Station (and so the cumulative doses are calculated by adding the contributions from the two sites).

14.5.52 To enable the calculation of cumulative effects from both developments, estimates of doses for each pathway are required for activities associated with decommissioning the Existing Power Station. These are then combined with the calculated doses for the Power Station to give a total dose for each exposure pathway and Representative Person. These total doses are then assessed according to the methodology described in chapter B14 (Application Reference Number: 6.2.14).

Doses from authorised discharges

14.5.53 Environmental levels of radioactivity and hence doses to local Representative Persons are a reflection of current and past discharges from the Existing Power Station (as well as including contributions from authorised discharge from facilities further afield). Local levels are reported annually in the RIFE series of reports (see section 14.3). Terrestrial and marine doses to the local Representative Persons range from 5µSv/y to 10µSv/y (with a maximum of 13µSv/y). It is conservatively assumed that a value of 13µSv/y is typical of the dose incurred by each group.

14.5.54 It is assumed that, during the initial phases of decommissioning at the Existing Power Station, aqueous discharges remain similar to current levels. This is because the waste treatment plants continue to operate in a similar fashion to during operations. Gaseous discharges would reduce markedly as the reactor power has reduced and defueling commences. However, in the first instance, it is assumed gaseous and aqueous discharges remain similar to those during operations and result in similar doses to members of the public.

14.5.55 Predicted future discharges during decommissioning of the Existing Power Station are included within assessment prepared for the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 [RD44]. Doses to the fishing (0.033µSv/y) and farming families (1.1µSv/y) resulting from these discharges are calculated as part of the combined assessment section in the EP-RSR application for the Power Station [RD2].

Doses from external irradiation

14.5.56 External radiation doses would still result from waste stores at the Existing Power Station. It is assumed that external radiation sources and dose rates from these facilities are similar to those calculated for the proposed Power Station. No detailed assessment is available; however, it is stated that direct radiation would not exceed 20µSv/y [RD44].

14.5.57 For the three walking groups, the assumed locations are all at much further distances from the Existing Power Station, and there is no equivalent group in the assessment for the Existing Power Station.

Doses from transport

14.5.58 Doses from transport of radioactive material from the proposed Power Station are reported in section 14.5 (table D14-20). Doses would also result from transport of radioactive materials from the Existing Power Station. There is unlikely to be a synchronous correspondence between the transport

activities at the two sites because of the different development phases of each site. For instance, spent fuel would have been removed from the Existing Power Station before the Power Station commences operations. The transport associated with the removal of ILW wastes from both sites and spent fuel from the Power Station would occur over the same periods, following the availability of the GDF.

14.5.59 VLLW and LLW would be removed from the Existing Power Station during decommissioning, and this would occur at the same time as operational transports occur for the Power Station. However, there is no current information available on amounts of decommissioning wastes likely to arise from the Existing Power Station.

Doses to biota

14.5.60 In the Environmental Permit application [RD2], a simple assessment is made of the impact of discharges from the Existing Power Station on non-human biota in each habitat type. These are reported as follows:

- terrestrial wildlife 1.2µGy/hr;
- marine wildlife 0.59µGy/hr; and
- freshwater wildlife 0.15µGy/hr.

14.5.61 Combining these with the highest species doses in each habitat type from table D14-21, gives the following total doses:

- terrestrial birds, mammals and reptiles 1.82µGy/hr;
- marine mammals 0.59µGy/hr; and
- freshwater insect larvae 0.19µGy/hr.

Summary

14.5.62 The cumulative doses and impacts are assessed for the most exposed receptors affected by operation/decommissioning at the Power Station and decommissioning of the Existing Power Station. The total dose to the farming family Representative Person is calculated based on contributions from gaseous and aqueous discharges, external irradiation and current discharges. The magnitude of the effect is calculated using the methodology presented in chapter B14 (Application Reference Number: 6.2.14). In all cases, all regulatory criteria would be met and disposals and discharges from both projects would be continually reduced by the application of BAT, so the effects are judged to be not significant. The results are summarised in table D14-24.

Table D14-24 Combined doses to exposure groups and cumulative effects

Exposure group	Power Station dose (µSv/y)	Existing Power Station dose (µSv/y)	Total (µSv/y)	EIA magnitude/ significance

Exposure group	Power Station dose (µSv/y)	Existing Power Station dose (µSv/y)	Total (µSv/y)	EIA magnitude/ significance
Most exposed persons – Farming family	37.7 (infant)	1.1	38.8	Small/ negligible
Most exposed persons – Fishing family	6.8E-05 (adult)	0.033	0.033	Negligible/ negligible
External irradiation at residential location	0.063 (adult)	20	>20	Small/ negligible
External doses whilst walking at the Power Station Site perimeter	1.78 (Walker 1)	(no equivalent)	1.78	Negligible/ negligible
External doses from transport (commercial property) – initial fuel loading	0.73	0	0.73	Negligible/ negligible
External doses from transport (commercial property) – operations	2.1 (LLW + VLLW + outage refuelling)	No information available	>2.1	Negligible/ negligible
External doses from transport (commercial property) – ILW disposals	0.31	No information available	>0.31	Negligible/ negligible
External doses from transport (commercial property) – Spent fuel disposals	1.28	0	1.28	Negligible/ negligible
CRP – Farming family with contribution from aqueous discharges and external irradiation	37.8	1.1	71.9 (includes a contribution of 13µSv/y from current discharges and 20µSv/y from	Small/ negligible

Exposure group	Power Station dose (µSv/y)	Existing Power Station dose (µSv/y)	Total (µSv/y)	EIA magnitude/ significance
			external irradiation)	
Doses for the following exposure groups are measured in µGy/hr.				
Terrestrial biota (bird, mammal, reptile)	0.62	1.2	1.82	Negligible/ negligible
Marine biota (mammal)	5.0E-05	0.59	0.59	Negligible/ negligible
Freshwater biota (insect larvae)	0.04	0.15	0.19	Negligible/ negligible

14.6 Additional mitigation

14.6.1 In accordance with chapter B1 (introduction to the assessment process) (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to radiological effects were taken into account when determining the 'pre-mitigation' significance of effects. These are detailed in the design basis and activities section of this chapter.

14.6.2 No potential significant effects have been identified; therefore, no additional mitigation measures have been required.

14.7 Residual effects

14.7.1 Minor effects related to the impact of gaseous discharges on the farming and fishing family CRP were assessed (see table D14-20), which were assessed as being of negligible significance (see paragraph 14.5.27).

14.7.2 No significant adverse radiological effects from routine construction, operation and decommissioning were identified, as shown in table D14-25.

14.7.3 There is an extensive body of knowledge on the operation of nuclear plants, likely radioactive discharges and their environmental effects. There are uncertainties associated with model assumptions and input parameters. The dose assessment for the EP-RSR application is based on realistic but conservative assumptions, and the resulting assessment meets regulatory constraint levels. The doses are at the lower end of the magnitude of impact criteria (see table B14-11 in chapter B14, Application Reference Number: 6.2.14), and as such, the certainty attached to this assessment of effects is judged to be high.

14.7.4 In addition, there is an ongoing requirement as part of EP-RSR to review continuously the application of BAT, including a commitment to achieve future incremental reductions in discharges where potential improvements are identified.

