Pentland Floating Offshore Wind Farm

Addendum of Additional Information

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Glossary of Project Terms

Key Terms	Definition
Dounreay Trì Floating Wind Demonstration Project (the 'Dounreay Trì Project')	The 2017 consented project that was previously owned by Dounreay Trì Limited (in administration) and acquired by Highland Wind Limited (HWL) in 2020. The Dounreay Trì Project consent was for two demonstrator floating Wind Turbine Generators (WTGs) with a marine licence that overlaps with the Offshore Development, as defined. The offshore components of the Dounreay Trì Project consent are no longer being implemented.
Highland Wind Limited	The Developer of the Project (defined below) and the Applicant for the associated consents and licences.
Landfall	The point where the Offshore Export Cable(s) from the PFOWF Array Area, as defined, will be brought ashore.
Offshore Export Cable(s)	The cable(s) that transmits electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OECC)	The area within which the Offshore Export Cable(s) will be located.
Offshore Site	The area encompassing the PFOWF Array Area and OECC, as defined.
Onshore Site	The area encompassing the PFOWF Onshore Transmission Infrastructure, as defined.
Pentland Floating Offshore Wind Farm (PFOWF) Array and Offshore Export Cable(s) (the 'Offshore Development')	All offshore components of the Project (WTGs, inter-array and Offshore Export Cable(s), floating substructures, and all other associated offshore infrastructure) required during operation of the Project, for which HWL are seeking consent. The Offshore Development is the focus of this Environmental Impact Assessment Report.
PFOWF Array	All WTGs, inter-array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the PFOWF Array Area, as defined, excluding the Offshore Export Cable(s).
PFOWF Array Area	The area where the WTGs will be located within the Offshore Site, as defined.
PFOWF Onshore Transmission Infrastructure (the 'Onshore Development')	All onshore components of the Project, including horizontal directional drilling, onshore cables (i.e. those above mean low water springs), transition joint bay, cable joint bays, substation, construction compound, and access (and all other associated infrastructure) across all project phases from development to decommissioning, for which HWL are seeking consent from The Highland Council.
PFOWF Project (the 'Project')	The combined Offshore Development and Onshore Development, as defined.

Acronyms and Abbreviations

Bq/g	Becquerels per gram
CDM	Construction Design Management
CEH	Centre for Ecology and Hydrology
CfD	Contracts for Difference
CI	Confidence Intervals
CIRIA	Construction Industry Research and Information Association
CPG	Counterfactual for Population Growth
CPS	Counterfactual for Population Size
CRM	Collision Risk Modelling
DSRL	Dounreay Site Restoration Limited
EASR	Environmental Authorisation (Scotland) Regulations 2018
EIAR	Environmental Impact Assessment Report
EUNIS	European University Information System
FSS	Food Standards Scotland
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Appraisal
HRGS	high resolution gamma spectrometry
HSE	Health and Safety Executive
HVAC	High Voltage Alternating Current
HWL	Highland Wind Limited
kbq	kilo becquerels
km	kilometres
LEDS	Liquid Effluent Discharge System
m	metres
mLAT	metres below lowest astronomical tide
MS	Marine Scotland
MS-LOT	Marine Scotland Licencing Operations Team
MSS	Marine Scotland Science
MW	Megawatt
NORM	Naturally Occurring Radioactive Material
OECC	Offshore Export Cable Corridor

PFOWF	Pentland Floating Offshore Wind Farm
PRAG-D	Particles Retrieval Advisory Group (Dounreay)
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
RIFE	Radioactivity in Food and Environment
RSPB	Royal Society for the Protection of Birds
SD	standard deviation
SEANSE	Strategic Environmental Assessment North Sea Energy
SEPA	Scottish Environment Protection Agency
SHET	Scottish Hydro Electric Transmission
SNCB	Statutory Nature Conservation Bodies
SPA	Special Protected Area
TA	Technical Appendices
THC	The Highland Council

1 Introduction

In August 2022 Highland Wind Limited (HWL) (the Applicant) submitted an application to the Scottish Ministers to develop the Pentland Floating Offshore Wind Farm (PFOWF) off the coast of Dounreay, Caithness. The following applications were submitted for the Offshore Development which comprises the PFOWF Array Area and Offshore Export Cable Corridor (OECC):

- An application for consent under Section 36 of the Electricity Act 1989 for the construction and operation of an offshore generating station; and
- Two Marine Licence applications under part 4 (Section 20) of the Marine (Scotland) Act 2010 for the deposit of substances and objects and the construction, alteration, or improvement of works within the Scottish Marine Area in relation to the PFOWF. One Marine Licence application is made for the offshore wind farm and one Marine Licence application is made for the associated Offshore Transmission Works.

A separate application for Planning Permission in Principle for the Onshore Development (comprising onshore substation, export cables and associated infrastructure) was submitted to the Highland Council (THC) for approval in October 2022, under the Town and Country Planning (Scotland) Act 1997.

The consent applications for the Offshore Development were supported by an Environmental Impact Assessment Report (EIAR) and a Habitats Regulations Appraisal (HRA): Report to Inform Appropriate Assessment (RIAA), prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

The PFOWF Array Area is located approximately 7.5 km off the coast of Dounreay, Caithness. The OECC extends south from the PFOWF Array Area to a landfall at the Dounreay coast. The Offshore Development comprises up to seven wind turbine generators (WTG) and associated floating substructures, up to nine mooring lines and anchors for each floating substructure, up to seven inter-array cables (dynamic and static) and up to two offshore export cables.

Construction for the Offshore Development is anticipated to commence in 2024 at the earliest with the project fully commissioned and operational by the end of 2026.

1.1 Purpose of this Document

The purpose of this document is to support the application for consents for the Offshore Development through provision of further clarification and additional information, as requested by Marine Scotland Licensing and Operations Team (MS-LOT) on 9 December 2022. The Additional Information as defined in the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 is provided in the form of this Addendum to the EIAR, submitted in support of the consent applications made in August 2022.

The additional information provided within this document relates to the assessment of marine ornithology, marine physical processes and water and sediment quality only and all information in relation to all environmental assessments, other than these topics, remains as provided within the

EIAR and RIAA for the consent applications, submitted in August 2022. No changes to the Project design envelope, as defined in EIAR Chapter 5: Project Description, are proposed.

