HORIZON NUCLEAR POWER

ENERGY WORKING FOR BRITAIN

Response to Environmental Permitting Regulations 2016 Schedule 5 Notice, Issued 11/12/2018

Application number: PAN-002427

Document Number: HNP-HZCON-PAC-REP-00011

Revision: 1.0

Revision History				
Date	**Rev No.**	**Summary of Changes**	**Ref Section**	**Purpose of Issue**
08/02/19	1.0	Issue Document	All	Response to Sch.5 Notice

Introduction

This document provides Horizon's response to the Schedule 5 Notice issued by NRW on 11/12/2018 under paragraph 4 of Part 1 of Schedule 5 of the Environmental Permitting Regulations (England and Wales) 2016. The Notice requires further information on Horizon's Operational Water Discharge Activity Environmental Permit application PAN-002427.

NRW's requests for information are reproduced in the tables below (shown in bold text), together with Horizon's response.

1. Hydrodynamic Modelling, H1 Assessment and Water Quality

1.1 We note that for the 23°C absolute temperature target mixing zone, the hydrodynamic model uses a background temperature of 16.44°C. You have produced further statistical modelling (WYL-PD-PAC-REP-00012, Appendix G) using more up-to-date data (1993 to 2013 or 2003-2012) where the 98%ile is 16.6°C or 16.7°C, respectively. Using the more up to date data could impact on the areal extent calculated for absolute temperature / mixing zone. Provide the areal extent for absolute temperature/mixing zone using the up to date data.

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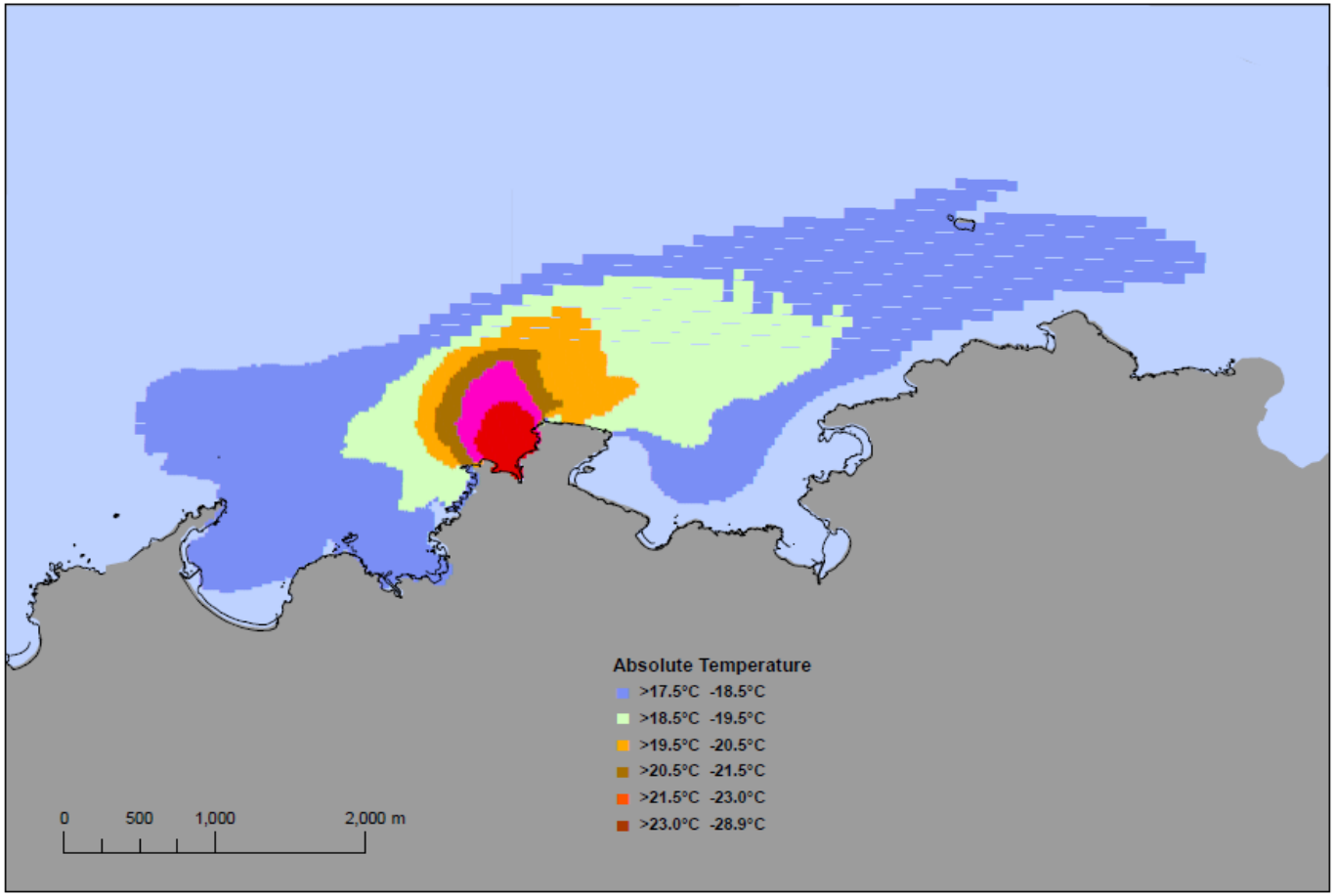
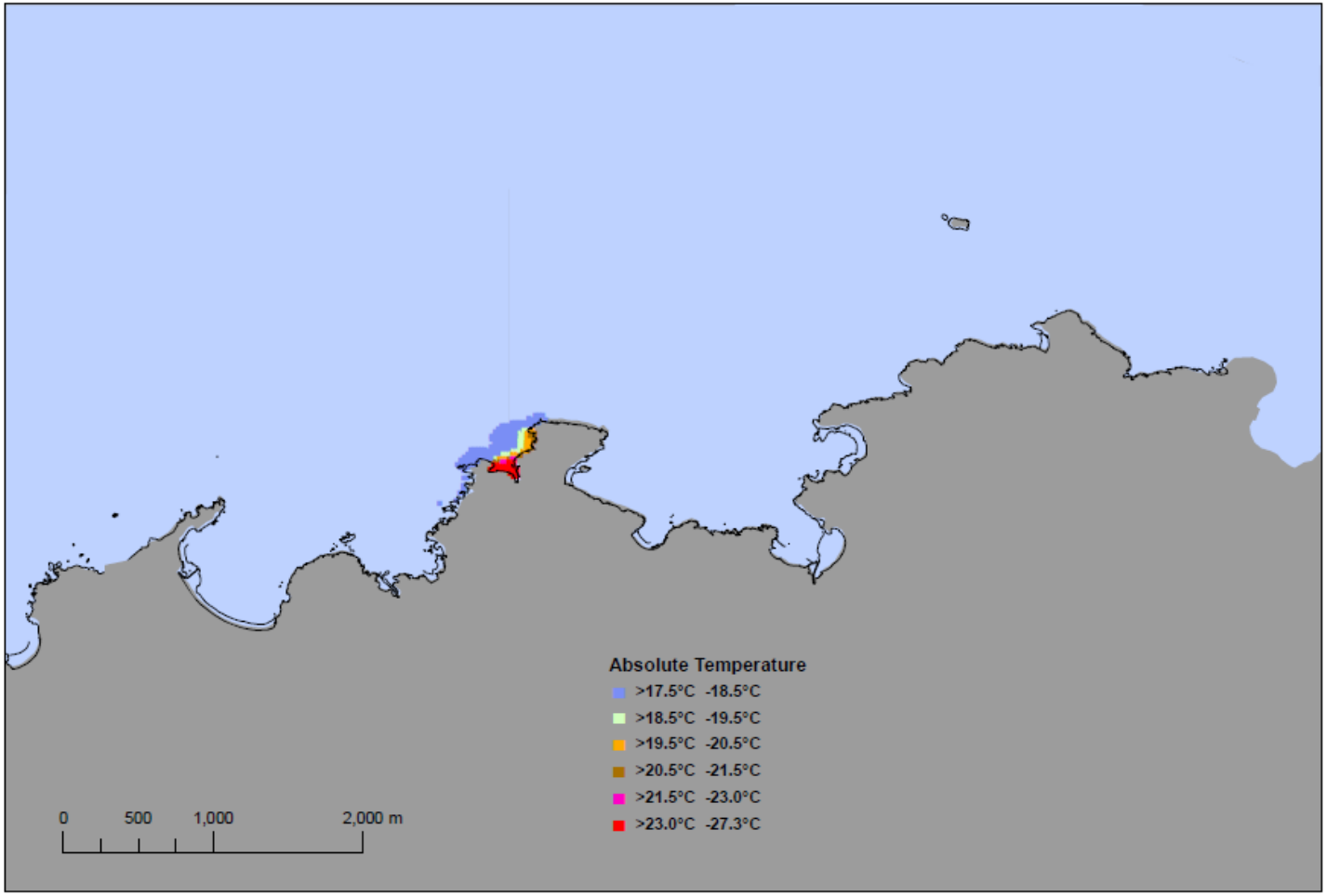
Horizon's Response

1.1 Updated absolute temperature figures for surface and bed are provided below. The 23 °C mixing zone areas are 0.14 km^2 and 0.01 km^2 at the surface and bed, respectively.



Absolute Temperature, surface (16.7 °C baseline)



Absolute Temperature, bed (16.7 °C baseline)

1.2 The H1 assessment indicates that sodium nitrite has been modelled conservatively and that decay has not been included. It might be expected that, as sodium nitrite is being modelled as a conservative tracer, the contaminant will travel with the thermal plume associated with the cooling water discharge. Consequently, the sodium nitrite mixing zone will depend on the size of the thermal plume. The summer base case has been used to model the extent of sodium nitrite which results in a smaller thermal plume extent than the autumn base case. As a result, it is unclear whether the worst-case scenario has been modelled and assessed. The following is required:

1.2.1 Provide worst case scenario to model the extent of the sodium nitrite.

1.2.2 Provide the area of effect in in km^2.

1.2.3 Provide information on the importance of this area to the designated interest features and their conservation objectives.