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Table D14-25 Summary of residual effects

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Construction								
Construction worker	High	Doses to workers on the Power Station construction sites from potential radioactive contamination in soils and sediments	Adverse Local Short-term	Negligible	Negligible	N/A	Negligible	Negligible
Operation								
Gaseous discharges CRP – farming family with contribution from aqueous discharges and external irradiation	High	Doses to the public from routine gaseous discharges	Adverse Local Long-term	Small	Negligible	N/A	Small	Negligible

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Aqueous discharges CRP – fishing family with contribution from gaseous discharges and external irradiation	High	Doses to the public from routine aqueous discharges	Adverse Local Long - term	Small	Negligible	N/A	Negligible	Negligible
Existing Power Station workers	High	Doses to workers at the Existing Power Station from direct radiation from reactor operations and the generation and storage of solid radioactive wastes at the Power Station	Adverse Local Short-term	Negligible	Negligible	N/A	Negligible	Negligible

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Recreational walkers adjacent to Power Station boundary	High	Doses to the public from direct radiation from reactor operations and the generation and storage of solid radioactive wastes at the Power Station	Adverse Local Short-term	Negligible	Negligible	N/A	Negligible	Negligible
Most exposed residents adjacent to transport routes	High	Direct doses to the public from transport of radioactive materials to and from the Power Station	Adverse Local Short-term	Negligible	Negligible	N/A	Negligible	Negligible

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effect
Non-human species with highest doses in the terrestrial, marine and freshwater environments	High	Doses to non-human species in the terrestrial, marine and freshwater environments close to the Power Station Site	Adverse Regional Long-term	Negligible	Negligible	N/A	Negligible	Negligible
Decommissioning – identical to those for operation								

14.8 References

Table D14-26 Schedule of references

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HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

6.4.15 ES Volume D - WNDA Development D15 - Shipping and navigation

PINS Reference Number: EN010007

Application Reference Number: 6.4.15

June 2018

Revision 1.0

Regulation Number: 5(2)(a)

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-JAC-PAC-CHT-00047

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15 Shipping and navigation

15.1 Introduction

15.1.1 This chapter describes the assessment of potential shipping and navigation effects resulting from the construction, operation and decommissioning of the Power Station, other on-site development as described in chapter A1 (introduction) (Application Reference Number: 6.1.1) of this Environmental Statement, the Marine Works and the Site Campus within the Wylfa Newydd Development Area.

15.1.2 Please refer to chapter B15 (shipping and navigation) (Application Reference Number: 6.2.15) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the shipping and navigation assessment; and assessment methodologies and criteria.

15.2 Study area

15.2.1 This section describes the study area relevant to the shipping and navigation assessment.

15.2.2 The study area covers an area of approximately 25 nautical miles by 18 nautical miles, which includes The Skerries Traffic Separation Scheme (TSS) to the west and north of the Wylfa Newydd Development Area, Dulas Bay to the east and encompasses the Disposal Site at the newly licensed Holyhead North (IS043) site. Figure 1 in the Navigational Risk Assessment (NRA) (appendix D15-1, Application Reference Number: 6.4.99) depicts the study area.

15.2.3 The Skerries TSS is regularly used by vessels transiting to and from ports on the north coast of Wales and on the north-west coast of England, in particular Liverpool. It is located four nautical miles, at its nearest point, from the north Anglesey coastline.

15.2.4 Territorial waters extend 12 nautical miles from the coast where that country has sovereignty. There is also the exclusive economic zone for each country, which extends 200 nautical miles from the coast where that country has rights over the marine resources in that area. The Irish Sea is completely within the UK and Irish exclusive economic zone, so there are no international waters in the Irish Sea.

15.3 Baseline environment

15.3.1 This section provides a summary of the baseline conditions for shipping and navigation within the study area described in section 15.2.

15.3.2 The baseline environment for commercial shipping and recreational navigation within the study area was reviewed in the NRA (appendix D15-1, Application Reference Number: 6.4.99) and a summary is provided within this section. A full description of the baseline environment is provided in the NRA (appendix D15-1, Application Reference Number: 6.4.99).

Navigational equipment

15.3.3 Porth-y-pistyll Bay is not currently used by commercial vessels. Due to navigational features in the area such as navigational buoys and The Skerries off the north-west coast of Anglesey (see figure 2 of appendix D15-1, Application Reference Number: 6.4.99), large vessels typically navigate around four nautical miles from the coastline. The largest port within the study area is the Port of Holyhead, which is operated by Stena Line Ports Ltd, which has ferry services to Ireland operated by Stena Line Ports Ltd and Irish Ferries. The other harbours located within the study area are at Cemaes Bay and Amlwch. These harbours are mainly used by smaller recreational and fishing vessels. A pilot boarding station is located two nautical miles north of Point Lynas.

15.3.4 A significant feature within the study area is The Skerries TSS, which is regularly used by vessels transiting to and from ports on the west coast of Wales and the north-west coast of England.

Statutory responsibilities and management procedures

15.3.5 There are currently no statutory harbour authorities covering the location of the Marine Works. Recreational vessels regularly report their departure and intentions to the coastguard station situated at Holyhead, and vessels navigating to or from Holyhead contact Holyhead Port Control, which is operated by Stena Line Ports Ltd.

Recreational facilities

15.3.6 Within the study area, there are recreational facilities available at Holyhead Marina where approximately 350 berths are offered, alongside the Royal Yachting Association accredited Holyhead sailing club. In general, cruising takes place all year round with increased intensity in the summer months. The Holyhead Sailing Club organises yacht racing between April and October with several of their racing routes following the north coast of Anglesey. The bays and inlets along the north coast of Anglesey do not provide permanent mooring facilities, but do provide sheltered anchorages for an overnight stop-off point. These are regularly navigated by recreational kayakers and other small craft. These craft can be navigating in the embayments and close to the coastline to gain shelter from weather conditions due to the profile of the coastline.

Fishing activities

15.3.7 Vessels operating out of Cemaes and Amlwch harbour regularly undertake fishing activities in Cemlyn Bay. Some fishing activities, such as pot laying, are undertaken within the Wylfa Newydd Development Area.

Aids to navigation

15.3.8 There are a number of cardinal marker buoys to the east of Wylfa Head marking where rocks are close to the surface, and also to the west marking The Skerries. A radar beacon is in operation at The Skerries lighthouse to enable its location to be represented on a vessel's radar screen. Further to

this, a differential global positioning system is located at Point Lynas on the north-east tip of Anglesey.

15.3.9 The Existing Power Station jetty located within the Wylfa Newydd Development Area has port lateral marks to aid vessels berthing at the jetty.

Emergency responses

15.3.10 A range of emergency responses are available in the study area, including HM Coastguard and Royal National Lifeboat Institution located at Holyhead and Moelfre. These services have access to a number of resources including aircraft, vessels and coastal search teams. The coverage area for the two lifeboat stations is sufficient to cover the north coast of Anglesey.

Marine incidents

15.3.11 Over the past 10 years, the most common marine incident within the study area is the failure of vessel equipment, with an average annual frequency of 17.3 occurrences per year. More serious marine incidents, such as ship-to-ship collisions, fire/explosion and sinking/capsizing occur very infrequently within the study area, with only five reported occurrences within the ten-year analysis period: three of these were sinking/capsize; one was collision; and one was fire/explosion.

Evolution of the baseline

15.3.12 The NRA (appendix D15-1, Application Reference Number: 6.4.99) assesses the potential future changes in vessel movements in detail. The future prediction uses the rationale of an approximate 3% increase in vessel transits over the period of construction for the Wylfa Newydd Project. The future prediction completes at the point at which the reactor becomes operational.

15.3.13 It should be noted that predicted vessel use has been based on data provided by the Department for Transport. It is intrinsically linked to national and international economic conditions.

15.4 Design basis and activities

15.4.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that will be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

15.4.2 As described in chapter D1 (proposed development) (Application Reference Number: 6.4.1), the application for development consent is based on a parameter approach. The assessment described within this chapter has taken into consideration the flexibility afforded by the parameters. A worst case has therefore been assessed from a shipping and navigation perspective within the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction of MOLF

15.4.3 The construction phase of the Marine Off-Loading Facility (MOLF) precedes the Main Construction phase.

Basis of assessment and assumptions

Marine construction and MOLF

15.4.4 The marine facilities would encompass two purpose-built quays with mooring dolphins for use as bulk berths, and a Roll-on Roll-off (Ro-Ro) berth. These would be located in Porth-y-pistyll, directly to the south-west of the Existing Power Station. The MOLF would be required to facilitate the construction of the Power Station through delivery of key freight by sea, and would therefore be constructed early in the programme and be operational throughout the Main Construction phase. It would provide purpose-built berths to allow delivery of freight by sea.