1.2 EIAR and RIAA Implications

The clarifications and further information provided herein do not alter any of the assessments completed within the EIAR and RIAA and the conclusions of those assessments remain the same.

2 Representations Received on the Application

A number of representations on the application have been received from statutory consultees and other stakeholders with an interest in the proposed Offshore Development. Representations received to date (as of 15 December 2022) have been responded to directly by the Applicant where necessary. Where it is considered that the clarifications and information provided to consultees may comprise additional information (as determined by MS-LOT) this has been collated within this document and the individual responses that have been provided to the consultees are included at Appendix A.

2.1 Request for Additional Information

Requests for clarification have been received by MS-LOT from three consultees comprising:

- NatureScot: Request for clarification and information regarding ornithological assessment, including apportioning values used for screening Special Protection Areas (SPAs), displacement analysis for puffin, collision risk modelling options for great black backed gull and herring gull, and population modelling outputs to consider 25 and 30 years. In addition, request for clarification regarding marine physical processes assessment regarding confirmation of hydrodynamic changes.

- Royal Society for the Protection of Birds (RSPB): Request for clarification regarding ornithological assessment, including survey data used and Population Viability Analysis (PVA) in terms of how the model was run and parameters used.

- Scottish Environment Protection Agency (SEPA): Request for clarification regarding sampling procedures and rationale and monitoring and management of radioactive particles.

2.1.1 NatureScot

A clarification note was provided to NatureScot on 4 November 2022 that set out the responses received and further information to provide clarification to the concerns raised. This note is included at Appendix A and the further detail requested by NatureScot is set out in Appendix B. Following provision of the clarification note, a follow up response was provided by NatureScot on 8 December and a meeting has been arranged with NatureScot on 20 December 2022, to discuss the information provided.

2.1.2 RSPB

Following receipt of a holding objection from RSPB (pending provision of further clarification and information) the Applicant held a meeting with the RSPB on 11 November 2022 to discuss the

Project. The meeting was positive, providing an opportunity to discuss the Offshore Development, and agreement that the Applicant would provide further detail to clarify the assessment methodology. Following the meeting, the Applicant provided a clarification note to the RSPB on 30 November 2022 that set out to address the concerns raised. This note is included at Appendix A and the further detail requested by the RSPB is set out in Appendix C.

2.1.3 SEPA

It is noted that SEPA initially objected to the application and requested clarification regarding sampling procedures and rationale regarding the monitoring that had been undertaken for radioactive particles. It is noted that some of SEPA's concerns relate to the potential disturbance of existing radioactive contamination during the construction and operation of the Offshore Development and the associated risk of increased numbers of particles being recovered onshore. The potential effects of the development disturbing the seabed sediment and radioactive particles were considered within the EIAR (Volume 2) in Chapter 7: Marine Physical Processes, Chapter 8: Water and Sediment Quality and Chapter 21: Risk of Major Accidents and/ or Disasters.

In response to this request for clarification, the Applicant held a meeting with SEPA on 16 November 2022 to discuss the responses received and to provide clarifications on the issues raised. The meeting also provided an opportunity to update SEPA on the application process and to discuss the potential inclusion of a consent condition related to monitoring radioactive particles. The Applicant confirmed that it is content to accept a condition for the development of a monitoring strategy for radioactive particles in consultation with SEPA (and other relevant consultees), to ensure this risk is managed during and after construction activities. Commitment to such a condition was also made within the EIAR submitted in support of the applications for consent.

Following the meeting the Applicant provided a clarification note to SEPA on 23 November 2022 that set out the response received and detail requested to address the concerns raised. The clarification note provided to SEPA is included at Appendix A and the further detail requested by SEPA is set out in Appendix D.

On 9 December 2022, SEPA confirmed to the Applicant that it is minded to remove its objection, provided the concerns are addressed by a suitable condition, agreed with MS-LOT, is attached to any consent/licence granted. It is noted that precedent for this type of condition exists within the existing consent for the Dounreay Trì Project, which is located within the same area as the PFOWF Project and which has consent for the same cable route as that sought by PFOWF's current application, and also within the consent for the SHET HVAC cable from Orkney to mainland Scotland which also crosses the FEPA Zone and makes landfall adjacent to the Offshore Development's landfall at Dounreay. Discussions on suitable condition wording are ongoing between SEPA, MS-LOT and the Applicant.

Section 3 of this document provides further details of the Applicant's response to address the requests for further information received from MS-LOT on 9 December 2022.

3 Additional Information

The following sections respond to the points raised in MS-LOT's request for additional information, received by the Applicant on 9 December 2022. Table 33.1 below presents the information requested by MS-LOT and signposts to where within this document each request is addressed. MS-LOT's request was that the information should be supplied to MS-LOT either as an addendum to the EIAR already submitted or contained within a revised EIA Report and the Applicant has opted for the former; the information presented within this document comprises an addendum to the EIAR that has already been submitted.

Table 33.1 MS-LOT request for further information

ID	MS-LOT request	Where addressed
Marine Ornithology		
MS1	Any incorrect references to apportioned values of seabirds to SPAs within the EIA Report must be updated to reflect the correct figures.	Section 3.1
MS2	The outputs from Option 2 of the Band CRM must be provided for herring gull and great black-backed gull.	Section 3.1 and Appendix B, Annex A
MS3	The displacement assessment for puffin must be updated to include a 2km buffer, and the SeabORD outputs must be scaled up to include this.	Section 3.1, Appendix B, Annex B and Appendix B, Annex C
MS4	Information is required regarding the difference between the counterfactual for population size (CPS) and the counterfactual for growth rate (CGR) in relation to puffin and kittiwake, specifically anything in particular related to the population modelling that might be driving the difference between these two ratio metric outputs and why the CPS is more sensitive in this case.	Section 3.1
MS5	Information is required on the cumulative assessment for puffin and kittiwake, specifically which developments the mortality estimates are from and which SPAs these values were apportioned to.	Section 3.1
MS6	The population modelling outputs from the PVA spreadsheets must be extracted and be clearly presented. PVA and CRM spreadsheets were submitted to MS-LOT on 5 December 2022. These will be included in the additional information consultation unless any updates are provided through this request. We understand the 50 year outputs have been provided to NatureScot, these are not required as part of the additional information request as the application is only for 30 years.	Section 3.1 and Appendix B, Annex C
MS7	The RSPB in their response to the consultation raised some concerns about the displacement assessment of juvenile seabirds using the matrix approach and the displacement mortality rates used in the assessment.	Section 3.1
Marine Physical Processes		
MS8	Table 7.19 in the Physical Processes chapter must be updated with the correct percentage changes and consideration given as to whether conclusions in receptor chapters where hydrodynamic change may be impacted also require updating.	Section 3.2