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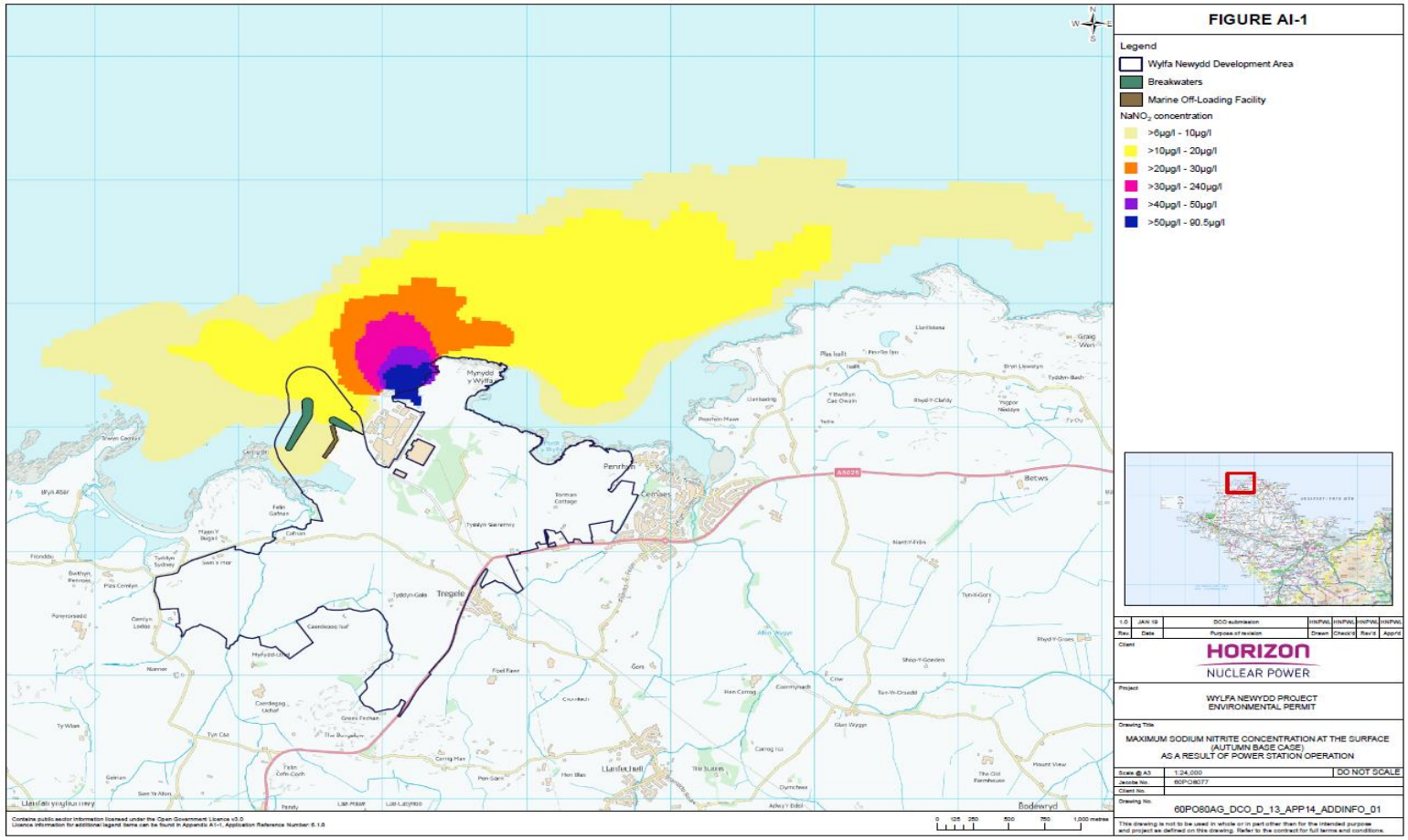
Horizon's Response

1.2 No specific response required for this. The relevant questions are being asked in sub-requirements 1.2.1 – 1.2.3.

1.2.1 Sodium nitrite modelling has been repeated using the autumn base case as a worst-case scenario. The outputs are provided below (surface figure AI-1 and bed figure AI-2); figures show the sodium nitrite mixing zone out to the Predicted No-Effect Concentration (PNEC) value of 6 µg/l.



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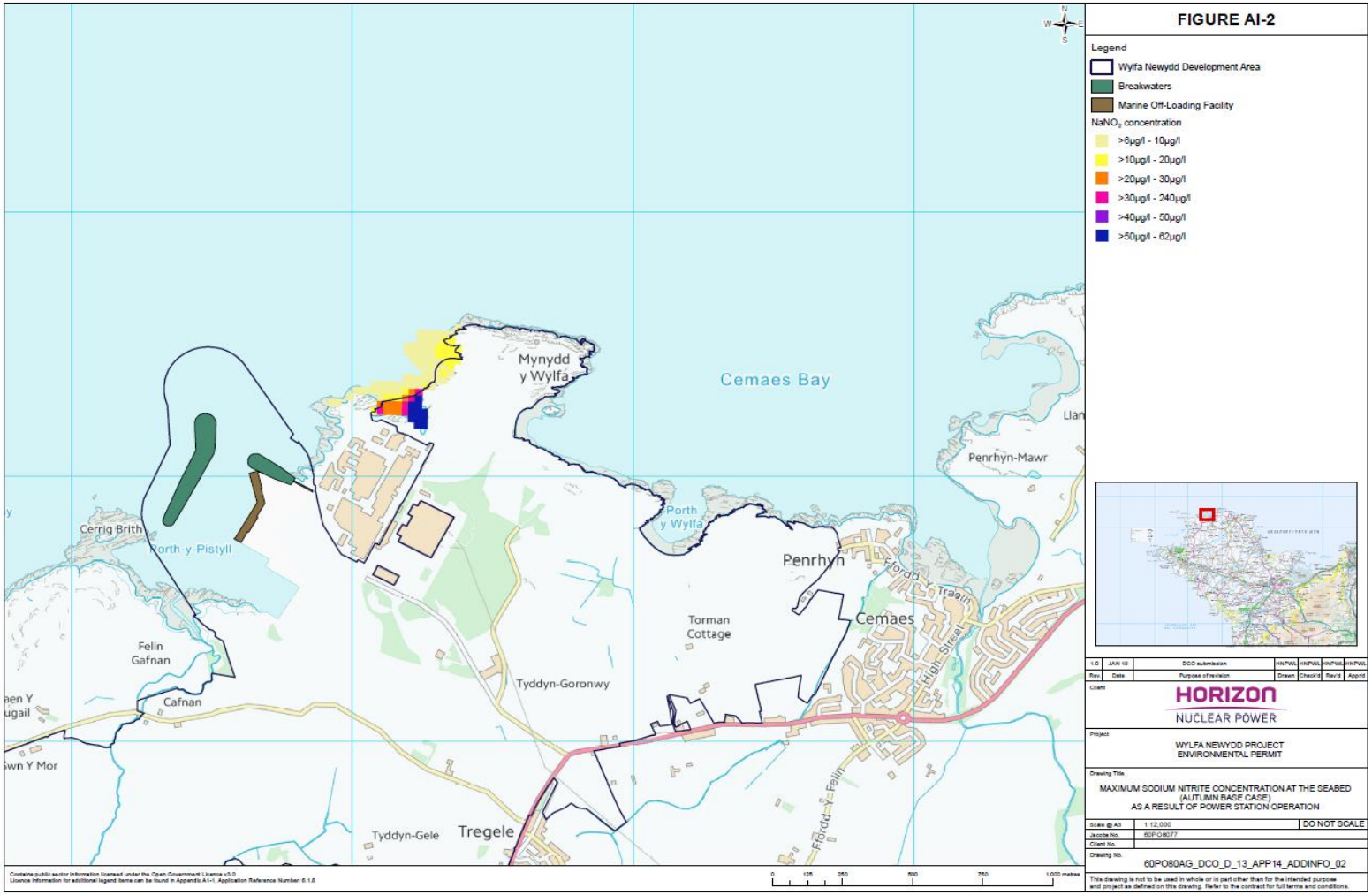


1.2.2 Sodium nitrite modelling has enabled the area of the mixing zone for this case to be determined. This area equals 7.29 km^2 at the surface and 0.058 km^2 at the bed.

1.2.3 Based on the sodium nitrite mixing zone modelled area (to the PNEC value of 6 µg/l) at the surface (area of 7.29km^2), the following assessment can be made for the Gogledd Môn Forol/North Anglesey Marine candidate SAC/Site of Community Importance (cSAC/SCI):

- The percentage of the Gogledd Môn Forol/North Anglesey Marine cSAC/SCI area (3,249km^2) within the modelled area is 0.22%.
- The potential number of harbour porpoise within the modelled area is 9.2 individuals (based on abundance estimates of 1.26 harbour porpoise per km^2); this represents 0.0088% of the Celtic and Irish Seas Make-Up (MU) reference population (104,695 harbour porpoise) that could potentially be in the sodium nitrite mixing zone at the surface or could be affected by any changes to prey within this area.

Based on the sodium nitrite mixing zone modelled area (to the PNEC value of 6 µg/l) at the seabed (area of 0.058km^2), the following assessment can be made for the Gogledd Môn Forol/North Anglesey Marine cSAC/SCI:

- The percentage of the Gogledd Môn Forol/North Anglesey Marine cSAC/SCI area (3,249km^2) within the modelled area is 0.0018%.
- The potential number of harbour porpoise within the modelled area is 0.073 individuals (based on abundance estimates of 1.26 harbour porpoise per km^2); this represents 0.00007% of the Celtic and Irish Seas MU reference population (104,695 harbour porpoise), that could potentially be in the sodium nitrite mixing zone at the seabed or could be affected by any changes to prey within this area.

Predicting the importance of the area within the sodium nitrite mixing zone to the PNEC value of 6 µg/l for the Morwenoliaid Ynys Mon/Anglesey Terns Special Protection Area (SPA) requires detailed analysis of tern foraging activity (i.e. density of foraging attempts) that occurs within the area predicted to be encompassed by the mixing zone, with this ideally considered for different levels of predicted sodium nitrite concentration. Following the same approach as adopted in the Shadow HRA, a prediction can be made by comparing the extent of the mixing zone with the area of sea encompassed by the predicted foraging range of the SPA Sandwich tern population (Wilson et al. 2014) (with Sandwich tern being the key breeding species at the Cemlyn lagoon colony) (see following paragraph).

The predicted foraging range extends across an area of 7,882km^2, although 95% of the usage of this modelled range is predicted to occur within an area of 69km^2 (as reported in the Shadow HRA). Based on the modelled sodium nitrite mixing zone area (to the PNEC value of 6 µg/l) at the surface (area of 7.29km^2), this equates to 0.09% of the predicted total foraging area for Sandwich tern from the Cemlyn colony, and 11% of the area within which 95% of the foraging by this population is predicted to occur.

In addition to identifying the potential importance of the area within the sodium nitrite mixing zone for qualifying interest features of European Designated Sites, it is important to note 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. The Environmental Statement reports that the temporary nature of the discharge of sodium nitrite and the toxicity-reducing effects of the saline receiving waters (i.e. which blocks nitrite uptake by organisms) would ensure the effects on marine biota would be unlikely. The Environmental Statement also reports that the prey species of qualifying interest features would not be affected.

In conclusion, based on the above analysis, the area affected by the sodium nitrite mixing zone is insignificant in the context of the area of the European Designated Sites and the risk

posed by sodium nitrite to qualifying interest features is very low. Consequently, it can be concluded that there would be no adverse effect on the integrity of the European Designated Sites.

Reference: Wilson, L.J., Black, J., Brewer, M.J., Potts, J.M., Kueper, A., Win, I., Kober, K., Bingham, C., Mavor, R. and Webb, A. 2014. Quantifying usage of the marine environment by terns Sterna sp. around their breeding colony SPAs. JNCC Report no. 500.