15.4.5 Use of the MOLF would greatly reduce the number of deliveries by road and therefore the volume of traffic and its associated effects. Current estimates are approximately 60% to 80% of all construction materials (by weight), including the majority of Abnormal Indivisible Loads, would be delivered via the MOLF. This chapter considers the worst case for its assessment.

15.4.6 In addition to the bulk and Ro-Ro quays, the MOLF would include a temporary layby berth that vessels could be moored against for short-term waiting until the destination bulk or Ro-Ro berth is available. The berth would be located at the southern end of the western breakwater and consist of a series of berthing and mooring dolphin structures.

15.4.7 A pontoon would be required for mooring tugboats, pilot vessels and other small workboats during the construction of the Power Station. It would be located in the vicinity of the Ro-Ro MOLF. The pontoon would take the form of a floating pontoon supported by guide piles drilled and grouted into the seabed. Fenders and bollards would be installed on the pontoon to allow for berthing. The pontoon would be connected to the shore by an articulating access bridge on piled supports drilled and grouted into the seabed.

15.4.8 A temporary access ramp would be constructed as one of the initial marine construction activities at the southern end of Porth-y-pistyll. This would take the form of a slipway and would be used to import the large-scale construction plant required for the site establishment and levelling and deep excavations. Once built, it is anticipated that the ramp would remain in place for a limited period of time before being dismantled and removed.

15.4.9 A further initial marine construction activity would be the construction of a temporary berthing and unloading facility, established in order to accommodate barges importing construction materials for subsequent Marine Works, rock armour units for the cooling water intake breakwaters, and for the berthing of other marine construction plant. Once the MOLF is part-constructed, the temporary barge berth would be removed.

15.4.10 Further details of construction can be found in chapter D1 (Application Reference Number: 6.4.1) of this Environmental Statement.

Breakwater construction

15.4.11 The principal purpose of the breakwaters would be the creation of a calm wave environment for the cooling water intake. However, it would serve a secondary purpose, which would be the provision of calm waters inside the harbour for operation of the MOLF. This would facilitate easy berthing of the vessels at the MOLF.

15.4.12 There would be two breakwaters extending out into Porth-y-pistyll to provide shore protection and create acceptable wave conditions for operation of the cooling water intakes. The western breakwater would be connected to shore by a temporary causeway during construction whilst the eastern breakwater would be shore-connected.

15.4.13 Further detail of the lengths and levels of the breakwaters can be found in chapter D1 (Application Reference Number: 6.4.1) of this Environmental Statement.

Dredging

15.4.14 Dredging would be required to form the navigational access channel and berthing area adjacent to the MOLF. It is anticipated that approximately 242,000m^3 of soft sediment (as a bulked volume) and approximately 368,000m^3 of rock material (as a bulked volume) would be dredged. All the soft sediment would be disposed of at sea. Although it is intended to re-use as much of the excavated rock material as possible within the construction works, any material that is unsuitable for re-use or surplus to requirements would be disposed of at sea. The worst case has been assessed within chapter D12 (coastal processes and coastal geomorphology) (Application Reference Number: 6.4.12) and D13 (the marine environment) (Application Reference Number: 6.4.13) of this Environmental Statement, which assumes that all dredged material (i.e. 610,000m^3) is disposed of at sea.

15.4.15 The Disposal Site situated at Holyhead North approximately 18km west of Porth-y-pistyll.

Embedded mitigation

15.4.16 No embedded mitigation measures have been identified for shipping and navigation for construction of the Marine Works.

Good practice mitigation

15.4.17 There are a number of mitigation measures representing established industry practice or guidance that would be undertaken to meet legislative requirements, detailed in table D15-1. These will be secured as detailed in section 5 of the Marine Works sub-Code of Construction Practice (CoCP) (Application Reference Number: 8.8).

Table D15-1 Good practice mitigation measures

Good practice mitigation measure	Description
Communications equipment	Appropriate use of communications equipment between the port area and incoming/outgoing vessels.
Notices to mariners	Issued weekly by the Admiralty to advise mariners of important matters affecting navigational safety.
Safe systems of work	Safe working methods to be established at the port to eliminate or reduce risks associated with the identified hazards.
International Regulations for Preventing Collisions at Sea 1972 (COLREGS) [RD1]	Adherence to the international COLREGS, which set out the navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels.
Emergency services equipment	To be provided shoreside for immediate use by emergency services in the event of a marine incident.
Safety operating procedures	A set of written instructions that document a routine activity, intended to reduce risk and assist with staff training.
Visual observation	Crew on board vessels to be aware of other vessels in their path to allow deviation if required.
Shoreside signage	Provide individuals who are unfamiliar with methods and regulations with information, to reduce risk of marine incidents.
Tidal levels	Tide level observed on-site and made available to vessels to inform navigation.
Vessel safety procedures	Vessels to have their own safety procedures on-board to manage marine incidents, should they occur.
Standards of Training, Certification and Watchkeeping for Seafarers [RD2]	Sets qualification standards for masters, officers and watch personnel on seagoing merchant ships to ensure suitably qualified personnel in vessel operation.
Passage planning	Plan of a vessel's voyage from start to finish to prepare for hazards that may be encountered and reduce impacts associated with these hazards.
Inspections and surveys	Port and flag state inspections and surveys of vessels to ensure they are fit for use –

Good practice mitigation measure	Description
	reducing chances of vessel-related marine incident.
Notification of vessel defects	Requirement for vessels to notify the port of any vessel defects allowing for appropriate accommodation of the vessel.
Weather forecasting	Advance warning and weather forecasts gained from available internet resources and metocean forecasts.
Notice of hazardous cargo	Advance warning of hazardous cargo to ensure appropriate measures are put in place for its handling.
Tug/workboat certification	Ensures that tugs/workboats are fit for purpose.
Tow survey	Carried out by classification society to set maximum limits for wind and wave heights.

Operation of MOLF

15.4.18 The operational phase of the MOLF would occur simultaneously with the Main Construction phase.

Basis of assessment and assumptions

15.4.19 The marine facilities are intended to be available for use three months prior to the First Nuclear Construction. Therefore, by First Nuclear Construction, the MOLF would be operational to facilitate construction of the Main Site.

15.4.20 There would be approximately 1,571 bulk vessels and 330 Abnormal Indivisible Load barges, plus approximately 825 barges for both transporting dredge material to Disposal Site and importing rock material. These shipping numbers are expected to occur over approximately an 80-month period and account. Each vessel would have two movements associated with it.

15.4.21 For further detail on the proposed operational period of the MOLF, refer to chapter D1 (Application Reference Number: 6.4.1) of this Environmental Statement.

Embedded mitigation

15.4.22 No embedded mitigation measures have been identified for the operational phase of the MOLF, which would occur simultaneously with the Main Construction phase.

Good practice mitigation

15.4.23 All good practice mitigation measures identified for the Marine Works and MOLF construction phase would also be applicable during the MOLF operational phase.

Operation of Power Station

Basis of assessment and assumptions

15.4.24 There is currently no confirmed usage of the MOLF during the operational phase of the Power Station. However, all or part of the MOLF may be retained for use during Power Station operation. The Ro-Ro quay may be used for delivery of replacement parts, which are Abnormal Indivisible Loads; it is currently assumed that only one vessel per year would use the MOLF during operation.

Embedded mitigation

15.4.25 No embedded mitigation measures have been identified for the operational phase of the Power Station.

Good practice mitigation

15.4.26 All good practice mitigation measures applicable to the Marine Works and MOLF construction and MOLF operational phases would be applicable to the operational phase of the Power Station.

Decommissioning

Basis of assessment and assumptions

15.4.27 The decommissioning process is not anticipated to occur for over 60 years and would require a further Environmental Impact Assessment under the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999, which would assess in detail the effects against the baseline conditions at that time. For this topic, it was suggested by the Maritime and Coastguard Agency (MCA) that decommissioning did not need to be considered with the NRA. However, this Environmental Statement chapter does broadly consider the possible effect of the decommissioning phase.