ID	MS-LOT request	Where addressed
Water and Sediment Quality/Radioactive Material		
MS9	Provide updates to sections 8.4.5.5 and 8.4.6 of the EIA report to reflect that particle retrieval work by Dounreay Site Restoration Limited is a requirement of Environmental Authorisations (Scotland) 2018 permit and is not deemed remediation.	Section 3.3
MS10	Detail of the sampling rationale for section 8.4.5.5 must be provided.	Section 3.3 and Appendix D, Annex A
MS11	Detail on whether particles discussed in 8.4.5.5 were separated out from surrounding sediment matrix must be provided.	Section 3.3 and Appendix D, Annex A
MS12	The significance of sample numbers in 8.4.5.5 Section 8.4.8 should be amended unless statistical significance is demonstrated.	Section 3.3 and Appendix D, Annex A
MS13	Radiation Risk Assessment methodology and documentation must be provided.	Section 3.3 and Appendix D, Annex B
MS14	Assessment of impact of cable maintenance on sediment suspension concentrations must be undertaken.	Section 3.3
MS15	Re-evaluation of section 8.6 in relation to radioactive contaminants to reflect uncertainties identified in the SEPA consultation response.	Section 3.3 and Appendix D, Annex B
MS16	Consideration of onshore effects from offshore radioactive contaminants.	Section 3.3 and Appendix D, Annex B

3.1 Marine Ornithology

<u>MS1: Any incorrect references to apportioned values of seabirds to SPAs within the EIA Report must be updated to reflect the correct figures.</u>

Apportioned values are all correct in the originally submitted Technical Appendices (TAs) supporting the EIAR and in the RIAA; these were the values which were used in the assessment. The six errors identified in Section 12.4.4 (Baseline Description) of the EIAR (Volume 2) Chapter 12: Marine Ornithology are typos that occurred when the pre-existing tables in the draft were updated with new apportioning values for the revised project boundary (this having been undertaken in April 2022).

The correct apportioned values for the six species/ Special Protected Areas (SPA) identified by NatureScot are detailed in Table 3.2

Table 33.2. These have been used in the assessment within the submitted EIAR and therefore the assessment outcomes remain valid and correct.

Table 33.2 Correct apportioned values for SPAs used within the assessment

SPA	Correct Apportioned Value
Kittiwake for Marwick Head SPA	0.026
Guillemot for Sule Skerry and Sule Stack SPA	0.004
Razorbill for West Westray SPA	0.015
Fulmar for North Caithness Cliffs	0.925
Fulmar for Hoy SPA	0.058
Gannet for Fair Isle SPA	0.027

MS2: The outputs from Option 2 of the Band CRM must be provided for herring gull and great black-backed gull.

Option 2 CRM outputs for great black-backed gull and herring gull are available from the Band (2012) spreadsheets, offered by the Applicant in the EIAR (Volume 2) Chapter 12: Marine Ornithology, as part of the submission (and which are available for download on the PFOWF website and via this link). These outputs are also summarised in Appendix B; Annex A of this document.

MS3: The displacement assessment for puffin must be updated to include a 2km buffer, and the SeabORD outputs must be scaled up to include this

Puffin displacement estimates for the PFOWF Array Area plus 2 km buffer are presented in the submitted EIAR (Volume 3), Technical Appendix:12.4 Marine Ornithology: Displacement Analysis. The requested scaled-SeabORD outputs for puffin are provided in Appendix B; Annex B of this document.

Updated PVA modelling for puffin includes the scaled-SeabORD outputs, as requested, as well as an impact scenario for the PFOWF Array Area plus 2 km buffer. PVA outputs for puffin are provided as part of Appendix B; Annex C of this document. This information has been provided on request from NatureScot and it should be noted that it has no material impact on the assessment presented within the EIAR or RIAA.

MS4: Information is required regarding the difference between the counterfactual for population size (CPS) and the counterfactual for growth rate (CGR) in relation to puffin and kittiwake, specifically anything in particular related to the population modelling that might be driving the difference between these two ratio metric outputs and why the CPS is more sensitive in this case.

CPS and CGR are measuring different criteria and as such would not be expected to have similar sensitivities. CPS is the difference in actual population size between impact scenario and baseline, while CGR is the difference in the annual growth *rates* between impact scenario and baseline. CGR is always the less sensitive metric.

If outputs across the species modelling are compared, as shown in Table 3.3, puffin is showing no greater CPS sensitivity than the other species (for example, when comparing the kittiwake PVA outputs [Table 6 of EIAR (Volume 3), Technical Appendix 12.5: Population Modelling] with those for puffin [Table 8 of EIAR (Volume 3), Technical Appendix 12.5: Population Modelling]).

Table 3.3 Comparison of counterfactual values for key species

Species / impact scenario	CGR	CPS
Kittiwake impact scenario 4	0.995	0.854
Puffin impact scenario 3	0.995	0.854
Puffin impact scenario 5	0.994	0.836
Kittiwake impact scenario 5	0.993	0.813
Puffin impact scenario 4	0.990	0.724

In a review of the suitability of PVA output options in impact assessment for offshore renewable energy projects (Jitlal et al., 2017) CGR was demonstrated to perform consistently better than CPS in terms of having a low sensitivity to mis-specification of input parameters and was considered to result in the most robust basis for assessment for offshore renewables. A consequence of this observation, and similar observations by other authors (Cook, A.S.C.P. & Robinson, R.A. [2016] and [2017]), is that CGR is now the most routinely utilised PVA output value in HRA for offshore wind farms in England.