1.3 Ammonia concentrations have been calculated (Appendix G, section 9.3, table 30, pg 116) using incorrect water temperatures when compared to the information within Appendix E. Recalculate the Ammonia concentrations using an appropriate maximum temperature.

Horizon's Response

1.3 The ammonia concentrations have been recalculated below:

Condition	T(°C)	T (K)	pH	Salinity	Ratio-Unionised / Total Ammonia	Unionised Concentration (mg/l)
Average	11.78	284.93	8.07	34.3	0.02037	0.00060
Average + 12°C	23.78	296.93	8.07	34.3	0.04845	0.00142
Max Ambient	16.84	289.99	8.07	34.3	0.02944	0.00086
Max Ambient + 12°C	28.84	301.99	8.07	34.3	0.06913	0.00203

1.4 The water quality monitoring undertaken to support the application, Appendix E (ES Appendix D13-01), only includes summary data (e.g. annual averages). You need to show the conceptual model, statistical basis of analysis, the expected confidence in the results obtained and provide clarity of the assumptions you have made. For each determinand, we advise that the following information is necessary:

1.4.1 Provide all the raw data that makes up the annual average data. This includes sample results at each sample location at each sampling period, not just the average figures of all sample sites. Maximum and minimum concentrations of each substance should be clearly shown.

1.4.2 The state of the tide (including whether spring/neap).

Horizon's Response

1.4 Please see information below in 1.4.1 and 1.4.2.

1.4.1 Horizon has issued the raw data that make up the annual average data, as an excel workbook submitted with this response (raw water quality data which provide minimum, maximum and mean concentrations is appended to this response as document '1.4.1 appended response_WQ results 2010-2016_min+max'.

1.4.2 Tidal state and types for each survey and site have been tabulated and provided in Appendix 1.

1.5 The permit application states that "There will be a discharge (348m^3/y) from the high chemical impurity waste (HCW) stream which will contain radioactive contaminants and is therefore outside of the scope of this assessment. It should be noted that under normal operating conditions, the non-radioactive components of discharges to the HCW will be treated prior to being discharged to a holding tank for re-use within the ABWR. However, should the holding tank be at capacity, a discharge may be made to the seal pit, although this will have been treated by the HCW (evaporator and demineraliser treatment stages), and so is considered outside of the H1." Please provide further justification as to why treating the discharges by the HCW leads to a conclusion that any non-radioactive discharges are then considered to be outside the scope of the H1 assessment.

Horizon's Response

1.5 The HCW system is a radioactive treatment system that used the Best Available Techniques including evaporation, reverse osmosis and ion exchange to effectively remove all non-hydrogen radioisotopes. It is not expected to give rise to any release of non-radioactive pollutants. Therefore, its contribution to the conventional operational water discharges have not been considered. Horizon anticipates that the performance of the treatment system will be demonstrated during commissioning and full operation. A Report confirming the performance of the HCW system can be provided to NRW after commissioning takes place.

1.6 The most significant issue highlighted with this MUWTP effluent stream is its deviation from neutral pH as a result of resin regeneration but will be neutralised and monitored. Confirm what the pH range will be in the effluent discharge.

Horizon's Response

1.6 As described in the OWD EP supporting document (Section 3.5.4), the technology for the Make-Up Water Treatment Plant (MUWTP) is still to be determined. Forward Work Plan item no.13 includes a commitment to provide details of the monitoring of the effluents in the process drainage systems, and the selection of discharge criteria to the environment of the chemicals present in those effluents. Full details on the monitoring plan for the discharge from the MUWTP will be provided through the close out of that Forward Work Plan item. However, it is expected that the effluent from the MUWTP would be neutralised to within a range of pH 6 to pH 9.

1.7 Chlorine dioxide and its principle reaction products in water (chlorate, chlorite and chloride) are not generally considered as elements of Total Residual Oxidants (TRO). Will the method you use to measure TRO detect the chlorine dioxide by products? There is no Environmental Quality Standard (EQS) for chlorine dioxide due to there being insufficient data for its break down products. There is some data available in the link below and that could be used to derive a value suitable for the H1 assessment. Please assess the impacts of chlorine dioxide (need to consider Habitat Regulation Assessment - HRA and Water Framework Directive -WFD impacts). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291220/strp80-e-e.pdf.

Horizon's Response

1.7 Chlorine dioxide is referred to in the H1 assessment report as the chemical to be used in the RUHS to control *Legionella*. However, the main application document does not specify the chemical to be used, but instead has forward action plan item FAWDA6 which states that Horizon will provide details of the chemical to be used nine months before commissioning of Unit 1.

Horizon therefore wishes to issue an amendment to the following paragraphs and table within the relevant sections of the *Operational* H1 assessment report:

4.4.3.2 Demineralised water (trade effluent)

(2nd sentence of the 2nd paragraph of this section)

For the RUHS system, trade effluent from regular cleaning of the open loop for the control of the Legionella microorganism will result in the use of a chemical which is still to be selected (information will be provided to NRW as detailed in FAWDA6).

4.5.2.1 Potable water (trade effluent)

(The whole of the second paragraph of this section)

During outage, a trade effluent batch discharge will be made from the RUHS from the drain down of the open loop following operation or maintenance to the seal pit. The discharge will contain a chemical for the control of the Legionella microorganism (See 4.4.3.2).

Table 4-1 Expected chemical discharges from the Power Station during operation

CHEMICAL DISCHARGE	SYSTEM	DISCHARGE POINT	CONTINUOUS OR BATCH DISCHARGE	MAXIMUM DISCHARGE VOLUME PER ABWR UNIT	DISCHARGE VOLUME FOR BOTH ABWR UNITS*	CONCENTRATION	NOTES
Sodium hypochlorite (TRO)	CW	Sea (cooling water outfall) via seal pit	Continuous		369,600m^3/h	TRO 0.1mg/l	TRO is being modelled separately outside of the H1 assessment, therefore it is not considered further here.
	TSW		Continuous		14,800m^3/h	TRO 0.1mg/l	
	RSW		Continuous		18,000m^3/h	TRO 0.1mg/l	
	SWSD		Batch	240m^3/d	480m^3/d	TRO 0.1mg/l	
	RUHS		Batch	No data	No data	TRO 0.1mg/l	
Chemicals present in potable water	TSW	Sea (cooling water outfall) via seal pit	Batch	39m^3 every three months	78m^3 every three months	Various	See H1 Assessment spreadsheet. Chemicals present in potable water at 10x normal concentration
	RSW	Sea (cooling water outfall) via seal pit	Batch	79m^3 per week	158m^3 per week		
	MUWTP	Sea (cooling water outfall) via seal pit	Batch	45m^3/d	90m^3/d		

Sodium hydroxide		Sea (cooling water outfall) via seal pit	Batch			1 te/d	Regeneration chemicals
Sulphuric acid		Sea (cooling water outfall) via seal pit	Batch			0.5 te/d	
Chemicals present in demineralised water	Controlled area drain (CAD)	Sea (cooling water outfall) via seal pit	Batch	2.7m^3/d	5.4m^3/d		
	Non-radioactive storm drain (NSD)	Sea (cooling water outfall) via seal pit	Batch	24m^3/d	48m^3/d		
** Please note that the discharge volumes presented here for the Circulating Water, RSW and TSW systems are those occurring at low tide (LAT) and are therefore the minimum discharge volumes for these three discharges. These volumes are used in the H1 assessment as they present a worst case in terms of the lowest volume of cooling water in which dilution of the process effluents will occur. The other discharge volumes presented in this column are maximum volumes. The maximum volumes of the process effluents are used to assess the maximum concentrations of the individual chemicals present. The process effluent discharge volumes are not affected by the tide.*							

1.8 We would recommend that the standards set out in the UK SI The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 are used and referenced in the H1 assessment. These Directions are the basis for the statutory EQSs in the H1 spreadsheet. Please review and revise H1 assessment as necessary. The link to the SI is provided below.
http://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf.
For substances where there are no standards our preferred option would be for data that has had some level of quality assessment to be used and this has been done for many of the substances. Other sources include the ECHA website, and the University of Hertford website for pesticides.

Horizon's Response

1.8 This is the approach taken for the H1 Assessment and it is therefore compliant with the above comment.

1.9 For substances where a Predicted No Effect Concentration (PNEC) has not been derived, the WFD guidance on EQS derivation should be applied to any toxicity data. The use of LC50, EC50 and NOEC (No Observable Effect Concentration) values is not necessarily appropriate and should be considered in line with the WFD guidance. A link to the guidance is provided below – the critical section for deriving saltwater values is 3.3.2, page 45
https://circabc.europa.eu/sd/a/0cc3581b-5f65-4b6f-91c6-433a1e947838/TGD-EQS%20CIS-WFD%2027%20EC%202011.pdf.
Your H1 assessment should be reviewed to ensure that any standards used meet the requirements of the guidance, with appropriate amendments made as necessary.

Horizon's Response

1.9 After consideration of this comment, Horizon notes that the method used for the H1 assessment process was consulted with NRW prior to submission (12th March 2018). The approach was undertaken in line with the EA's H1 process and other H1 assessments such as Hinkley Point C. At Hinkley Point C, for chemicals with no EQS, the H1 assessment states that "*a Predicted No Effect Concentration (PNEC) value, where available, is used as the benchmark value against which the significance of discharges may be assessed. Where no PNEC values are available then the lowest concentration found in review of ecotoxicity testing literature has been adopted for direct comparison with either the calculated Predicted Environmental Concentration (PEC) value (where baseline data are available) or with the Process Contribution (PC) value.*"

Horizon has carried out a comprehensive review of available data relating to ecotoxicological concentrations including PNECs and NOECs. Horizon believes that the extent of available data for remaining substances (the majority being potable water-derived) would not be appropriate for the application of the assessment factor approach, whereby potentially large factors (up to 10,000 in some cases) are applied to the concentration to derive a quality standard (QS) which may be an extreme worst case, particularly where the supporting ecotoxicological data do not comply with the requirements (e.g. in terms of numbers/type of taxa). The guidance (referred to in comment 1.9) itself states that: "*The quantity of data available for deriving an EQS can vary… if however, only a very small dataset is available, the residual uncertainties can be large. Uncertainty is accounted for by the use of assessment*

factors (AFs) but, clearly, there is a considerable difference in the robustness and reliability of such EQSs compared to those based on extensive data sets, ***and it may even be inadvisable to implement such EQSs****. This technical guidance does not recommend when uncertainties are so large that an EQS should not be implemented, or used in only an advisory capacity. That decision is for policymakers but this could come under review as we gain more experience in setting and using environmental standards for the WFD. However, the scientist has an important role in advising the policymaker about the major uncertainties and key assumptions involved in deriving an EQS. This is particularly important for EQSs which are to be applied across Europe (e.g. for Priority Substances or Priority Hazardous Substances)."*

Regarding the WFD guidance referred to above, it is reiterated that there have been several consultations with NRW relating to the methodology used for H1 process, where Horizon were advised that NRW had fully adopted the EA's approach and the use of this WFD guidance is not referred to within the EA's Surface water pollution risk assessment online guidance. Furthermore, this WFD guidance referred to is targeted at scientists who are directly or indirectly implementing the Water Framework Directive in river basins – Horizon would highlight that its role in this H1 process constitutes compliance. In conclusion, Horizon believes that the alternative thresholds presented in the H1 assessment represent the most appropriate by which to screen the operational discharge.