15.4.28 Activities associated with decommissioning are outlined in chapter D1 (Application Reference Number: 6.4.1). The decommissioning activities that are of particular relevance to shipping and navigation are: the removal of structures including the intake, outfall and MOLF, but not the breakwaters.

15.4.29 The details of decommissioning are not known at this time and to facilitate the assessment a number of assumptions have been made:

- the Power Station would operate for 60 years;
- the removal of structures would be carried out using similar equipment as for construction;
- there would be no requirement for marine disposal activities.

15.4.30 Whilst the potential use of the MOLF during the decommissioning phase is currently unknown, it is likely that a proportion of demolished materials may be transported from the Wylfa Newydd Development Area during this phase. However, vessel volumes during the decommissioning phase are not likely to

exceed that of Main Construction and would occur over a significantly longer period of time, which suggests that the increase in vessel movements on the baseline condition would likely be significantly less. It should be noted that vessel movements can only be assumed at this stage.

Embedded mitigation

15.4.31 No embedded mitigation in relation to decommissioning has been identified at this stage.

Good practice mitigation

15.4.32 No good practice mitigation in relation to decommissioning has been identified at this stage.

15.5 Assessment of effects

15.5.1 This section presents the findings of the assessment of effects associated with the construction and operation of the Wylfa Newydd Project.

15.5.2 As discussed in chapter B15 (Application Reference Number: 6.2.15), the assessment in this chapter is based on the risk assessment presented in appendix D15-1 (Application Reference Number: 6.4.99); the effects assessed are based on those identified as 'significant risk' or above during the NRA hazard identification workshop at which Trinity House Lighthouse Service (THLS), the MCA and key stakeholders were present. Significant risk or above identified in the NRA (appendix D15-1, Application Reference Number: 6.4.99) is equivalent to a 'moderate' or 'major' significance of effect in terms of assessed significance of effects. For further details, please refer to figure B1-2 in chapter B1 (introduction to the assessment process) (Application Reference Number: 6.2.1).

15.5.3 The effects are assessed for the construction of the MOLF and then the operational phase of the MOLF (which runs in tandem with the Main Construction of the Power Station).

Construction of MOLF

15.5.4 The following potential effects were identified for the construction period of the MOLF and associated marine developments. Additional descriptions of the effects are contained within section 8 of the NRA (appendix D15-1, Application Reference Number: 6.4.99). Where the terminology used to describe the sensitivity and magnitude of the effects in the NRA differs from that used in the Environmental Statement, it has been altered in this chapter. Further detail of the methodology used can be found in chapter B15 (Application Reference Number: 6.2.15) of this Environmental Statement.

Dredge/construction plant collision with commercial vessels

15.5.5 During the dredging and Marine Works activities, there would be increased vessel movements to and from Porth-y-pistyll Bay. Dredged material would be taken from site and transported to Holyhead North marine disposal site, and construction vessels would transport pre-cast concrete elements to site.

These additional transits would increase the risk of vessel collision between dredge/construction plant and marine commercial traffic.

15.5.6 Vessels approaching the MOLF, or those working on-site, would be very unlikely to interact with other passing commercial vessels due to the distance between the site and the commercial shipping routes, approximately four nautical miles off the north-west coast of Anglesey. The additional construction vessel movements associated with the Wylfa Newydd Project would represent an increase of approximately 50% from the baseline environment.

15.5.7 This potential effect would have a medium level of sensitivity due to the ability of vessels to react to the situation by manoeuvring to avoid a collision situation. This type of incident has the potential to occur throughout the vessel's passage during the Marine Works construction phase and therefore presents a magnitude which is assessed as medium. This effect would be localised to within the study area. Therefore, the overall significance of the effect would be moderate adverse.

Tug and tow collision with commercial vessels

15.5.8 During the dredge and Marine Works activity, tug and tow operations would operate into, and out of, the Wylfa Newydd Development Area. These operations would be associated with dredge disposal and/or relocation of dredged materials, and the transport of construction materials. 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 area. Should this occur, a drifting tug and tow could be involved in a collision, if the incident were to occur in areas used by other vessels.

15.5.9 This potential effect would have a medium level of sensitivity as any vessel subject to steering/propulsion failure would show the appropriate lights and shapes, along with a Very High Frequency (VHF) broadcast to the coastguard and all vessels. This would allow for the reaction of other vessel traffic to the situation. The potential effect would be present for the Marine Works construction phase only and would occur infrequently throughout the period of the Marine Works in the study area, resulting in a magnitude of small. Therefore, the overall significance of the effect would be minor adverse.

Dredge/construction plant collision with recreational vessels

15.5.10 The additional vessel transits associated with the Marine Works increase the risk of vessel collision between dredge/construction plant and recreational vessel traffic. This is more likely to occur closer to the shoreline, as smaller vessels typically transit closer to the shore to avoid routes used by commercial vessels and vessels with deeper draughts. Some of the dredge/construction vessels would be restricted in their ability to manoeuvre.

15.5.11 This potential effect would have a medium level of sensitivity due to the ability of vessels to react to the situation by manoeuvring to avoid a collision situation. This type of incident has the potential to occur throughout the vessel's passage, and therefore presents a magnitude which is assessed as medium.

The potential effect would be present during the Marine Works construction phase and would be unlikely to occur outside of the study area. The overall significance of this effect would be moderate adverse.

Dredge/construction plant on-board fire

15.5.12 During the Marine Works construction phase, vessel fire is possible and could potentially lead to an explosion if uncontained. Vessel fires within a Marine Works site can have consequences for other vessels, infrastructure and shoreside buildings or equipment in the vicinity. However, given the proximity of shoreside emergency response, uncontrolled situations would be unlikely and contained quickly. Immediate action by the crew in response to a fire is the most effective measure to prevent a larger marine emergency. Any response to a fire on board a vessel can lead to pollutants entering the water.

15.5.13 This potential effect would have a medium level of sensitivity due to the type of work being carried out by construction craft (such as hot works, which can include welding) and the range of vessels engaged with the Marine Works. The potential effects would be localised to the extent of the Marine Works construction area and would be present for the Marine Works construction phase only. A fire or explosion would have the potential to occur throughout the construction phase, but is an infrequent risk, which leads to an assessed magnitude of small. The overall significance of this effect would be minor adverse.

Ordnance found during dredge/construction

15.5.14 During the dredge/construction phase, unexploded ordnance could be discovered and inadvertently detonated by dredgers or construction plant. The resulting explosion would be likely to cause severe damage to the vessel and fatalities to the crew. However, considering the geographic location of the Wylfa Newydd Project and previous military activities, the presence of unexploded ordnance is highly unlikely.

15.5.15 In the instance that unexploded ordnance were to be discovered, the potential effect would affect vessel safety, with a sensitivity of high. The potential outcomes would be limited to the extent of the marine construction area or location of the dredge/construction plant. The effect would have the potential to occur throughout the construction phase, and could alter the construction programme. It would not occur frequently, leading to an assessed magnitude of small. The overall significance of this effect would be minor adverse.

Tug and tow grounding due to steering/propulsion failure

15.5.16 During the dredge and Marine Works activity, tug and tow operations would operate into, and out of, the Wylfa Newydd Development Area. These operations would be associated with dredge disposal and/or relocation of dredged material, and the transport of construction materials. 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 transit the area. Should this occur whilst the tug and tow are close to shore, then they may drift and ground on rocky outcrops in shallow water. The

coastline and seabed near the Wylfa Newydd Development Area is predominantly rocky meaning that grounding would lead to major damage to the tug and tow. This damage could lead to loss of life and marine pollution from vessel bunkers and cargo.

15.5.17 The potential effect would have a high level of sensitivity due to the limited time and ability for the vessel crew to react to the situation. There is scope for the vessel crew to anchor the tug and tow; however, there are particularly strong currents in the area contributing to a high sensitivity. The potential effect would be present for the MOLF construction phase only. This effect would not be likely to occur often, which leads to an assessed magnitude of small. The overall significance of this effect would be minor adverse.