Cumulative apportioning for each species is addressed in EIAR (Volume 3), Technical Appendix:12.5 Marine Ornithology Population Modelling; Annex A (calculation of impact scenarios for PVA). For kittiwake and guillemot, it was possible to retrospectively apply the MSS apportioning tool to the Moray Firth wind farms and, as such, this was undertaken, as noted in Technical Appendix:12.5 Marine Ornithology Population Modelling; Annex A of the EIAR (paragraph 13 on kittiwake and paragraph 26 on guillemot). The apportioning outputs from the MSS tool for the Moray Firth wind farms for these two species are available for download on the project website and via this link.

Puffin is not addressed by the MSS apportioning tool and therefore it was not possible to update the calculation of Moray Firth apportioning weightings for this species. However, as only the North Caithness Cliffs SPA was screened in for potential 'likely significant effect' in relation to puffin in the Moray West ES (for each of the three Moray Firth wind farms), using the apportioning weightings from that ES can be considered precautionary. If any further puffin SPAs were to have been screened in (on the basis of the increased foraging ranges given in Woodward et. al [2019]) then it would be expected that this would result in a reduction in the relative apportioning weightings calculated for puffin at North Caithness Cliffs for the Moray Firth wind farms (i.e. there would be a greater number of SPAs to be apportioning between).

The Applicant notes that the wider matters around cumulative apportioning are under current consideration by NatureScot and MSS in relation to development of the cumulative effects framework. Going forward, the Applicant would be happy to assist NatureScot and MSS in the development of such a framework.

<u>MS5: Information is required on the cumulative assessment for puffin and kittiwake, specifically which developments the mortality estimates are from and which SPAs these values were apportioned to</u>

This information is provided in the submitted Section A3.2 of Technical Appendix 12.5: Population Modelling of the EIAR. All of the information used is obtained from the Moray West application (particularly the Report to Inform Appropriate Assessment) and the figure of 39.84 puffin mortalities at 60% / 2% displacement and mortality rates (as apportioned to North Caithness Cliffs SPA) in

Table A3.2.1 of Technical Appendix: 12.5 of the EIAR equates to the unrounded figure of 40 puffin in Table 6.9.44 of the Moray West RIAA and is the same as the figure of 40 puffin used in MS-LOT's appropriate assessment for Moray West (paragraph 19.2.3).

This estimate of 40 (or 39.84) puffin mortalities is the cumulative total (at the 60% / 2% rates) for Beatrice, Moray East and Moray West combined. The Applicant has not been able to ascertain the reasons for apparent anomalies in the apportioning weightings provided by Moray West for the three Moray Firth wind farms and it was not possible to re-calculate these weightings.

For kittiwake, the information on cumulative impacts against the North Caithness Cliffs SPA population is presented in A3.1 of Technical Appendix 12.5: Population Modelling of the EIAR. Cumulative assessment includes the three Moray Firth wind farms (Beatrice, Moray East and Moray West) as presented in Table A.1.2.1 (displacement mortality estimates) and Table A.1.2.2 (collision mortality estimates), and then all the North Sea wind farms within the 'BDMPS' area defined by Furness (2015), as listed in Table A1.3.1 (collision mortalities). All apportioning is to the North Caithness Cliffs SPA kittiwake population.

<u>MS6: The population modelling outputs from the PVA spreadsheets must be extracted and be clearly presented. PVA and CRM spreadsheets were submitted to MS-LOT on 5 December 2022. These will be included in the additional information consultation unless any updates are provided through this request. We understand the 50 year outputs have been provided to NatureScot, these are not required as part of the additional information request as the application is only for 30 years.</u>

The submitted application is for a maximum 30-year operational period, therefore, 30 years was used as the defined impact period for both project-alone and cumulative scenarios, as there is no mechanism in the Natural England PVA tool to apply differential levels of impact across years.

PVA outputs at 25 years have been extracted from the existing PVAs and these are presented in Appendix B; Annex C of this document. Model re-runs have also been undertaken to extend the period of impact to 50 years. Whilst included here for completeness, as noted by MS-LOT this information does not form part of the application which is for a maximum operational period of 30 years.

As indicated by the Applicant in the EIAR, the full spreadsheets of PVA outputs were also offered as part of the submission and are available for download on the PFOWF website and via this link. It should also be noted that 50-year baseline PVAs had been undertaken for kittiwake and puffin as presented in EIAR (Volume 3), Technical Appendix 12.5: Marine Ornithology: Population Modelling.

<u>MS7: The RSPB in their response to the consultation raised some concerns about the displacement assessment of juvenile seabirds using the matrix approach and the displacement mortality rates used in the assessment.</u>

It should be noted that the PFOWF displacement matrices are based on 'all birds' (all age-classes) not 'adults only'. Displacement impacts derived from these matrices are then apportioned across adults and juveniles for inclusion in the population modelling and all age-classes (with their associated impacts) have been modelled under PVA, none have been excluded.

This approach follows the advice given in the SNCB (2017) displacement guidance (and in the PFOWF scoping advice from NatureScot):

> *"Where possible, the ratio of detected age classes should be reported… While separation of age classes is not directly used in the 'Matrix Approach' (the matrix should include*

abundance figures that relate to all birds in the project area, across all age classes), it can be crucial for later stages in the assessment process (e.g., when applying appropriate biologically relevant population scales and making assessments of population-level impacts)."

3.2 Marine Physical Processes

MS8: Table 7.19 in the Physical Processes chapter must be updated with the correct percentage changes and consideration given as to whether conclusions in receptor chapters where hydrodynamic change may be impacted also require updating.

The Applicant acknowledges the error made within Chapter 7 of the EIAR and provides clarification that Chapter 7; Table 7.19 of the EIAR should correctly read as follows in Table 33.4Table 3.4.

Due to the water depths present across the Offshore Site (20 –102 metres below lowest astronomical tide (mLAT)), and the maximum 1 m height associated with the cable protection, variations in water levels, downstream and above the cable protection would be indiscernible from water levels upstream. This is still the case at the shallowest point along the OECC, at around 20 mLAT near the Horizontal Directional Drilling (HDD) exit point. As the cable protection would be entirely submerged, it was analysed as a low dam based on vertical closure empirical formulae from the Construction Industry Research and Information Association (CIRIA) rock manual (CIRIA, 2007), subcritical flow. As there will be no variation to water levels with respect to the crest of the cable protection, upstream or downstream of the protection, there will be no alteration to flow speeds.