1.10 You must carry out additional screening for all priority hazardous pollutants even if the pollutants did not need modelling as a result of screening tests. You need to find out whether the annual load of pollutants you discharge is more than the significant load limit (an annual load limit that has been set for priority hazardous pollutants).

Horizon's Response

1.10 Horizon has calculated the annual average load limit of priority hazardous pollutants contributed by the operational discharge against the significant load limits set by Defra and Environment Agency (2018) following the steps in the Screening test: 'priority hazardous pollutants' in the Surface Water pollution risk assessment (Defra and Environment Agency, 2018). None of those which are specified as priority hazardous pollutants would be discharged in quantities in excess of the significant load limits, even when background is included (see table below, which sums discharges for both operational and maintenance batch discharges and includes background). Calculations are presented in the H1 Appendix J spreadsheet.

Determinand	Annual load contribution of the station (including background) (kg/year)	Defra and Environment Agency Significant load limit (kg/year)
Cadmium total	0.003	5
Mercury total	0.001	1
PAH total	0.001	5

Therefore, no additional screening is required.

Defra and Environment Agency, 2018. Available at: https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit.

1.11 Please can the figures used in the H1 spreadsheet (Appendix J) be cross referenced with the results in the Tables of section 6 of the H1 report (Appendix I). Some of the data does not appear to match. Example: for Mercury, there are different EQS figures in the H1 spreadsheet to the Tables in the H1 report. Another example: Arsenic, Table 6-7 has the MAC EQS as 25µg/l but the H1 spreadsheet has the MAC EQS as 1.54µg/l (mean background data). This 1.54µg/l figure actually appears to be the average background concentration figure and not the maximum background concentration figure which is 1.81µg/l (according to Appendix J). This appears to be a common error across the assessment.

Horizon's Response

1.11 The mercury EQS/threshold values in the report table have been amended. Horizon agrees that there is an error relating to the EQS data in the spreadsheet, and these have been amended, with the report tables now embedded in the workbook so it can be seen how the values are linked. The Appendix J spreadsheet (H1 Workbook) is submitted alongside this response.

1.12 Trichloroethylene (trichloroethene) is listed with a EQS of 100µg/l AA in your report/assessments but the EQS is 10µg/l AA in the estuaries and coastal water pH data on our guidance for surface water pollution risk assessment for your environmental permit. Please amend as necessary.

Horizon's Response

1.12 Horizon has checked and updated the trichloroethene AA EQS data in the H1 supporting spreadsheet. Tables 5-1, 6-2, 6-6 and 6-7 have been amended also (as this has the AA in place of the MAC). The MAC EQS has been taken as background (0.05 µg/l). The Appendix J spreadsheet (H1 Workbook) is submitted alongside this response.

1.13 Confirm if there is data missing for pesticides in the H1 spreadsheet (Appendix J), e.g the AA and MAC EQS data is not included but is in the H1 report (Appendix I).

Horizon's Response

1.13 Horizon has added missing background data into the background data tab of the Appendix J spreadsheet (H1 Workbook). The updated version of the Appendix J spreadsheet (H1 Workbook) is submitted alongside this response.

1.14 Clarify why the Mercury figures in the Background info tab of Appendix J under chemicals present in potable water are all 0.

Horizon's Response

1.14 The mercury potable water value was rounded to 0d.p. and then pasted as absolute values. Horizon confirms that although this is an error, there are no formulae that rely on this value and the values that the H1 spreadsheets are reliant on, use the correct mercury concentration for potable water (i.e. 0.03 µg/L). The updated version of the Appendix J spreadsheet (H1 Workbook) is submitted alongside this response with this error amended.

1.15 Confirm if the Annual Averages table on the Background info tab of Appendix J is complete.

Horizon's Response

1.15 Horizon has checked and completed any gaps in the data in the background info data tab and the updated version of the Appendix J spreadsheet (H1 Workbook) is submitted alongside this response.

2. Water Framework Directive (WFD)

The Skerries Waterbody

2.1 Section 7.3.73 – 7.3.80 of your WFD Compliance Assessment considers effects on the Biological Quality Elements (BQE) of the Skerries Coastal Water Body. Further information is required to demonstrate that benthic invertebrates would not be at risk of deterioration as a result of the operational water discharge activities:

2.1.1 Provide, in addition to the relative percentage of water body affected, the potential effects on BQEs in the context of the spatial extent criteria set out in Table 1a of the UK Technical Advisory Group on the Water Framework Directive's Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive (December 2007) –

https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Recommendations%20on%20surface%20water%20status%20classification_Final_010609.pdf

2.1.2 With regard to cumulative effects on benthic invertebrates, further clarity is required on the total extent (both % of water body and area in km^2) of all combined non-temporary effects on benthic invertebrates in The Skerries. Impacts as a result of the operational water discharge activities (i.e. the extent of increased temperature and Total Residual Oxidant at the seabed) could result in deterioration when considered cumulatively with the marine works (as part of the marine licensable activities).

Horizon's Response

2.1 The Skerries water body comprises the coastal environment from the existing power station out to around 2km north-west of The Skerries islands and to just south of Porth Trwyn on the west coast of Anglesey. There are a number of fluvial non-reportable water bodies within the Wylfa Newydd Development Area which drain into The Skerries water body, including watercourses within the:

Afon Cafnan Catchment; and
Power Station Catchment (Nant Porth-y-pistyll)

The Cemlyn Lagoon coastal waterbody is situated to the west of the study area and discharges into The Skerries coastal waterbody via a sluice. Cemlyn Lagoon is considered separately to The Skerries (see WFD Compliance Assessment) and has a small, non-reportable water body (Nant Cemlyn) associated with it.

The Skerries water body is classified as having high status overall. Data provided by NRW (see appendix B of WFD Compliance Assessment) show that biological quality elements are at high status (based on benthic invertebrates). The classification of physicochemical quality elements (based on dissolved oxygen) is also at high status. The hydromorphological supporting elements are at high status (based on morphology being classified as high) and the chemical assessment is good.

The Skerries coastal water body is characterised by strong tidal currents, semi-diurnal tides and localised eddies in the bays around Wylfa Head. The water body waters are well mixed all year round with no evidence of a permanent temperature or salinity gradient (thermocline and halocline respectively) or seasonal stratification (see ES appendix D13-1, Application Reference Number: 6.4.83, ES appendix D13-1 was also included as Appendix D to the Operational Water Discharge Environmental Permit application). The coast mainly comprises hard rocky cliffs with sandy bays. The hard geology would have been covered by ice sheets in

the last glaciation and loose material eroded/detached during that period has since been moved and sorted by currents driven by tidal and wave forces.

Offshore, the sea floor is composed of a mixture of solid bedrock, boulders, cobbles, gravels and sands. Over the long term, the rocky coast will be extremely slow to change, even with strong tidal currents (see appendix D12-2, Application Reference Number: 6.4.81 which is provided as part of this response).

The results of water quality surveys carried out between 2010 and 2014 showed expected concentrations of chemicals sampled (many below the limit of detection), with values in line with previous studies and typical of coastal waters around the north of Anglesey (see appendix D13-1, Application Reference Number: 6.4.83).

Phytoplankton production is low, most likely as a consequence of the low nutrient levels, which is a known feature of this area of the Irish Sea (see appendix D13-1, Application Reference Number: 6.4.83). The intertidal ecological communities are characteristic of an exposed, western, rocky coastline, and the habitats support diverse assemblages of macrophytes (see appendix D13-2, Application Reference Number: 6.4.84 which is provided as part of this response). The subtidal benthic communities are considered to be of high quality and are generally undisturbed (see appendix D13-2, Application Reference Number: 6.4.84).

Where comparisons can be made, the baseline data collected for the Wylfa Newydd Project show good correlation with WFD water body monitoring data as provided by NRW.

The above information also aligns with that presented in DCO Relevant Representation stating that the potential risk of deterioration for The Skerries Coastal water body in respect of benthic invertebrates was considered but ultimately discounted in the WFD Compliance Assessment. This conclusion was based upon the outcome of detailed marine assessment work conducted for the proposed development. This information is as presented in ES Volume D – WNDA Development: D13 – The Marine Environment. Effects on benthic invertebrates are addressed in more detail in response to NRW's comments regarding benthic invertebrates.

Horizon has held meetings with NRW on these issues through the Statement of Common Ground process, and in the context of the Marine Licence Application. Horizon will ensure that NRW has the information necessary to inform its assessment of in respect of the Water Framework Directive.

The Horizon Memo (Water Framework Directive Statement of Common Ground. Benthic Invertebrates, 11th October 2018) has also been provided as part of this response, document reference HNP-HZCON-PAC-MEM-00004.

2.1.1 & 2.1.2 Within section 7 of the WFD Compliance Assessment, it is shown that 23.5ha of subtidal (i.e. coastal bed) and 7.6ha of intertidal invertebrate habitat would be permanently lost under the footprint of the Marine Works in Porth-y-pistyll.

Assuming a 'worst case' scenario using an annual base case with a continuous discharge of 126m^3/s and no wind stress, the predicted areal extent of thermal effects (>2$^{\circ}C$ rise at the seabed) encompasses that for total residual oxidants (TRO) effects (0.01mg/l (95 percentile)). Assessment text was missing from the DCO application and accompanying WFD Compliance Assessment but has been provided into the DCO process in FWQ 8.0.23 for deadline 2 and in response to NRW's Written Response WR-1-138 at deadline 3. This work identified a further 5.6ha of sub-tidal loss.

Potential thermal and TRO effects to intertidal areas within The Skerries waterbody due to Cooling Water discharge is expected to be highly localised, being limited to a couple of hundred metres to the west of the Cooling Water outfall. Consequently, there is limited cumulative

impact to invertebrates found intertidally and therefore the assessment of effects remains as reported above (for direct loss under the footprint of the Marine Works).

Cumulatively, the predicted losses represent 0.6% of subtidal habitats and 3.6% of intertidal habitats within the Skerries water body. With reference to UKTAG guidance, this is consistent with High Status. Even with the additional cumulative loss associated with the TRO effect, we conclude that the project is compatible with the normative definition of benthic invertebrates (i.e. no loss of sensitive species).