Dredge/construction plant grounding as a result of Marine Works

15.5.18 During the dredge and Marine Works activity, there would be an increased risk of dredge/construction vessels grounding in the vicinity of the Marine Works; this would be as a result of working close inshore, in complex tidal conditions, with limited room to manoeuvre. In addition, the available water depth and nature of the coastline means there is reduced room to manoeuvre and uncharted topography, which can be a risk to vessels navigating in the area.

15.5.19 This potential effect would have a high level of sensitivity due to the limited time and ability for the vessel crew to react to the situation. The potential effect would be localised to the extent of the marine construction area and would be present for the Marine Works construction phase. It has the potential to occur frequently, which leads to an assessed magnitude of medium. The overall significance of this effect would be major adverse.

Mooring failure on temporary moorings

15.5.20 The initial moorings available during the construction phase of the MOLF and breakwaters would be exposed to the prevailing environmental conditions in the area. Large waves from the west and strong winds from the east would place extra strain on mooring systems; though these conditions would not be likely to occur simultaneously. This could result in the moorings parting, setting the vessel adrift or damage to the temporary moorings and vessel due to movement and contact.

15.5.21 Weather forecasting services for the area present adequate time for a vessel to leave moorings and anchor in sheltered waters or proceed to local ports. This means that the sensitivity would be low. This effect would be localised to the Marine Works area and present on a temporary basis until either the permanent berths are completed or the breakwater reaches a sufficient level of development to provide shelter, resulting in a magnitude of small. The overall significance of this effect would be minor adverse.

Vessel damage due to weather conditions

15.5.22 High winds and swell developing from the Irish Sea would be likely to affect dredge and construction craft operating at the Marine Works. The vessels would be operating close to shore in confined locations with shallow water. Any adverse weather conditions can increase the risk of a vessel striking upon

Marine Works, grounding or collision with other vessels within the dredge/construction area.

15.5.23 This potential effect would have a medium sensitivity due to the restricted ability to react to building swell conditions and the time available to move to a more sheltered location. The potential effect would be localised to the extent of the study area and would be present for the Marine Works construction phase only. However, the effect would have the potential to occur frequently throughout the period of construction, leading to an assessed magnitude of medium. The overall significance of this effect would be moderate adverse.

Diversion of vessels

15.5.24 The dredge and construction operations carried out as part of the Marine Works and resultant transit routes to and from the Wylfa Newydd Development Area would result in recreational and fishing vessels, which currently navigate within that area, being diverted into areas where larger vessels navigate. These larger vessels would be temporarily diverted either further offshore, or more likely a timing delay would occur to vessel transits, to avoid crossing paths, thereby avoiding potential collision situations.

15.5.25 The potential effect would have a medium level of sensitivity due to the potential safety effects and the inability of vessels to react to the traffic situation. The potential effect would be limited to the extent of the study area and would be present on a permanent basis during the Marine Works construction phase, leading to an assessed magnitude of medium. The overall significance of this effect would be moderate adverse.

Stranding of small recreational vessel on breakwater

15.5.26 The surrounding areas of the Wylfa Newydd Development Area are regularly navigated by recreational kayakers and other small craft. These craft can be navigating in the embayments and close to the coastline to gain shelter from weather conditions due to the profile of the coastline. During periods of adverse weather conditions, it is possible that these craft would strand on the sloped faces of the breakwaters. The resulting damage would mean that it would be unlikely for a stranded vessel to be refloated safely.

15.5.27 A stranded small vessel would be likely to have communications equipment available; however, this may not be operational in the conditions that would cause this incident giving a sensitivity of medium. The potential incident would be localised to the footprint of the breakwaters and would be present throughout the Marine Works construction phase giving a magnitude of medium. The overall significance of this effect would be moderate adverse.

Operation of MOLF

15.5.28 The following potential effects were identified for the operational phase of the MOLF, which occurs simultaneously with the Main Construction phase of the Power Station.

Allision of vessel with breakwaters

15.5.29 Allision is a violent striking (such as in a collision) with a fixed object by a vessel. Manoeuvring of vessels in close proximity to the breakwaters would have the potential for contact with the structure, especially during periods of adverse weather conditions when wind activity and wave action may adversely affect vessel-manoeuvring. In addition, tidal flow conditions provide additional cause for consideration depending on the time the vessel would be expected to enter or leave the harbour and the tidal conditions during the vessel's transit.

15.5.30 The confined area within the breakwaters means that a vessel would have reduced ability to make corrective actions. Provided that a slow approach was taken to the harbour, which can be controlled through use of tugs and pilotage, there would be sufficient time to make course alterations through application of engines, rudder and bow thrusters. These factors lead to a medium level of sensitivity. In addition, the potential effect would be localised to the area of the MOLF, and would occur throughout the operational phase of the MOLF, leading to a magnitude of medium. The overall significance of this effect would be moderate adverse.

Allision of a vessel with the MOLF

15.5.31 The confined area within the harbour created by the breakwaters would increase the risk that a vessel would make contact with the MOLF whilst manoeuvring to berth, especially in periods of adverse weather conditions when wind activity has the potential to adversely affect vessel manoeuvring. Any allision that has the potential to cause damage to a vessel may lead to a pollution event and injuries to personnel.

15.5.32 This potential effect would have a medium level of sensitivity due to the confined area within the breakwaters, giving the vessel less space to manoeuvre. However, provided that a slow approach is taken to the berth, there would be adequate time to react to the risk of an allision. In addition, the potential effect would be limited to the area of the MOLF and would occur throughout the operational phase of the MOLF, leading to a magnitude of medium. The overall significance of this effect would be moderate adverse.

Collision of recreational/fishing/high speed/harbour vessel with vessel transiting to or from the MOLF

15.5.33 Recreational vessels generally navigate close to the shore to avoid traffic in deeper water further to the north of the Wylfa Newydd Development Area. There is potential for one of these vessels to be involved in a collision with vessels transiting to or from the harbour.

15.5.34 In addition, high-speed vessels navigate in the area between The Skerries TSS and the Wylfa Newydd Development Area. Analysis of Automatic Identification System (AIS) has shown that these vessels are generally crew-transfer vessels operating between the wind farms in the area and Holyhead Port. These vessels are very manoeuvrable and able to take avoiding action rapidly and as required.

15.5.35 This potential effect would have medium sensitivity due to the ability of vessels to react to the situation by manoeuvring to avoid a collision situation. This type of incident has the potential to occur throughout the operational phase of the MOLF, resulting in a magnitude of medium. The overall significance of this effect would be moderate adverse.

Grounding of vessel within the harbour

15.5.36 Vessels using the harbour area would have the potential to ground in shallower waters towards the south-eastern area, near the cooling water intake, particularly when manoeuvring to the Ro-Ro berth. The Ro-Ro berthing vessel would be likely to enter this area bow-first when swinging, before going astern to the berth. Any grounding in this location is likely to involve puncturing of the hull or major damage, which could lead to a pollution event.

15.5.37 The potential effect would have high sensitivity due to the limited time and ability for the vessel crew to react to the situation, and the limited manoeuvrability possible within the area confined by breakwaters. The potential effect would be limited to the extent of the harbour area and would be present on a permanent basis during the operational phase of the MOLF. Should this effect occur, it would be on an infrequent basis during the initial stages of MOLF construction; it would diminish with time as vessel crews become more experienced with the harbour conditions, leading to an assessed magnitude of medium. The overall significance of this effect would be major adverse.

Steering/propulsion failure entering or leaving the harbour

15.5.38 There would the potential for engine, thruster or rudder failure whilst a vessel was manoeuvring from the berth and proceeding out of the harbour. The increased use of these systems during these manoeuvres increases the likelihood that these systems may fail. The restricted water available within the harbour means that, should the vessel lose steering or propulsion, there would be the possibility the vessel could collide with the quay or breakwaters.