Table 33.4 Corrected downstream flow speed changes due to remedial protection

Location	Analysed water depths (mLAT)	Flow speed (m/s)[1]		Spring [2]		Neap [2]	
		Spring	Neap	Downstream flow speed	Percentage change	Downstream flow speed	Percentage change
OECC	20, 45 and 70	0.31	0.10	0.31	No Change	0.10	No Change
PFOWF Array Area	66 and 102	0.54	0.30	0.54	No Change	0.30	No Change

[1]: Flow speed across the Offshore Site, informed by the baseline characterisation (Section 7.4.4.7 of Chapter 7: Marine Physical Processes within the EIAR); and

[2]: Assessed changes to flow speeds as a result of the 1 m high scour or remedial protection.

On the basis that there is no change to the flow speeds with the cable protection in place, the impact assessment completed and presented within the EIAR is still applicable and the conclusions remain the same.

3.3 Water and Sediment Quality / Radioactive Material

MS9: Provide updates to sections 8.4.5.5 and 8.4.6 of the EIA report to reflect that particle retrieval work by Dounreay Site Restoration Limited is a requirement of Environmental Authorisations (Scotland) 2018 permit and is not deemed remediation

In information published by Dounreay Site Restoration Limited (DSRL) for Dounreay available at *Radioactive particles in the environment around Dounreay government* website[1], and the '*Particles Retrieval Advisory Group (Dounreay)'* report from 2012[2], the particle retrieval exercises were described as "remediation", with further monitoring being part of ongoing remediation plans / programme. Although, it is recognised that the ongoing retrievals are part of the Environmental Authorisations (Scotland) Regulations (EASR) 2018 permit, the terminology applied within the EIAR is in line with all publicly available documents referenced and information.

The Applicant will ensure any further discussion of the topic makes the distinction between remediation and particle retrieval exercises in line the EASR permitting activities.

<u>MS10: Detail of the sampling rationale for section 8.4.5.5 must be provided</u>

The primary purpose of these sediment grab samples was to enable benthic characterisation and were selected on the basis of the European Nature Information System (EUNIS) groups / biotypes present (informed through site geophysical data), with the aim of capturing as many biotypes as possible, in line with NatureScot advice. No seabed grab samples were collected at < 2 km of coast within the Dounreay radioactive FEPA zone, due to the absence of a SEPA permit for these 2021 activities. Instead, only video transects were taken in the nearshore area, to capture the presence of any rocky substrate, to ensure these could be characterised. The survey methodology is detailed within EIAR (Volume 3) Technical Appendix: 9.1: Environmental Baseline Report.

Sampling of radioactive particles was not proposed within the Scoping Report or Scoping Report Addendum and nor was it requested in the Scoping Opinion or Scoping Opinion Addendum. Therefore, samples were not taken for the purpose of providing a statistical representation across the Offshore Site in relation to radioactive particles originating from historical Dounreay discharges and those samples that were taken were not intended to be statistically representative. Instead, radioactivity analyses were completed on behalf of the Applicant at each grab sample location to inform Health and Safety Executive (HSE) requirements, due to the location of the Offshore Site to Dounreay facilities and known historic contamination sources.

It is also noted that, although general Pre-Application Advice was received by SEPA in March 2020, no comment was provided from SEPA on the Scoping Report in the September 2021 Scoping Opinion, issued by MS-LOT, on the scope of the assessment as refined since the pre-application advice or guidance on the analytical survey requirements. Comments from SEPA on the Scoping Addendum Report did not raise any concerns with radioactivity.

However, as discussed during the consultation meeting with SEPA held on 16 November 2022, the Applicant requested the results against the Dounreay irradiated nuclear fuel fingerprint ("Dounreay

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[1] *Radioactive particles in the environment around Dounreay corporate reports available at https://www.gov.uk/government/publications/radioactive-particles-in-the-environment-around-dounreay*

[2] *Particles Retrieval Advisory Group (Dounreay) 2012 Report available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/696375/PRAGD_Dounreay-2012-report.pdf*

fingerprint") to provide further confidence in the results. The results are summarised below, and the laboratory report is provided in Appendix D; Annex A of this document.

- All 18 sediment samples have been subject to HRGS and gross alpha and gross beta analysis, with the HRGS spectrum being compared to the Dounreay radionuclide library;
- Only NORM at activity concentrations typically expected in nature were detected in all of the samples, with one exception;
- One sample (sample 16, located ~2 km from shore, i.e., immediately adjacent to the Dounreay radioactive FEPA zone) gave a result that included 0.0064 Becquerels per gram (Bq/g) of the man-made radionuclide Americium-241;
- There were no other man-made radionuclides associated with this positive result (typically we may expect Ceasum-137 to also be present as a fission product);
- The "out of scope" threshold for Americium-241 in the EASR 2018 is 0.1 Bq/g, therefore this radioactivity level is approximately 15 times below the threshold for being considered radioactive under the relevant legislation.

<u>MS11: Detail on whether particles discussed in 8.4.5.5 were separated out from surrounding sediment matrix must be provided.</u>

For the 18 sediment grab sample locations, Nuvia undertook real-time monitoring onboard vessels to ensure that the samples did not inadvertently include Dounreay radioactive particles. The limit of detection of this monitoring was typically 10 kilo becquerels (kbq) screening onboard for core samples (which is below transport thresholds). This real-time monitoring did not identify any Dounreay radioactive particles, so there was no requirement to separate any particles out from the surrounding sediment matrix.

As part of the initial screening, samples were sent to a nuclear radiochemical laboratory for analysis prior to being sent to the environmental laboratory. The purpose was to provide reassurance that any radioactivity present was at environmental levels (i.e. NORM), and such that the samples could be further analysed in a non-radiochemical laboratory. On acceptance of the samples at the nuclear radiochemical lab, high resolution gamma spectrometry (HRGS), including Gross Alpha and Gross Beta, were requested for analyses, which acted as an initial "screening" to determine if any of the samples would benefit from further analyses for additional radioactive isotopes. The results of the initial screening analyses confirmed that all radioactivity was at environmental levels, and as such no further analysis was requested and no particles were separated out from the surrounding sediment matrix as the purpose of the analysis for HSE had been fulfilled.