In reality, it is not anticipated that all invertebrates within the total area of The Skerries water body potentially affected by the Wylfa Newydd Project would be at risk of deterioration. Outfall surveys at the Existing Power Station have shown that acute effects such as reduced species diversity and abundance, as well as the loss of key characterising species would only likely occur within a couple of hundred metres of the outfall. Beyond 300m no significant differences in the subtidal communities were observed during Cooling Water outfall surveys of the Existing Power Station (appendix D13-5 Application Reference Number: 6.4.87 which is provided as part of this response). Although the Wylfa Newydd Power Station would discharge Cooling Water at a greater rate and temperature, the Cooling Water outfall has been designed to direct the plume away from the seabed thereby reducing effects to benthic invertebrates.

As evidenced in section 13.6 of chapter D13 of the Environmental Statement, it is considered that most benthic invertebrate species would not experience lethal effects from TRO at the highest concentrations (i.e. 0.1mg/l) modelled close to the outfall. In addition, there is considered to be no impact to invertebrate species from additional chemical changes associated with Cooling Water and other construction or operational water discharges (e.g. metal concentrations, dissolved oxygen, pH and ratio of ionised to unionised ammonia).

Therefore, whilst deterioration of habitat and sessile invertebrate species is likely to occur in Porth-y-pistyll under the footprint of the Marine Works and within the immediate vicinity of the Cooling Water outfall (i.e. several hundred metres), significant deterioration is not anticipated outwith this area. Furthermore, mobile benthic invertebrates would be able to move away from areas of disturbance or unfavourable conditions, and so whilst habitat may be lost, mortality may not occur. Subtidal and intertidal habitats along the north Anglesey coastline are not considered to be a limited resource for marine invertebrates known to be present within the area potentially affected.

Based on the worst-case assessment outlined above, the proportion of The Skerries waterbody potentially at risk of deterioration for marine invertebrates does not exceed 5% of its surface area, nor does it cover a contiguous surface area which exceeds 0.5km^2. This conclusion remains valid when intertidal and subtidal areas are considered in combination and isolation. Therefore, in accordance with the normative definition outlined in Table A1a of the UK Technical Advisory Group Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive (UK TAG, 2007), the predicted cumulative effect to marine invertebrates as a biological quality element of The Skerries does not represent a failure which is inconsistent with classification as high ecological status.

Considering this and the additional information presented in chapter D13 of the Environmental Statement and summarised above, the current classification for marine invertebrates is not considered to be at risk of deterioration as a consequence of the Wylfa Newydd Project.

Anglesey North Waterbody

2.2 The Anglesey North WFD water body is currently failing for mercury. Further information is required to assess the impact on load and distribution of additional/concentrated mercury due to the cooling water discharge. Where an element comprising surface water chemical status is already in the lowest status class, then any further deterioration (within class) is considered a deterioration of the waterbody. Any negative change must be measurable and meaningful at a water body scale in order for it to be considered deterioration. Any further analysis should be presented in this context.
Horizon's Response
2.2 Horizon has reviewed the data available and confirms that mercury is present in the potable water supplied to the site. However, Horizon concludes that any negative change in mercury would not be measurable (i.e. average increases in the operational batch discharge are in the order of 0.000002 µg/L) at a waterbody scale, from both a measurement location and laboratory detection aspect (LOD is 0.01 µg/L).

2.3 Please note the requests in section 1 regarding H1 which are also relevant to the WFD.
Horizon's Response
2.3 Reference to the WFD is made in all relevant responses to the H1 in section 1. Horizon's responses to 1.1, 1.7, 1.8 and 1.9 are relevant to The Skerries coastal water body as well as Anglesey North.

3. Conservation of Habitats and Species Regulations 2017

3.1 The cooling water discharge and proposed marine works (subject separately to the marine licensing process) are located within the Anglesey Terns SPA and the North Anglesey Marine SCI. With regards to the predicted impacts on fish (as key prey items for the four species of terns, harbour porpoise and bottlenose dolphins and other relevant interest features of Natura 2000 sites) there has been no consideration of the potential effects of the creation of a sheltered bay as the result of the proposed breakwaters. This has the potential to increase the use of the sheltered area by key fish species which could result in higher entrapment rates than predicted by the modelling. In addition, there is also a risk that large amounts of shoaling fish, including sand eels, sprats and herring (key prey items for the interest features) could be herded into the area behind the proposed breakwaters by predators. Under certain weather conditions and at certain times of the year this could also lead to increased entrapment rates of these key prey species. In relation to above please:

3.1.1 Confirm how the modelling has been validated to take into consideration these uncertainties regarding the change in environmental conditions created by the breakwaters over the operational phase for these key prey species.

3.1.2 Provide further details of proposed monitoring of these key species to validate the modelling assumptions between the construction and operational phases and during the operational period.

3.1.3 Confirm what other mitigation measures have been considered that could be incorporated to provide improved confidence in the predicted model outputs, taking into account the limited evidence available on the long-term efficiency and maintenance requirements of behavioural deterrents and lack of data on the effects of low approach velocities and AFD's for sandeels (Shadow HRA, Section 10.3.225 pg 736).

Horizon's Response

3.1 The assessment of the effect of the Project on impingement and entrainment included in the Shadow HRA is based on actual data from the unmitigated Wylfa A Magnox intake (that would not meet current best practice) scaled to operational flow. Consequently, the predictions of impingement and entrainment (i.e. the numbers of fish/larvae/eggs, biomass and equivalent adult values) that informed the Shadow HRA represent the worst-case and it was concluded that the effect on all fish species (and on their availability as prey for terns) would be negligible. This conclusion was reached on the basis of the small-scale loss predicted of all fish through impingement and entrainment in relation to the estimated size of the respective populations of each species.

For the Project, the acoustic fish deterrent (AFD) to be installed at the intake is designed to 'deter' fish, including sprat, herring and sandeel (hearing sensitive species) which are key prey items for terns, from the vicinity of the intake. The mitigation measures proposed also include a low approach velocity to the intake and a fish recovery and return system.

To give an indication of the likely effectiveness of the mitigation for those species referred to by NRW (for which data are available), based on data from other power stations, the estimated efficiency in reducing impingement of the low approach velocity is greater than 95% for herring and sprat; and the estimated efficiency of the AFD is 95% and 88% respectively for these species (Table D13-31 of the Environmental Statement).

This evidence demonstrates that should the presence of the breakwater lead to increased fish density in the area to be semi-enclosed by it, it is not the case that their loss due to

impingement and entrainment would increase beyond the worst-case prediction (because the mitigation measures referred to above would be active and evidence suggests the measures would be highly effective); i.e. the effect of the Project on prey availability would still be negligible.

It is also the case that the community of fish that is likely to occur in the vicinity of the breakwater could mean greater local availability of prey for the Cemlyn terns.

3.1.1 It is not possible to validate the modelling to take into account the effect of the potential change in environmental conditions created by the breakwaters on prey species. See 3.1 which outlines the background to the response.

3.1.2 Initial discussions with NRW regarding a monitoring / watching brief approach have been held in connection with NRW's comments on the DCO and Marine Licence applications.

The Wylfa Newydd Code of Operational Practice (CoOP) confirms that 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.

3.1.3 The potential for further mitigation measures has been raised as part of the discussions referred to above (in response to 3.1.2). Other possible options can be explored and would be discussed with NRW Permitting Service as part of forward work plan item number 5. It should be noted that any possible measures would not necessarily provide confidence in the model outputs, but rather would provide confidence that measures could be put in place in the event that the monitoring (referred to in response to 3.1.2) does not confirm the predictions of the assessments.

A possible mitigation option that NRW has raised is locating an AFD system at the end of the breakwater. However, this would not be a feasible mitigation option as, to be effective, AFDs need to create a uniform sound field (a solid face). Furthermore, an AFD in this location could have a negative influence on marine mammals.

3.2 To comply with the requirements of Regulation 63(2) of the Conservation of Habitats & Species Regulations 2017 the following is required (and in relation to request 1.1):

3.2.1 Provide a figure showing the modelled area of sea which is greater than or equal to 0.2 degree mean surface water temperature rise above the prevailing environmental condition (baseline).

3.2.2 Provide the area of effect in km^2.

3.2.3 Confirm what baseline temperature has been used to represent the prevailing environmental conditions to produce the 98th percentile maximum temperature rise (surface) plot (request 1.1). This information will be used by NRW to consider the area of sea that is likely to be significantly affected by the proposed cooling water discharge mixing zone.

3.2.4 Confirm how predicted increases in sea temperatures (above the current baseline) over the operational lifetime of the project have been considered, in relation to assessing the effects of the thermal discharges on the affected European protected sites in order to consider the predicted effects of climate change. Confirm that the assessment is based on the best available information and review in light of results of

modelling re-run 4.2 and UKCP18. Confirm the extents given by the heat flux sensitivity scenarios. Ensure these are updated for the operational lifetime of the permit.

Horizon's Response

3.2 There is no specific action to address this point. The items requiring action are 3.2.1 – 3.2.4. below.

3.2.1 The figure is provided overleaf (figure 1-1) showing this (Autumn base-case). Note that this figure has been produced previously and provided to NRW in pre-application discussions (May 2018), in Horizon memo ref. WN0908-JAC-PAC-TEC-00001, also provided with this response.