15.5.39 The potential effect would have high sensitivity due to the limited time and ability for the vessel crew to react to the situation, and the confined area within the breakwaters limiting possible manoeuvring. The potential effect would be localised to the extent of the harbour area and would be present throughout the operational phase of the MOLF, leading to an assessed magnitude of medium. The overall significance of this effect would be major adverse.

Diversion of vessels

15.5.40 Transit routes to and from the Wylfa Newydd Development Area would result in recreational and fishing vessels that currently navigate within that area being diverted into areas where larger vessels navigate. These vessels would be temporarily diverted either further offshore, or more likely a timing delay would occur to vessel transits, to avoid situations where paths may cross.

15.5.41 This potential effect would have low sensitivity, as there is sufficient sea space north of Porth-y-pistyll for vessels to transit safely and perform actions to avoid

close quarters in accordance with the COLREGS [RD1]. The potential effect would be localised to the extent of the study area and would be present on a permanent basis during the operational phase of the MOLF, leading to an assessed magnitude of medium. The overall significance of this effect would be minor adverse.

Vessel unloaded incorrectly alongside the MOLF

15.5.42 When unloading vessels, it is possible that their stability could be compromised due to the distribution of weight. This can have several effects including, list, loll, excessive sheer forces or bending moments. These have the potential to cause either severe damage to the vessel or lead it to capsize.

15.5.43 There would be sufficient time before unloading operations commence, to perform unloading calculations to ensure that stability limits were not exceeded, hence a sensitivity of low is given. The potential effect would be localised to the extent of the harbour area and would be present on a permanent basis during the operational phase of the MOLF, leading to an assessed magnitude of medium. The overall significance of this effect would be minor adverse.

Stranding of small recreational vessel on breakwater

15.5.44 This effect is similar to the stranding effect as described in the stranding of small recreational vessel on breakwaters section above. During periods of adverse weather conditions, it is possible that these craft would strand on the sloped faces of the breakwaters. The resulting damage would mean that it would be unlikely for a stranded vessel to be refloated safely.

15.5.45 A stranded small vessel would be likely to have communications equipment available; however, this may not be operational in the conditions that would cause this incident, hence a sensitivity of medium. The potential incident would be localised to the footprint of the breakwaters and would be present on a permanent basis during the operational phase of the MOLF, giving a magnitude of medium. The overall significance of this effect is moderate adverse.

Operation of Power Station

15.5.46 During the operation of the Power Station, there is currently no identified operational requirement to use the MOLF. However, it would be subject to routine inspection to ensure it was structurally intact such that it did not present a health and safety hazard or operational hazard to the Power Station. Should it be decided to retain the MOLF during the Power Station operations, then it is currently assumed that only one vessel per year would use the MOLF during operation. As such, any potential effects would be addressed by the mitigation already in place from the Main Construction, resulting in negligible effects. In the context of the assessment such low-level use of the MOLF can be scoped out from further consideration, especially since relevant mitigation measures already in place for the construction phase would be adopted.

Transboundary effects

15.5.47 It is not anticipated that there would be any significant adverse environmental effects across national boundaries arising from additional vessel movements as a result of the proposed activities. Management of passage and heightened risk-awareness associated with navigation would be limited to the study area. The main TSS falls within UK territorial waters, and governance of the additional number of vessels related to the Wylfa Newydd Project would be defined by the United Nations Convention on the Law of the Sea (UNCLOS) [RD3]. Within UK territorial waters, the UK Government upholds the right of innocent passage, as defined in Article 17 of UNCLOS; beyond the 12 nautical mile limit of UK territorial waters, shipping has the freedom of navigation.

Decommissioning

15.5.48 Activities associated with decommissioning are described in chapter D1 (Application Reference Number: 6.4.1). The activities of particular relevance to shipping and navigation are:

- the removal of structures including the intake, outfall and MOLF
- transport of demolished materials

15.5.49 Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment, which would assess in detail the effects against the baseline conditions at that time.

15.5.50 The removal of structures including the intake, outfall and MOLF; would lead to an increase in vessel movements, as would the potential requirement to remove materials from the area by sea. However, the vessel movements required would not be greater than that already assessed for the construction phase. Therefore, the likely effects of decommissioning on shipping and navigation (navigational risk) would not exceed that already assessed under the construction of MOLF section above.

15.5.51 Much of the detail relating to decommissioning is not known at this time and therefore, a number of assumptions have been made, as listed under the Design basis and activities section of this chapter.

15.5.52 It is recognised that, given the duration of the operation phase (60 years), marine legislation would be likely to change during this time, which would influence the assessment of navigational risk. Any future assessment should review the baseline conditions at that time and redefine key navigational risks if necessary.

15.6 Additional mitigation

15.6.1 In accordance with chapter B1 (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to shipping and navigation were taken into account when determining the ‘pre-mitigation’ significance of effects. These are detailed in the design basis and activities section of this chapter.

15.6.2 Additional mitigation measures would be implemented to address potential significant effects identified in the assessment of effects section. These

additional mitigation measures are summarised in Table D15-2 and Table D15-2 for construction and operation of the MOLF respectively. No additional mitigation measures have been proposed for the operation of the Power Station phase, as it is unlikely that the MOLF would be used during this period.

15.6.3 As part of the NRA process, a number of additional mitigation measures were identified in order to reduce the risk of hazard scenarios occurring. As with the good practice mitigation measures, the current mitigation strategy including additional mitigation will be secured as set out in section 5 of the Marine Works sub-CoCP (Application Reference Number: 8.8).

15.6.4 Crucially, a number of these mitigation measures cannot be implemented without Harbour Authority powers; these are highlighted in Table D15-2. It is the current intention of Horizon to seek Harbour Authority powers through the application for development consent. Following award of development consent, Horizon would be constituted as the Statutory Harbour Authority and competent Harbour Authority for the harbour.

15.6.5 The proposed mitigation measures aim to reduce the navigational risk associated with the Wylfa Newydd Project and are therefore chiefly related to safety. The most appropriate achievement criteria would review key performance indicators for safety in the area; for example, analysing the number of vessel movements against the number of accidents. This would not differ for the various mitigation measures. They would all contribute to the same key safety performance indicators and have therefore not been detailed below.

Construction of MOLF

Table D15-2 Additional shipping and navigation mitigation measures – construction of MOLF and Marine Works