Reference to radioactivity within the EIAR are only with respect to NORM activity reported and are not with respect to radionuclides characteristics to the Dounreay fingerprint. As described in responses above, the principal safeguarding provided by Nuvia onboard the vessel, associated with the initial screening for HRSG, Gross Alpha and Gross Beta, means any radioactivity were within NORM environmental levels. Further analysis undertaken to clarify these results, as discussed during the meeting with SEPA held on the 16th November 2022, shows that only one positive result from an anthropogenic source was detected (Americium-241) and this positive result was below the 'out of scope' thresholds within the EASR (2018) legislation and therefore is not considered radioactive.

The methodology for the laboratory analysis is detailed in the EIAR (Volume 3), Technical Appendix: 9.1 Environmental Baseline Report, further clarification on the laboratory analysis applied for the HRGS is detailed within the laboratory report provided in Appendix D; Annex A of this document.

In conclusion, no particles of the activity magnitude akin to those which are monitored and reported on by DSRL were found (or analysed) so no particles were separated out from the surrounding sediment matrix.

MS12: The significance of sample numbers in 8.4.5.5 Section 8.4.8 should be amended unless statistical significance is demonstrated.

As stated above, grab samples were only obtained for the purpose of benthic characterisation and not to provide a statistical representation of the Offshore Site in relation to radioactive particles originating from historical Dounreay discharges. The completed initial screening for NORM at environmental levels was considered to be an additional benefit demonstrating the limited radioactivity at environmental levels only. The Dounreay fingerprint analysis, presented in Appendix D; Annex A of this document, also confirms this.

MS13: Radiation Risk Assessment methodology and documentation must be provided

The Radiation Risk Assessment was completed under CDM 2015 guidelines, primarily to inform the project team and contractors of the potential radioactivity risks. The Radiation Risk Assessment (Nuvia, 2021) is provided at Appendix D; Annex B of this document. Should further risk assessments pertaining to radioactivity be developed for health and safety purposes, the Applicant will provide these to SEPA for comment.

Independent of the EIAR submission, HWL have been in correspondence with SEPA in relation to the recent surveys completed under the EASR (2018) permit and have provided the radiological risk assessments for these activities as part of those discussions.

MS14: Assessment of impact of cable maintenance on sediment suspension concentrations must be undertaken

There is no publicly available information to indicate the presence of radioactive particles in the offshore area covering the PFOWF Array Area and there are no specific restrictions on activity in this area (e.g. it is outwith the FEPA Zone, and seabed trawling is permitted). The initial screening completed by the Applicant indicates the radioactivity present were at environmental levels (NORM), and subsequent clarification highlights only one positive result for an anthropogenic radionuclide, Americium-241, which was at levels 15 times less than the 'out of scope' threshold, at the edge of the Dounreay radioactive FEPA zone (i.e. well beyond the PFOWF Array Area).

Chapter 7 (Volume 2): Marine Physical Processes of the EIAR assessed the potential increase and dispersion of suspended sediments as a result of Project activities within the Offshore Site. The completed assessment was based on analytical spreadsheet calculations of sediment dispersion under peak spring flood and ebb flows (informed by observed tidal observations within the PFOWF Array Area and hindcast tidal timeseries within the offshore export cable corridor).

Within Chapter 7, the potential increases in suspended sediment concentrations associated with the operational movement of moorings were found to be localised and transient along the mooring line associated with the rise and fall of the tide. The assessment showed that when considering the worst case mooring system, it is the same sediment that would nominally be disturbed and resettled within the mooring swept area and would not reach the coast. Due to the temporary and localised nature of any disturbance the assessment concluded that this effect is unlikely to lead to changes to water and sediment quality within the PFOWF Array Area and overall effects are negligible and not significant. In terms of the risk of radioactivity, the effects during construction within the PFOWF Array Area were assessed as negligible and not significant within Chapter 8: Water and Sediment Quality of the EIAR, it is considered that any effect during operation within the PFOWF Array Area would be less than those assessed for construction.

As per the assessment in Chapter 7: Marine Physical Processes of the EIAR, with respect to the potential suspended sediment associated with operational maintenance of the cables, any disturbance and associated increases in suspended sediment concentration would be localised to the area of the works, as calculated through the dispersion modelling. Chapter 7 concludes that sediment displaced during the repair would quickly be redeposited to the seabed, with coarser sediment being deposited within the first 500 m and only finer sands and silt potentially being transported as a plume, but at low concentrations, up to a distance of around 2 or 3 km for an ebb or flood release, respectively. As per Chapter 7: Marine Physical Processes of the EIAR, the overall effect on suspended sediments were found to be minor and not significant within the OECC.

Despite the potential requirement for operational repair of cables within the Dounreay radioactive FEPA zone, the likelihood of encountering significant radioactive particles is considered to be low, particularly in light of any permitting protocols required for activities in this area. As concluded in the EIAR, Chapter 8: Water and Sediment Quality, the potential requirement for operational works for the cable are not considered sufficient to ultimately lead to changes in water or sediment quality. Despite the low likelihood, as discussed in the EIAR there is a pathway for suspended sediment disturbed within the first few kilometres of the export cable route from the Horizontal Directional Drilling (HDD) exit point, to reach the Dounreay foreshore. Nonetheless, considering the mitigation within EIAR (Volume 2): Chapter 8: Water and Sediment Quality, to include protocols for managing radioactivity risk, it is still considered that impacts during operations would be less than the construction phase which was fully assessed in the EIAR Chapter 8: Water and Sediment Quality, as minor and not significant within the OECC.

In line with the mitigations already proposed by the Applicant within the EIAR, the Applicant is amenable to developing a monitoring strategy for radioactive particles as detailed further in responses below. This requirement can be secured as a condition and developed once the full scope of the construction activities are known ahead of construction. It is noted that SEPA are minded to remove their objection on the basis of such a condition being developed in agreement with MS-LOT and are in discussions with the Applicant regarding suitable condition wording.