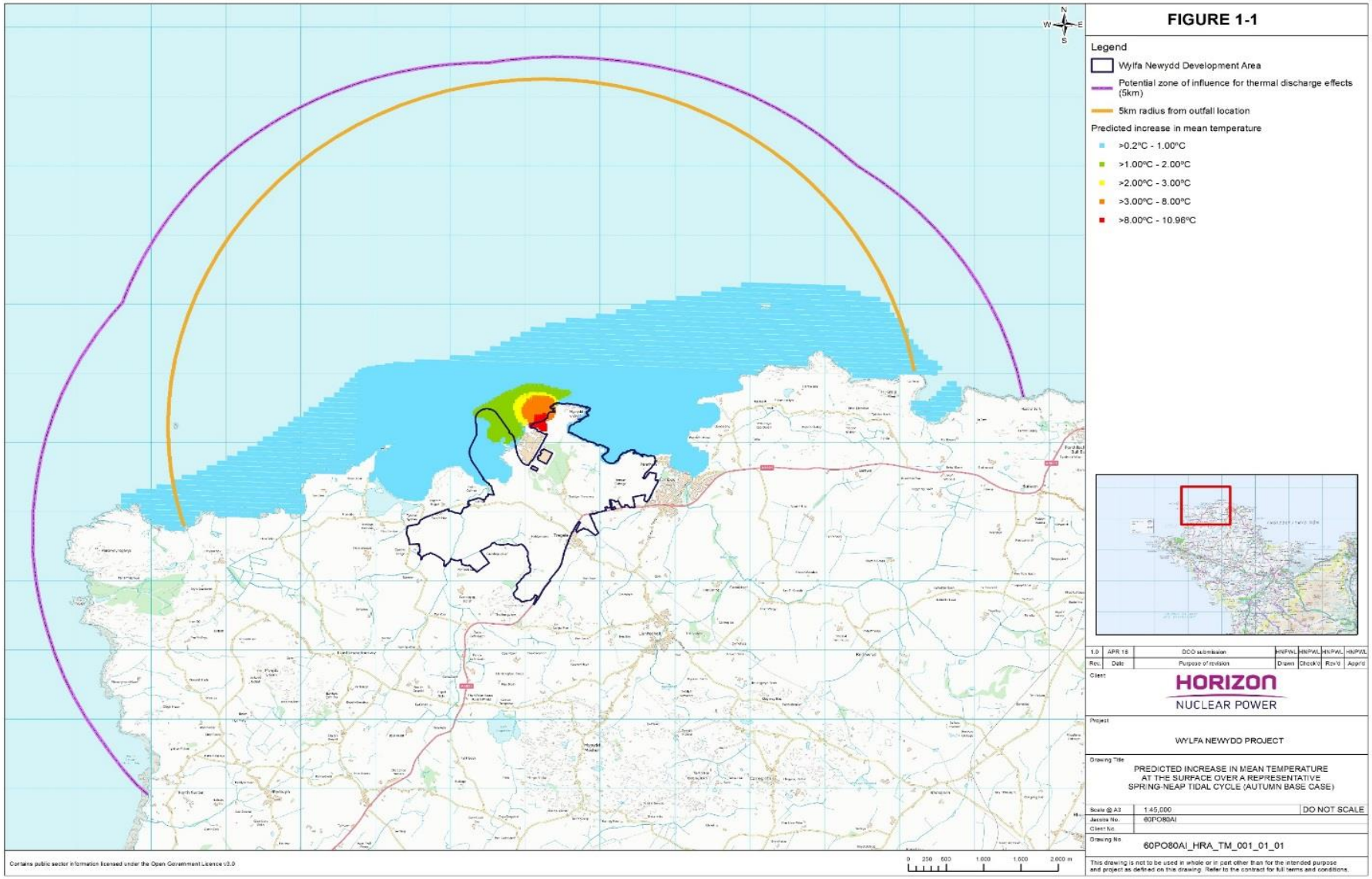
3.2.2 The area presented in the Autumn base case figure produced to address 3.2.1 equates to 14.40 km^2.

3.2.3 Horizon confirms that the baseline temperature used to represent the prevailing environmental conditions in the 98th percentile maximum temperature rise (surface) plot in Appendix G is 16.44℃. The figure provided in response to 1.1 updates this with an increased background temperature of 16.7℃.

3.2.4 Increases in sea temperatures have been considered in the assessment of effects on European Sites, in terms of the increases from the thermal discharge. As stated, the surface heat loss rates used for the seasonal base cases are reasonable for conditions under climate change therefore Horizon considers that this is using the best available information.

Where appropriate, Horizon has informed this by assessing the thermal tolerances of associated/relevant habitats and species and considering effects such as changes in species distribution (Lusitanian/boreal species moving northward/southward), changes in timing of spawning and other lifecycle characteristics due to increasing sea temperatures. The significance of rising seawater temperature in terms of the potential for seasonal advancement or delay as a result of Power Station operations was also assessed.

Response to Environmental Permitting Regulations 2016 Schedule 5 Notice	Document No.	Revision: 1.0
	HNP-HZCON-PAC-REP-00011	Issue date: 08/02/19



3.3 We understand that HNP have undertaken further tern tracking work in 2018 alongside your tern breeding observations work. Please provide this information to inform our assessment and ensure that it takes account of the best available information.

Horizon's Response

3.3 Please refer to Addendum to Seabird Baseline Report - Tern Tracking, document reference WYN-JAC-PAC-TEC-00024, provided with this response.

3.4 In relation to request 1.2, Provide information on the importance of the worst-case scenario modelled extent of sodium nitrite on the designated interest features and their conservation objectives.

Horizon's Response

3.4 Horizon has provided a modelling plot showing the sodium nitrite mixing zone (out to the PNEC value) using the autumn base case in response 1.2.1 and information on the importance of this area to the designated interest features in 1.2.3.

3.5 Please assess the impacts of chlorine dioxide on designated interest features and their conservation objectives, see request 1.7.

Horizon's Response

3.5 See the response for 1.7. No further action is proposed to address this requirement.

3.6 Provide information on the importance of changes in coastal processes has on designated interest features and their conservation objectives. See request 4.1.

Horizon's Response

3.6 See comments in response to item 4.1.

4. Coastal Processes and Benthic Habitats

4.1 The application does not provide an assessment of the impact of the cooling water discharge upon coastal processes. It is unclear whether the water discharge velocities and volumes over the water column could have a detectable change on the local dynamics; stratification, scour and sediment movement for an appreciation of impact. Please provide an assessment/model the effects of the cooling water on hydrodynamic processes.

4.1.1 Provide information on the importance of this area to the designated interest features and their conservation objectives.

4.1.2 Provide information on the importance of this area to the designated waterbodies.

Horizon's Response

4.1 The Cooling Water outfall will be located at Port Wnal, adjacent to the outfall of the existing power station. Cooling water discharges could cause localised changes to coastal and marine processes and affect the seabed through the effects of locally increased shear stresses. These have been assessed in chapter D12 of the Environmental Statement.

A hydrodynamic model study was undertaken to assess potential impacts of the operation of the cooling water intake and outfall during the lifetime of the project using DELFT3D (chapter D13) and including the discharge flows from the cooling water outfall. Changes to bed shear depicted in figure 15 (figure D12-15) indicate small areas of increased bed shear at the cooling water outfall location. However, these coincide with locations where soft sediments are not present and therefore no changes to sediment mobilisation would occur. At the cooling water 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 effect.

This point was also discussed in one of the Statement of Common Ground meetings with NRW on 27/9/18. Supplementary information on coastal processes to support the EIA and Shadow HRA has been prepared (submitted into the Examination for the DCO (as document reference REP2-007) to provide a written response to NRW on the matters discussed at the meeting, including this point. This document is appended to this response (reference WYN-JAC-PAC-TEC-00027).

4.1.1 The document referred to above in response 4.1 (reference WYN-JAC-PAC-TEC-00027) draws a conclusion on the implications of the further assessment on the conclusions of the Shadow HRA.

4.1.2 With respect to The Skerries coastal water body, it is at High status, despite the operation of the existing Power Station at the time that the 2015 status assessment was completed. WFD Compliance should in theory be assessed with reference to the 2015 WFD baseline (i.e. the publication of the cycle 2 RBMP). This would, in turn, have been informed by monitoring conducted during the operation of the existing power station. For the assessment conducted in the ES, full recovery has been assumed. Loss of sub-tidal and inter-tidal areas associated with the cooling water systems have fed into overall loss calculations for The Skerries coastal water body, which has driven a conclusion that the project is not compliant with the WFD as the proposed development is not compatible with the normative definition for a High-Status water body for hydromorphology. Materials have been prepared to inform an Article 4(7) derogation, which were submitted with the permit application. NRW

requested further evidence through the DCO process and Horizon has committed to provide these materials into the DCO process for deadline 6 (19th February 2019).

With respect to the Anglesey North coastal water body, the water body is not currently at High Status, meaning that hydromorphology is not a direct consideration for a WFD Compliance Assessment. Invertebrate surveys at the outfall of the Existing Power Station have been conducted. These have shown acute effects, such as reduced species diversity and abundance, as well as the loss of key characterising species would only likely occur within several hundred metres of the outfall. Beyond 300m no significant differences in the subtidal communities were observed during Cooling Water outfall surveys of the Existing Power Station. This means that the calculations of the spatial extent of the proposed discharge include areas that are physically and ecologically degraded (albeit recovering) and not pristine. The Marine Chapter of the ES describes the subtidal habitats within the study area as common in the local area, having some biodiversity characteristics (e.g. naturalness, contribution to diversity) and of local importance.

Further description of baseline conditions is provided in the following documents:

Chapter D12 of the Environmental Statement (provided as part of this response) https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010007/EN010007-001441-6.4.12%20D12-Coastal%20processes%20and%20coastal%20geomorphology%20(Rev%201.0).pdf

Chapter D13 of the Environmental Statement (provided as Appendix D of the Operational Water Discharge EP application)

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010007/EN010007-001442-6.4.13%20D13-The%20marine%20environment%20(Rev%201.0).pdf

4.2 Scenarios should be considered which include the impacts of climate change. To remain consistent with the wave modelling climate change scenarios, you must show what the potential impacts are in 2087 from reasonably foreseeable and credible maximum climate change scenarios. You must show changes due to climate change to the: hydrodynamics, thermal plume extent, stratification and impacts of the cooling water discharge on the marine environment. Information on the thermal plume extent should be in line with request 1.1.

Horizon's Response

4.2 Horizon has completed a model sensitivity run which allows for a comparison between the current summer base case with and without typical wave, and a climate change scenario. This includes changes to sea surface temperature, water level, typical wave height as a result of climate change. The summer case was used for these runs to align with the previous coupled simulations and allow a direct comparison between predicted mixing now and in 2087.

The modelling made use of HNP's validated DELFT3D hydrodynamic model of the sea around Anglesey. The simulations of the cooling water discharge were essentially a repeat of runs previously undertaken but with conditions representative of 2087. The hydrodynamic model was run with and without a wave model coupled. The coupled simulations were, as previously, undertaken to simulate the influence of wave on the vertical mixing of the cooling water plume. The coupled wave model was that used for the previous coupled wave-hydrodynamic simulations but used a boundary condition provided by HR Wallingford to represent typical conditions in summer 2087.

The climate change allowances were derived from UKCP09 with the water level changed from HR Wallingford's wave modelling. UKCP09 was used in preference to the more recent UKCP18 because the latter does not, as yet, provide predicted changes in sea temperature or marine air temperatures. It was also in keeping with the other marine modelling studies which also used UKCP09.

The climate change simulations required an appropriate summer season surface heat flux and ambient water temperature to be defined. The same methodology previously used to calculate the seasonal surface heat flux was used. To recalculate the summer surface heat flux in 2087 the sea surface temperature, over sea air temperature, cloud cover, relative humidity and air pressure were adjusted based on the UKCP09 projections. This used ten years' (Jan 2003 to December 2012 inclusive) meteorology data provided in Atmospheric Dispersion Modelling System (ADMS) format by AMEC. The seawater temperature for the same period was taken from CEFAS with the inclusion of measurements provided by Magnox.

For the mid-2080s the predicted change in sea surface temperature was 2.25°C in the summer with an air temperature rise of 2.3°C. The change in cloud cover was -1.5% A reduction in the relative humidity of 10% was adopted. Predictions of change in wind speed were not available and these were not varied. The pressure change by the mid-2050s was 0.3hPA and the sensitivity of the predicted surface heat flux to an increase of 0.3 and 0.6hPa were examined. The calculated surface heat flux was not sensitive to the assumed range of air pressure increase.

The end of operational life surface heat flux was 22.994 $Wm^{-2}K^{-1}$ which is an increase on the value used to date. The model was run with the ambient water temperature increased by 2.25°C while the salinity remained the same.