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Legal duty (Statutory Harbour Authority)	Directions (General) – issued by the Harbour Authority as a set of instructions and general rules that all users of the harbour area must follow. This power would be set out within the Development Consent Order. Directions (Special) – issued by the Harbour Master (or equivalent), this power provides a key control for directing traffic and controlling marine situations within the harbour.	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Aids to navigation	Aids to navigation – Horizon would ensure appropriate aids to navigation are provided to light the works appropriately. The location and type of aid would be determined after consultation with Trinity House.	Review key performance indicators for safety
Port Marine Safety Code compliance	Marine Safety Management System – Horizon would develop a Marine Safety Management System to provide guidance and procedures to allow safe operations within the harbour. This would be established prior to operations and based on risk assessments. The Marine Safety Management System is a requirement of the Port Marine Safety Code [RD5], set out by the UK Government and provides: • the management system for hazards and risks, and preparations for emergencies for a port; • the mechanism by which port specific customs and practices are formalised and documented, to ensure continuity with staff changes; • safety policies and procedures specific to the port and confirms roles and responsibilities; and • regular reviews and performance monitoring of the safety of the port. Hydrographic surveying program – regular scheduled surveys in line with Port Marine Safety Code [RD5] requirements. Dredging programme - informed by the results of hydrographic survey.	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Legal duty (contingency planning) (Statutory Harbour Authority)	Port Emergency Plan – a Harbour Authority would create or provide detailed plans and procedures to follow in the event of an emergency in the form of a Port Emergency Plan. The Port Emergency Plan would include measures that the Harbour Authority would need to have in place to accommodate the requirements of the Emergency Services in the event of an emergency. Horizon would provide a similar plan in the absence of a defined Harbour Authority. Oil spill contingency plan – The MCA require an OPRC ((International Convention on) Oil pollution Preparedness, Response and Co-operation) plan to be in place and approved by them prior to the commencement of Marine Works at the site. An oil spill contingency plan would detail actions to be taken in the event of oil spill. Horizon would provide a similar plan in the absence of a defined Harbour Authority. Contingency plan exercises – contingency plan exercises would be carried out as appropriate to test the Harbour Authority's (marine facing) emergency plan. Horizon would carry out similar exercises in the absence of a defined Harbour Authority. Training of port marine personnel – port marine personnel would be trained by the Harbour Authority to use contingency plans and associated equipment. Horizon would provide similar training in the absence of a defined Harbour Authority.	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Port services and vessel traffic monitoring	A Local Port Service (LPS) - a LPS will be established to provide a command and control centre for marine operations relating to vessel activity and on-the-water activity, in line with the guidance in the MCA's Marine Guidance Note [RD4]. It will be staffed by trained operatives using a range of sensor equipment including an AIS receiver to inform and update vessel masters of the prevalent conditions. Its responsibilities could potentially include coordination of marine responses, coordination of emergency responses, CCTV monitoring of the harbour area and being a point of contact for all harbour operations. The LPS will also include a broadcast of detailed movement information within the harbour, including information on local weather conditions and any safety-related issues. AIS coverage – all dredge/ construction vessels involved in the Wylfa Newydd Project, including barges, will carry AIS (A or B), which will be monitored by LPS marine personnel. Weather forecasting – sea state model will be used throughout the build phase of the MOLF to predict weather conditions and downtime. Dedicated VHF channel – licence obtained from OFCOM, information updated in Admiralty List of Radio Signals (ALRS) [RD6]. Towage, available and appropriate – harbour tugs employed to escort vessel through the breakwaters to the berth. Safety boat – appropriate craft capable of recovering a Man Over	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	Board - on call to be available in the event of emergency.	
Publish marine safety information (competent Harbour Authority)	Notices to Mariners – publication of Harbour Authority information, detailing ongoing safety and awareness information to harbour users and to local vessels navigation within area. Large-scale navigational charts – large scale Electronic Navigational Charts can be provided by the United Kingdom Hydrographic Office for vessels using the harbour area. Guidance for small craft – passive (informative) management of leisure traffic by Development Liaison Team, written information to the Royal Yachting Association and local yacht clubs, and available as a web-based resource.	Review key performance indicators for safety
Legal duty (competent Harbour Authority)	Pilots – following a review of the need for Pilotage, Horizon will establish a Pilotage service including Pilotage Directions	Review key performance indicators for safety
Safety zone (competent Harbour Authority)	Safety zone – determined and set by the Harbour Authority within its jurisdiction to restrict or manage access to parts of the harbour for safety reasons.	Review key performance indicators for safety
Protective fendering	Berthing points – protective fendering suitable for the vessels used would be in place on temporary berths, jetties and quays to prevent vessels making contact with the structures.	Review performance indicators for safety

Operation of MOLF

Table D15-3 Additional shipping and navigation mitigation measures – operation of MOLF and main construction of Power Station

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
Legal duty (Statutory Harbour Authority)	Directions (General) – issued by the Harbour Authority as a set of instructions and general rules that all users of the harbour area must follow. This power would be set out within the Development Consent Order. Directions (Special) – issued by the Harbour Master (or equivalent), this power provides a key control for directing traffic and controlling marine situations within the harbour.	Review key performance indicators for safety
Aids to navigation	Aids to navigation – setting out appropriate aids to navigation, to light the works appropriately. Location and type of aid determined after consultation with Trinity House. Aids to navigation management plan – plan setting out aids to navigation to light the works appropriately. Production and sign off by Trinity House will be a consent condition.	Review key performance indicators for safety
Port Marine Safety Code compliance	Marine Safety Management System – Horizon would develop a Marine Safety Management System to provide guidance and procedures to allow safe operations within the harbour. This would be established prior to operations and based on risk assessments. The Marine Safety Management System is a requirement of the Port Marine Safety Code [RD5], set out by the UK Government and provides: • the management system for hazards and risks, and preparations for emergencies for a port; • the mechanism by which port specific customs and practices are	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	formalised and documented, to ensure continuity with staff changes; • safety policies and procedures specific to the port and confirms roles and responsibilities; and • regular reviews and performance monitoring of the safety of the port. Hydrographic surveying program – regular scheduled surveys in line with Port Marine Safety Code [RD5] requirements. Dredging programme – informed by the results of hydrographic survey.	
Legal duty (contingency planning) (Statutory Harbour Authority)	Port Emergency Plan – a Harbour Authority would create or provide detailed plans and procedures to follow in the event of an emergency in the form of a Port Emergency Plan. The Port Emergency Plan would include measures that the Harbour Authority would need to have in place to accommodate the requirements of the Emergency Services in the event of an emergency. Horizon would provide a similar plan in the absence of a defined Harbour Authority. Oil spill contingency plan – the MCA require an OPRC plan to be in place and approved by them prior to the commencement of Marine Works at the site. An oil spill contingency plan would detail actions to be taken in the event of oil spill. Horizon would provide a similar plan in the absence of a defined Harbour Authority. Contingency plan exercises – contingency plan exercise would be carried out as appropriate to test the Harbour Authority's (marine facing) emergency plan. Horizon would carry out similar exercises in the absence of a defined Harbour Authority.	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	training of port marine personnel – port marine personnel would be trained by the Harbour Authority to use contingency plans and associated equipment. Horizon would provide similar training in the absence of a defined Harbour Authority.	
Port services and vessel traffic monitoring	A local LPS – a LPS will be established to provide a command and control centre for marine operations relating to vessel activity and on-the-water activity, in line with the guidance in the MCA's Marine Guidance Note [RD4]. It will be staffed by trained operatives using a range of sensor equipment including an AIS receiver to inform and update vessel masters of the prevalent conditions. Its responsibilities could potentially include coordination of marine responses, coordination of emergency responses, CCTV monitoring of the harbour area and being a point of contact for all harbour operations. The LPS will also include a broadcast of detailed movement information within the harbour, including information on local weather conditions and any safety-related issues. AIS coverage – all dredge/ construction vessels involved in the Wylfa Newydd Project, including barges, will carry AIS (A or B), which will be monitored by LPS marine personnel. Weather forecasting – sea state model will be used throughout the build phase of the MOLF to predict weather conditions and downtime. Dedicated VHF channel – licence obtained from OFCOM, information updated in ALRS.	Review key performance indicators for safety

Additional mitigation measures	Objective	Achievement criteria and reporting requirements
	Towage, available and appropriate – harbour tugs employed to escort vessel through the breakwaters to the berth. Safety boat – appropriate craft capable of recovering a Man Over Board - on call to be available in the event of emergency.	
Publish marine safety information (competent Harbour Authority)	Notices to Mariners – publication of Harbour Authority information, detailing ongoing safety and awareness information to harbour users and to local vessels navigation within area. Large scale navigational charts – large scale Electronic Navigational Charts can be provided by the United Kingdom Hydrographic Office for vessels using the Harbour Area. Guidance for small craft – passive (informative) management of leisure traffic by Development Liaison Team, written information to the Royal Yachting Association and local yacht clubs, and available as a web-based resource.	Review key performance indicators for safety
Legal duty (competent Harbour Authority)	Pilots – following a review of the need for Pilotage, Horizon will establish a Pilotage service including Pilotage Directions.	Review key performance indicators for safety
Safety zone (competent Harbour Authority)	Safety zone – determined and set by the Harbour Authority within its jurisdiction to restrict or manage access to parts of the harbour for safety reasons.	Review key performance indicators for safety
Protective fendering	Permanent berthing points – protective fendering suitable for the vessels used would be in place on berths, jetties, and quays to prevent vessels making contact with the structures.	Review key performance indicators for safety.

Operation of Power Station

15.6.6 No additional mitigation measures need be proposed for the operation of the Power Station.

Decommissioning

15.6.7 Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment which would assess in detail the effects against the baseline conditions at the time, and consider appropriate measures to mitigate these effects.