For the reasons discussed above, the potential impact *'Changes in water and sediment quality due to increased suspended sediment concentrations during operation, associated with the movement* *of moorings, and maintenance of cables'* will not result in significant adverse effects, particularly in light of the proposed mitigations and the development of the monitoring plan for radioactive particles.

<u>MS15: Re-evaluation of section 8.6 in relation to radioactive contaminants to reflect uncertainties identified in the SEPA consultation response</u>

The completed sediment sampling, including the initial screening analyses for NORM at environmental levels and further analysis against the Dounreay fingerprint, and additionally the principal safeguarding provided by Nuvia on board the vessel, all support the interpretation of little radioactivity, with any occurring only as NORM or at environmental levels, as presented within the EIAR.

The Applicant agrees with the statement from SEPA that the total inventory of radioactive particles (characteristic to the Dounreay fingerprint) is unknown. However, it is considered to still be the case that the potential occurrence of manmade radionuclides that originated from Dounreay would reduce into the future as also discussed in the Particles Retrieval Advisory Group (Dounreay) 2012 Report (PRAG-D, 2012). The primary reasons being:

- The closure of the historic Liquid Effluent Discharge System (LEDS), which was the historic source of contamination;
- The active removal of radioactive particles from the offshore area within the radioactive plume footprint; and
- The ongoing offshore and beach monitoring and particle recovery / retrieval programme being completed by DSRL near the Dounreay Site, which actively removes radioactive particles from the environment.

No grab samples were obtained from within the Dounreay FEPA radioactive zone as set out in responses above. To characterise the potential for radioactivity in the nearshore area, information was obtained from a range of publicly available data sources, which included:

- Particles Retrieval Advisory Group (Dounreay) Reports from 2012, 2008 and 2006 (PRAG-D, 2012; 2008; 2006);
- Annual monitoring and reporting of radioactive particle finds, published by DSRL (DSRL, 2022). All available information up to the most recent 2021 monitoring report were considered and used to develop the baseline understanding and to inform the impact assessment; and
- Annual Radioactivity in Food and Environment (RIFE) reports for the Dounreay site. Reports between 2016 and 2021 (Natural England *et al,* 2016 - 2021) were reviewed in order to characterise the potential for radioactivity within the Offshore Site. It was discussed within the EIAR that although RIFE reports were mostly in relation to terrestrial sources, it also did consider marine ecological sources that were considered to be useful indicators to inform the EIAR.

As stated in the responses above, the sediment grab samples were not collected for the purpose of characterising any radioactivity across the Offshore Site, so the acquired information supplemented the understanding developed from the publicly available data sources. Based on the range of information used to characterise the baseline environment, there is considered to be adequate understanding to support the impact assessment presented in the EIAR.

The completed impact assessment discussed within EIAR (Volume 2) Chapter 8: Water and Sediment Quality; Section 8.6, draws on all available publicly available datasets, with the additional site-specific radioactivity screening as above. The completed radioactivity analysis of the 18 sediment grab samples confirmed that any radioactivity present within the samples was at environmental levels or below ‘out of scope’ thresholds of the EASR 2018 regulations. In addition, the potential risk for radioactive particles within the Offshore Site was considered to be extremely unlikely as considered by Nuvia’s radiological risk assessments which were undertaken for health and safety purposes ahead of offshore surveys and works commencing. The risk assessment is provided in Appendix D; Annex B.

Separate to the consent application, various risk assessments undertaken by Nuvia have been provided to SEPA in correspondence on the EASR permit activities and will continue to be provided for any further offshore works pertaining to potential interaction with radioactive particles.

Therefore, with reference to the available information used to complete the assessment at the time of writing, and the re-evaluation of risk based on the SEPA comments, it is considered that the potential risk for radioactivity within the Offshore Site has been adequately considered and assessed within the EIAR and that there will be no significant adverse effects, particularly in light of the already proposed mitigation of protocols to manage radioactivity risk and the development of a monitoring plan for radioactive particles.

<u>MS16: Consideration of onshore effects from offshore radioactive contaminants</u>

The completed Radiation Risk Assessment for the Offshore Site, available in Appendix D; Annex B (undertaken for health and safety purposes ahead of offshore surveys and works commencing) evaluated the potential for encountering, disturbing and spreading of radioactive particles associated with construction and operation activities. The assessment concluded that it was very unlikely that contamination will arise and spread due to the very low potential across the PFOWF Array Area. It was stated that, should radioactive particles be encountered (be it large or small particles), they would be discrete insoluble items, similar in size to a grain of sand, and although they can break up into smaller particles this would not result in widespread contamination but would be localised around the particle, as has been the case with previous particle finds. The risk assessment further described that there had been no evidence of the spread of radioactive contamination associated with previous recovery of particles from the shoreline. The Nuvia risk assessments will continue to be provided to SEPA for further works, as required.

As presented within the EIAR, mitigation commitments through protocols and procedures have been incorporated into the Project design, which mitigates the potential for disturbing or spreading radioactive particles during construction and operation activities. Monitoring commissioned by DSRL to date indicates that the significant radioactive particle finds have been confined to within 1 km of the historic LEDS, which is beyond the point where the OECC will be placed/ buried on the seabed. Due to the low potential of radioactive particles occurring within the Offshore Site and the protocols and procedures in place to further mitigate the risk of encountering such particles, it is considered unlikely that radioactive particles will be disturbed.

EIAR (Volume 2): Chapter 7: Marine Physical Processes, details the sediment transport pathways across the Offshore Site and shows that sediment disturbed within the PFOWF Array Area will not reach the coast. The chapter also details that the only pathway for disturbed sediment to reach the coast and foreshore is in relation to construction works in the first few kilometres of the OECC beyond the HDD exit point.

As discussed during the consultation meeting 16 November 2022, to further mitigate the risk, particularly in the FEPA Zone, the Applicant is content to accept a condition requiring the development of a monitoring strategy for radioactive particles to ensure the risk is managed during and after construction activities. This requirement can be secured as a condition and developed once the full scope of the construction activities are known ahead of construction. These discussions are on-going with SEPA and the Applicant, who are accepting of developing a condition to this effect.