HR Wallingford used a sea level rise (2008 to 2087) of 1.5m for a credible maximum scenario. This credible maximum sea level rise (i.e. 1.5m in 2087) at the end of the projected operational

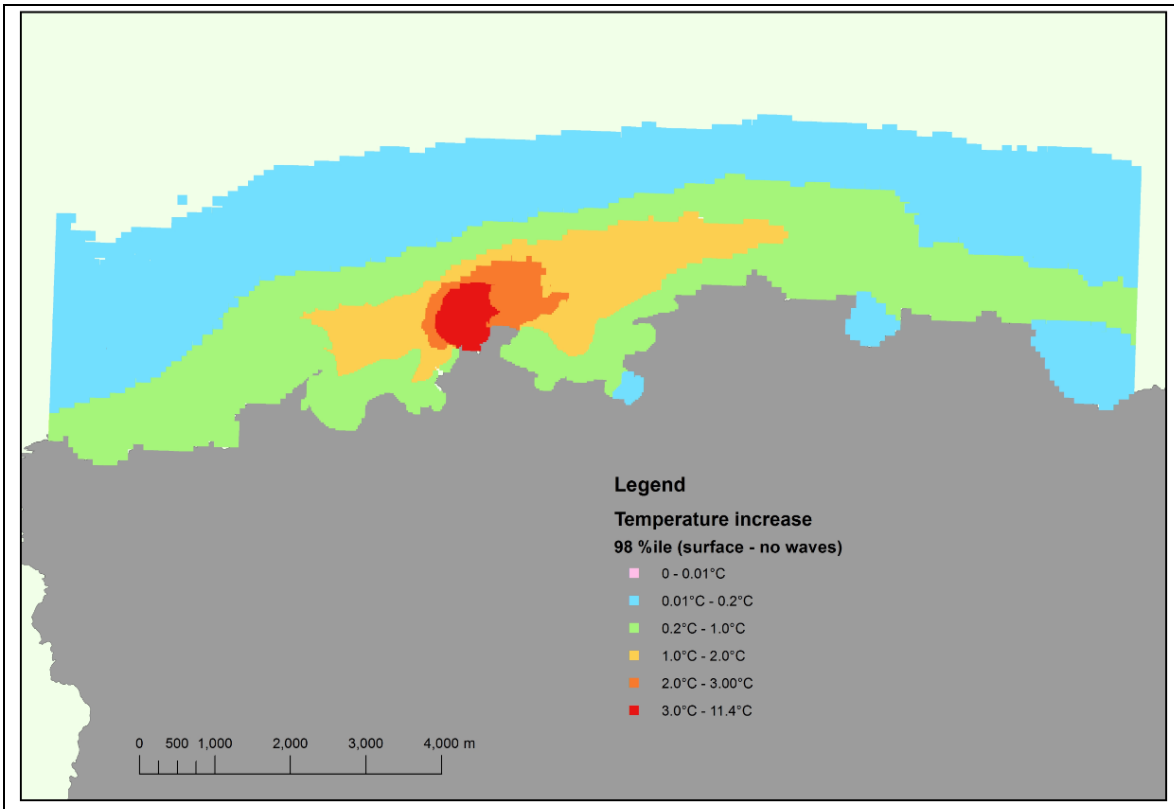
life was imposed at the boundary of the model. The coupled wave model was set up to use the water level data from the hydrodynamic model.

The areas of the 2°C and 3°C temperature rise mixing zones for the 2087 summer case with and without waves are tabulated below. For convenience the mixing zone areas for the non-climate change summer with and without waves from (6.4.90 ES Volume D PINS Reference EN010007) are included.

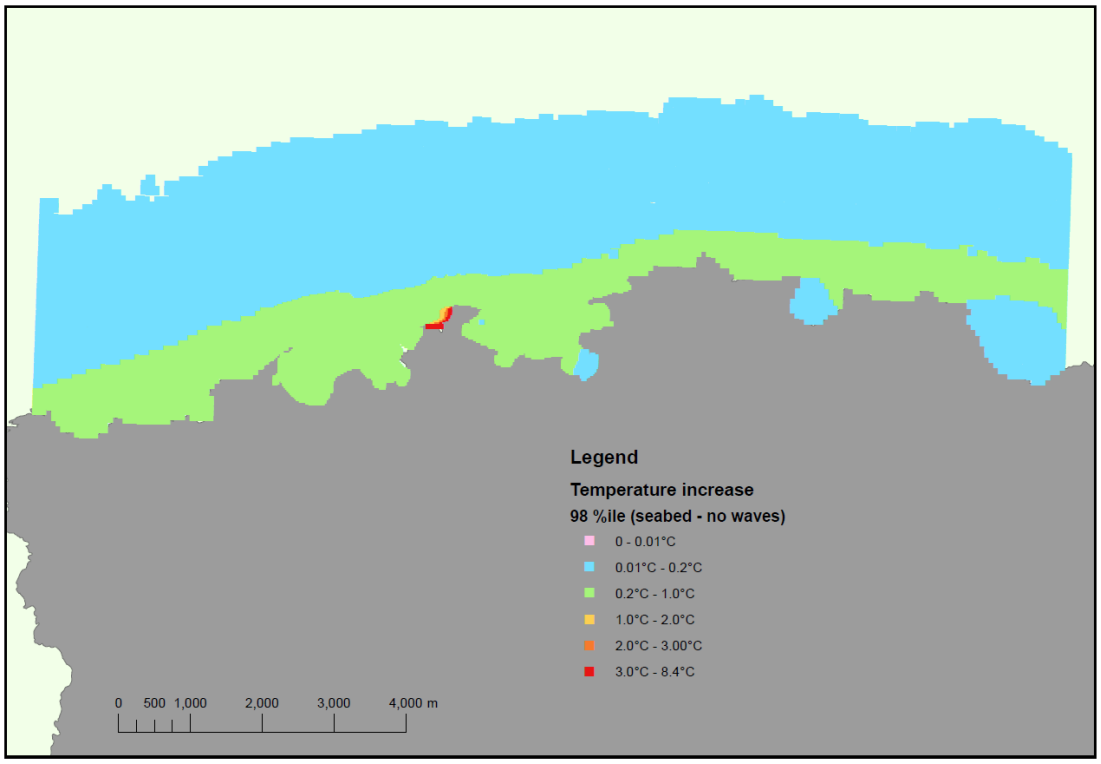
Case	2° rise Surface (km^2)	3° rise Surface (km^2)	2° rise Bed (km^2)	3° rise Bed (km^2)
No waves - 2087	1.677	0.580	0.033	0.024
With waves - 2087	0.899	0.456	0.037	0.028
No Waves – no climate change	2.270	0.887	0.035	0.027
With Waves – no climate change	1.500	0.630	0.040	0.029

The climate change simulations predict smaller mixing zones for both 2°C and 3°C rise than the previous (non-climate change) simulations. This will be due to changes to the surface heat flux under the assumed climate conditions in 2087 and the changes to mixing resulting from the assumed change in sea level.

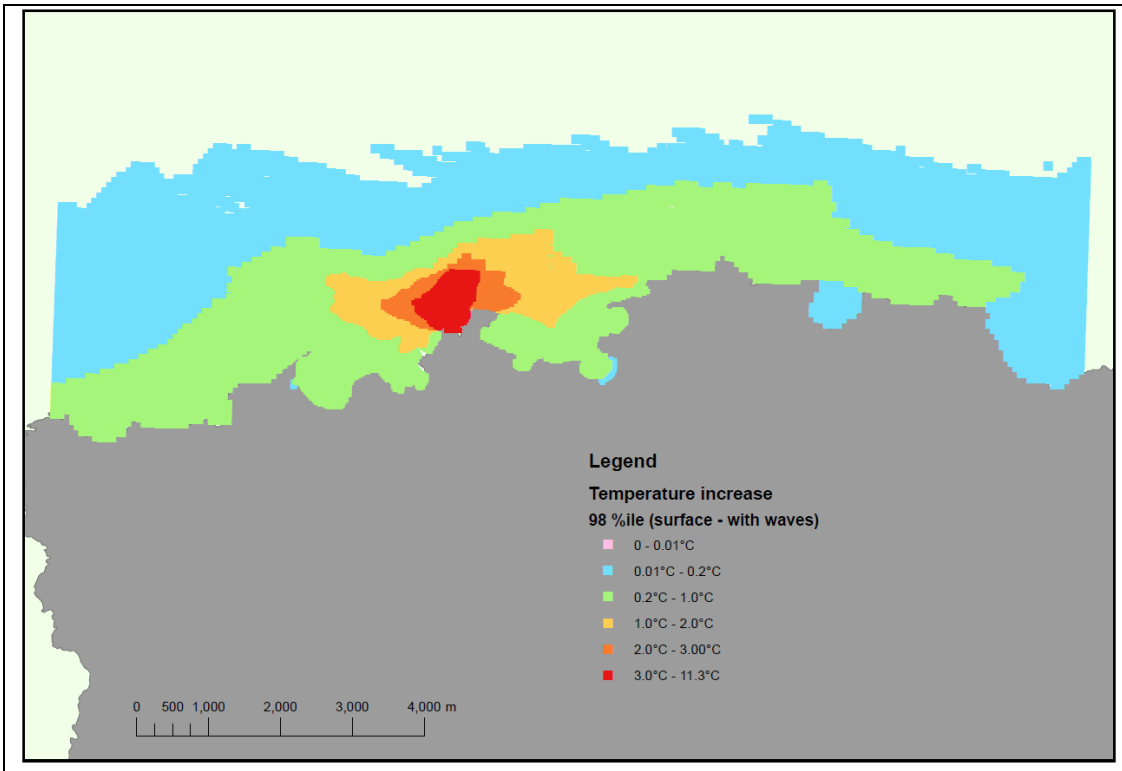
The resulting thermal plume contours are presented below for ΔT at both surface and bed, as well as absolute temperature at the surface only (with and without waves, baseline of 16.7 ºC), in line with response 1.1. The areas of sea surface of 23ºC and above for with and without waves are 0.29 and 0.33 km^2, respectively.