15.6.8 At this time, assuming that the effects would likely be enveloped by the effects during the construction of MOLF phase, it can reasonably be assumed that the mitigation measures applicable during this construction phase could also be put in place during the decommissioning phase.

15.7 Residual effects

15.7.1 This section describes the residual effects for shipping and navigation having taken into account the embedded, good practice and additional mitigation described above. Residual effects are those which have an assessed significance of moderate or above. Table D15-4 below provides a summary of significant residual effects identified either prior to or post application of additional mitigation for the construction and operational phases.

15.7.2 There would also be no residual effects identified for the decommissioning phase, though this would be assessed fully at a later date as part of a separate Environmental Impact Assessment.

15.7.3 Additionally, all effects of minor significance or greater identified in the assessment of effects section are summarised in appendix I3-1 (master residual effects table, Application Reference Number: 6.9.8).

15.7.4 All effects are ‘adverse’ unless otherwise stated.

15.7.5 Due to the nature of this assessment, the mitigation may change either the magnitude or the sensitivity of the effect. Therefore, Table D15-4 includes a column for change in post-mitigation sensitivity or magnitude.

15.7.6 There would be no significant residual effects following the application of additional mitigation.

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Table D15-4 Summary of residual effects

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
Construction phase of MOLF								
Dredge/construction craft collision with commercial vessel	Medium	During the dredge and construction works, increased vessel movements to and from the harbour area may result in collisions of project vessels with commercial vessels.	Direct Adverse Local Short-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan Safety zone AIS coverage Dedicated VHF channel LPS broadcast	Sensitivity - negligible	Negligible
Dredge/construction vessel collision with recreational vessel	Medium	Increased dredger and construction vessel movements could lead to collisions	Direct Adverse Local Short-term	Medium	Moderate	AIS coverage Dedicated VHF channel Guidance for small craft	Sensitivity - negligible	Negligible

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		with recreational vessels transiting closer to the coastline.				Marine Safety Management System Oil spill contingency plans Directions (General) Directions (Special) LPS broadcast Notices to Mariners Pilotage Port Emergency Plan Safety zone		
Grounding – dredge/construction craft due to Marine Works	High	Increased risk of dredge/ construction vessels grounding in the vicinity of	Indirect Adverse Local Medium-term	Medium	Major	Directions (General) Directions (Special) Notices to Mariners	Sensitivity - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		the Marine Works due to working close inshore, in complex tidal conditions with limited room to manoeuvre.				Pilotage Port Emergency Plan LPS broadcast Safety zone Aids to navigation Oil spill contingency plans		
Vessel damage due to weather conditions	Medium	High wind speeds and swell developing from the Irish sea would affect dredge and construction craft operating at the Marine Works.	Indirect Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan LPS broadcast Safety zone	Magnitude - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
						Marine Safety Management System Oil spill contingency plan Weather forecasting Protective fendering		
Diversion of vessels	Medium	Dredge and construction operations carried out as part of the Marine Works and resultant transit routes to and from the MOLF would result in other vessels being diverted into	Direct Adverse Local Short-term	Medium	Moderate	AIS coverage Directions (General) Directions (Special) LPS broadcast Notices to Mariners Pilotage Port Emergency Plan Safety zone	Magnitude - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		areas where larger vessels currently operate.						
Stranding – small recreational vessel on breakwater	Medium	During periods of adverse weather conditions, it is possible that small recreational vessels (such as kayaks) might strand on the sloped faces of the breakwaters. The resulting damage would mean it would be unlikely for	Direct Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan Safety zone LPS broadcast Marine Safety Management System Safety boat	Magnitude - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		the vessel to be refloated safely.						
Operational phase of MOLF								
Allision - vessel with breakwaters	Medium	Manoeuvring of vessels in close proximity to the breakwaters has the potential for contact with the structure, especially during periods of adverse weather conditions.	Direct Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan Safety zone LPS broadcast Aids to navigation AIS coverage Marine Safety Management System	Sensitivity - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
						Oil spill contingency plans Towage, available and appropriate Large scale navigational charts		
Allision - vessel with MOLF	Medium	Confined area within the harbour created by the breakwaters increases the risk that a vessel would make contact with the MOLF whilst manoeuvring to berth.	Direct Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan Safety zone Aids to navigation AIS coverage	Sensitivity - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
						Marine Safety Management System Oil spill contingency plans Large scale navigational charts LPS broadcast Protective fendering		
Collision - recreational/fishing/ high speed/harbour vessels with vessel transiting to or from Wylfa Newydd Development Area	Medium	Consultation with stakeholders indicates that recreational fishing and leisure vessels use the bays in the vicinity of the MOLF. These vessels	Direct Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notices to Mariners Pilotage Port Emergency Plan Safety zone AIS coverage	Sensitivity - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		would generally be navigating close to the shore to avoid traffic in deeper waters; there is potential for one of these vessels to be involved in a collision with a vessel navigating to or from the MOLF/Ro-Ro berth.				LPS broadcast		
Grounding – vessel within the Harbour	High	Vessels using the harbour have the potential to ground in shallower	Indirect Adverse Local Long-term	Medium	Major	Directions (General) Directions (Special) Notices to Mariners Pilotage	Sensitivity - low	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		water towards the south-eastern area near the cooling water intake, especially when manoeuvring to the Ro-Ro berth.				Port Emergency Plan Safety zone Aids to navigation Marine Safety Management System Oil spill contingency plans LPS broadcast		
Machinery-related accidents – steering or propulsion failure entering or leaving the harbour	High	There is the potential for engine, thruster or rudder failure whilst a vessel is manoeuvring from the berth and proceeding	Indirect Adverse Local Long-term	Medium	Major	Directions (General) Directions (Special) Notice to Mariners Pilotage Port Emergency Plan Safety zone	Magnitude – small	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
		out of the harbour.				Marine Safety Management System Oil spill contingency plans LPS broadcast Protective fendering		
Stranding – small recreational vessel on breakwater	Medium	During periods of adverse weather conditions, it is possible that small craft might strand on the sloped faces of the breakwaters.	Direct Adverse Local Long-term	Medium	Moderate	Directions (General) Directions (Special) Notice to Mariners Pilotage Port Emergency Plan Safety zone Safety boat on call	Magnitude – small	Minor

Receptor (or group of receptors)	Sensitivity of receptor(s)	Description of potential effect	Nature of effect	Potential magnitude of change	Potential significance of effect	Additional mitigation	Post-mitigation magnitude/ sensitivity of change	Significance of residual effect
						Marine Safety Management System LPS broadcast		

15.8 References

Table D15-5 Schedule of references

ID	Reference
RD1	International Maritime Organization. 1972. *COLREGS – International Regulations for Preventing Collisions at Sea*. [Online]. [Accessed: 21 November 2016]. Available from: http://www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20(copies)/COLREG-1972.pdf
RD2	International Maritime Organization. 1978. *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers.* [Online]. [Accessed: 21 November 2016]. Available from: http://www.imo.org/en/About/conventions/listofconventions/pages/international-convention-on-standards-of-training,-certification-and-watchkeeping-for-seafarers-(stcw).aspx
RD3	United Nations. 1982. *United Nations Convention on the Law of the Sea.* [Online]. [Accessed: 21 November 2016]. Available from: http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf
RD4	Maritime and Coastguard Agency. 2009. *MGN 401 (M+F) Navigation: Vessel Traffic Services (VTS) and Local Port Services (LPS) in the United Kingdom.* [Online]. [Accessed: 21 November 2016]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/461544/MGN_401.pdf
RD5	Department for Transport and Maritime and Coastguard Agency. 2012. *Port Marine Safety Code.* [Online]. [Accessed: 04 January 2018]. Available from: https://www.gov.uk/government/publications/port-marine-safety-code
RD6	United Kingdom Hydrographic Office. 2017. *ADMIRALTY List of Radio Signals.* Vol. 1 - 6. Taunton: United Kingdom Hydrographic Office.

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