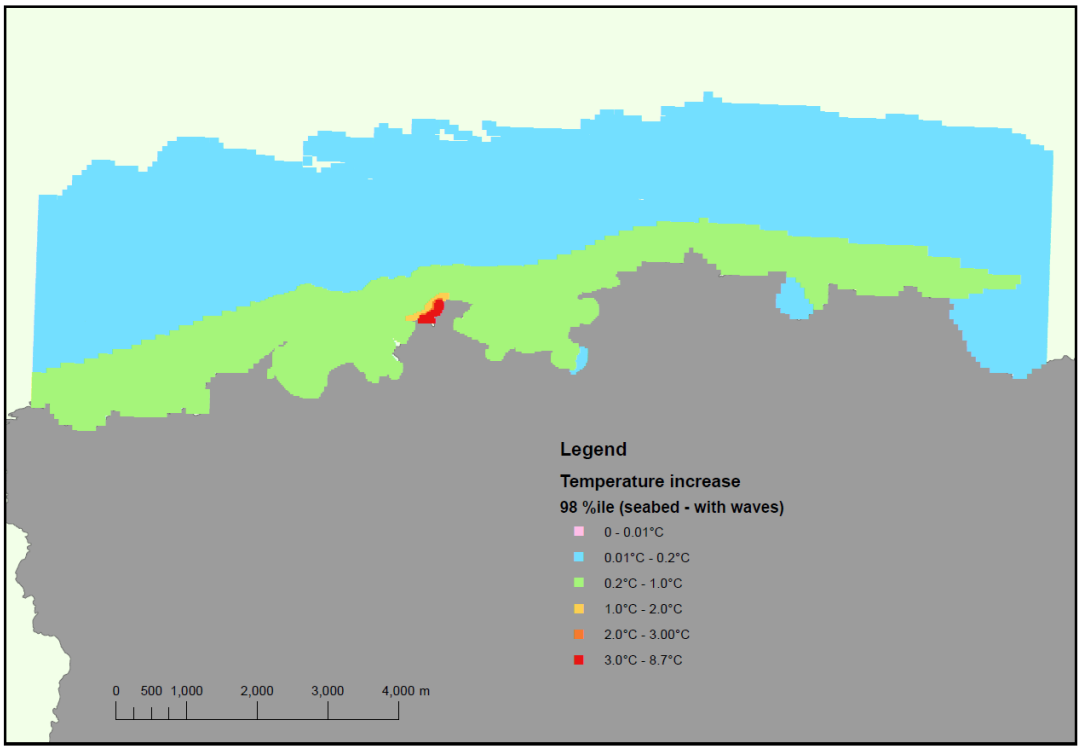
Temperature increase: climate change scenario, surface (no waves)



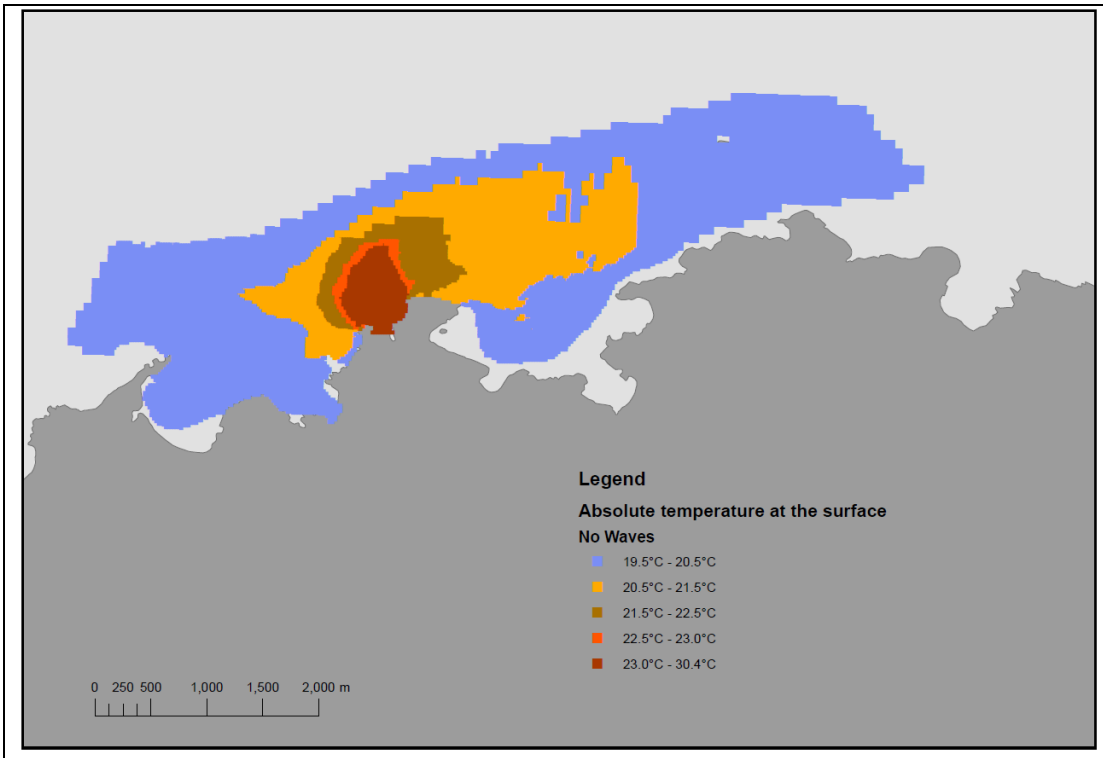
Temperature increase: climate change scenario, bed (no waves)



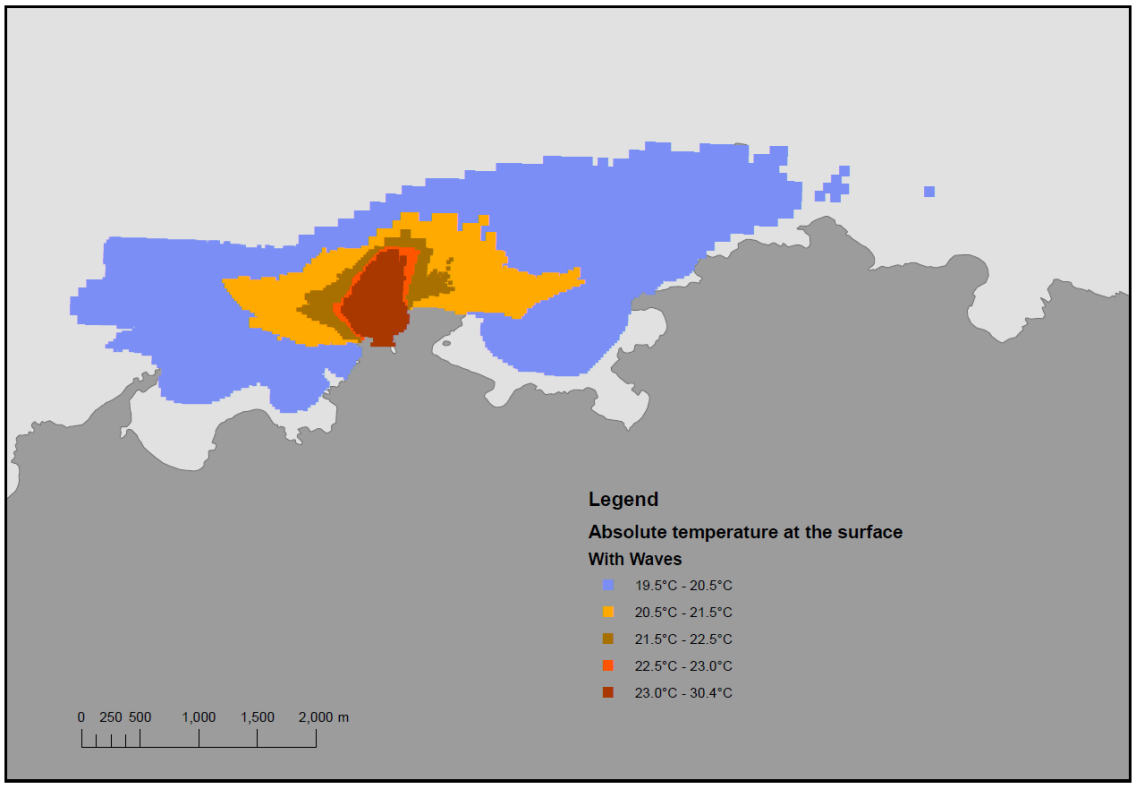
Temperature increase: climate change scenario, surface (with waves)



Temperature increase: climate change scenario, bed (with waves)



Absolute temperature at the surface: climate change (no waves)



Absolute temperature at the surface: climate change (with waves)

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Appendix 1 – State of tide for water quality surveys (1.4.2 response addendum)

Date	Tide type	WQ1	WQ2	WQ3	WQ4	WQ5
2010						
12-May	+4 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
16-Jun	+2 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
21-Jul	neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
18-Aug	-1 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
22-Sep	-3 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
13-Oct	-2 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
14-Nov	-1 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
14-Dec	-1 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
2011						
23-Jan	+1 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
09-Feb	-4 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
16-Mar	+2 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
12-Apr	neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
18-May	-1 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
14-Jun	-3 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood

12-Jul	+2 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood

Date	Tide type	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6
2011							
17-Aug	+2 springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
22-Sep	+1 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
13-Oct	springs	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
15-Nov	+4 springs	ebb	flood	flood	flood	flood	ebb/flood
2012							
11-Jan	springs	ebb	ebb	ebb	ebb	flood	ebb/flood
25-Feb	+2 springs	flood	flood	flood	flood	flood	flood
20-Mar	+3 neaps	ebb	ebb	ebb	flood	flood	ebb
02-May	+2 neaps	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood	ebb/flood
16-May	+2 neaps	ebb	ebb	ebb	ebb	ebb	ebb/flood
12-Jun	-1 neaps	flood	flood	ebb	flood	flood	ebb/flood
17-Jul	+4 neaps	ebb	ebb	flood	flood	flood	ebb/flood
07-Aug	+3 springs	ebb	flood	ebb	flood	ebb	ebb/flood
19-Sep	+1 springs	ebb	ebb	ebb	ebb	ebb	ebb/flood
09-Oct	neaps	flood	flood	flood	flood	ebb	ebb/flood
2013							
19-Feb	-1 neaps	-	ebb	-	flood	flood	ebb/flood
19-Mar	-2 neaps	-	flood	-	flood	flood	ebb/flood
23-Apr	+4 neaps	-	ebb	-	ebb	ebb	ebb/flood
04-Jun	+1 neaps	-	ebb	-	ebb	ebb	ebb/flood
18-Jun	neaps	-	ebb	-	flood	flood	ebb/flood
10-Jul	springs	-	ebb	-	flood	flood	ebb/flood

Date	Tide type	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6
14-Aug	-2 neaps	-	slack	-	ebb	ebb	ebb/flood
11-Sep	-3 neaps	-	slack	-	flood	flood	ebb/flood
01-Oct	+2 neaps	-	slack	-	ebb	ebb	ebb/flood

Date	Tide type	WQ2	WQ4	WQ6	WQ7	WQ8	WQ9
2014							
19-Feb	+3 springs	ebb	slack	ebb	ebb	ebb	ebb
26-Mar	+1 neaps	ebb	ebb	ebb	slack	flood	flood
16-Apr	-1 springs	flood	flood	slack	ebb	-	-
20-May	-3 neaps	flood	flood	flood	flood	flood	flood
10-Jun	+3 neaps	ebb	ebb	ebb	ebb	ebb	ebb
15-Jul	+1 springs	flood	flood	flood	flood	flood	flood
05-Aug	neaps	slack	ebb	flood	flood	flood	flood
02-Sep	-1 neaps	flood	slack	flood	flood	flood	flood
-		-	-	-	-	-	-
04-Nov	+3 neaps	ebb	ebb	ebb	ebb	ebb	ebb