As precedent for this type of condition, the Applicant highlighted the existing Dounreay Trì consent (which is located within the same area as the PFOWF Project) and the SHET HVAC cable from Orkney to mainland Scotland which also crosses the FEPA Zone and makes landfall adjacent to the Offshore Development's landfall at Dounreay. The scope of the offshore condition will be agreed with SEPA.

4 Summary

This document has been provided to support the application for consents for the Offshore Development, through provision of further clarification and additional information as requested by MS-LOT on 9 December 2022.

The additional information provided relates to the assessments of marine ornithology, marine physical processes and water and sediment quality only. The clarifications and further information provided do not change any of the assessments presented within the EIAR and RIAA and the conclusions remain the same. The assessment of other topics remain as provided within the EIAR and RIAA. No changes to the design envelope, as defined in Chapter 5: Project Description of the EIAR, are proposed.

A number of representations on the application have been received from statutory consultees and additional stakeholders with an interest in the Offshore Development. The Applicant has continued to engage with consultees to provide responses to representations made, clarifications to any concerns raised and to address requests for further information from NatureScot, RSPB and SEPA. It is noted that SEPA initially objected to the application and requested clarification regarding sampling procedures and rationale and monitoring for radioactive particles.

The Applicant has provided clarification notes and further information to address the requests for additional information and has held meetings with the relevant consultees to discuss the clarifications and information provided. The clarification notes provided are included at Appendix A.

On 9 December 2022 SEPA provided written confirmation to the Applicant confirming that it is minded to remove its objection provided the concerns raised are addressed by a suitable condition to any consent/licence granted. Discussions on suitable condition wording are ongoing between

SEPA and the Applicant. The Applicant is continuing to engage with NatureScot and RSPB to discuss the clarification notes and additional information provided.

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Appendix A: Clarification Notes provided (NatureScot, RSBP and SEPA)

Note where Appendices are referred to within the clarification notes provided to NatureScot and RSPB this information is set out within Appendix B, Annexes A-C (NatureScot) and Appendix C, Annex A (RSPB) to avoid duplication.

Kim McEwen
Marine Sustainability Adviser
NatureScot
Battleby, Redgorton
Perthshire
PH1 3EW

GBPNTD-PGM-PEN-CM-00012
4 November 2022

[redacted]

Dear Kim,

Application for consent under Section 36 of the Electricity Act 1998 and Marine Licence under Part 4 of the Marine (Scotland) Act 2010 to construct and operate the Pentland Floating Offshore Wind Farm: response on ornithology

Thank you for providing NatureScot's response (dated 13 October 2022) on the Pentland Floating Offshore Wind Farm (PFOWF) application. This letter addresses the NatureScot queries relating to marine ornithology and is copied to Marine Scotland for information.

In relation to NatureScot's queries, the four key points in their covering letter are addressed below (supported by the information in **Annexes A – C**) and then the more detailed advice they give in Appendix 1 – Ornithology is addressed in **Annex D**.

Query 1: We require clarification on which apportioned values are correct for all species and SPAs to ensure the apportioned impacts estimated are accurate, and the predicted impacts can be finalised.

Apportioned values are all correct in the Technical Appendices (TAs) and in the Report to Inform Appropriate Assessment (RIAA); these were the values which were used in the assessment. The six mistakes identified in Section 12.4.4 (Baseline Description) of the EIA Report Chapter are typos/oversights that occurred when the pre-existing tables in the draft were updated with new apportioning values for the revised project boundary (this having been undertaken in April 2022).

The correct apportioned values for the six species/SPAs identified by NatureScot are as follows, which have all been used in the submitted assessment:

- Kittiwake for Marwick Head SPA 0.026
- Guillemot for Sule Skerry and Sule Stack SPA 0.004
- Razorbill for West Westray SPA 0.015
- Fulmar for North Caithness Cliffs 0.925
- Fulmar for Hoy SPA 0.058
- Gannet for Fair Isle SPA 0.027

Query 2: We advise both option 2 and option 3 are included in the CRM assessment for great black-backed gull and herring gull.

Option 2 CRM outputs for great black-backed gull and herring gull are available from the Band (2012) spreadsheets offered by the Applicant in the EIA Report Chapter as part of the submission (and which can be forwarded if required). These outputs are now also summarised in **Annex A**.

Query 3: We advise the puffin displacement assessment should be revised to include the 2km buffer, and the SeabORD outputs should be scaled.

Puffin displacement estimates for the PFOWF array area plus 2km buffer are presented in the submitted Technical Appendix A.12.4 Marine Ornithology: Displacement Analysis.

The requested scaled-SeabORD outputs for puffin are provided in **Annex B**.

Updated PVA modelling for puffin (see next point below) includes the scaled-SeabORD outputs, as requested, as well as an impact scenario for the PFOWF array area plus 2km buffer. PVA outputs for puffin are provided as part of **Annex C**. This information has been supplied as per NatureScot's request and it should be noted that it has no material impact on the assessment presented in the EIA Report.

Query 4: We advise that population modelling outputs are provided for 25, 30 and 50 years, to enable comparison of impacts with other offshore wind farms and which may also help with interpreting the counterfactuals, in particular counterfactual for population size (CPS) which can be sensitive to the model time period.

The submitted application is for a maximum 30-year operational period, so this was used as the defined impact period for both project-alone and cumulative scenarios (as there is no mechanism in the NE PVA tool to apply differential levels of impact across years).

PVA outputs at 25 years can be extracted from the existing PVAs and are presented in **Annex C**. Model re-runs have also been undertaken to extend the period of impact to 50 years; this information has been supplied separately to NatureScot as it does not form part of the application (which is for a maximum operational period of 30 years).

As indicated by the Applicant in the EIA Report chapter, the full spreadsheets of PVA outputs are also offered as part of the submission and available on request. Note that 50-year baseline PVAs had already been undertaken for kittiwake and puffin as presented in Technical Appendix A.12.5 Marine Ornithology: Population Modelling.

I trust that the information provided within this letter provides NatureScot with the necessary clarifications requested. It should be noted that this does not constitute new information, nor does it change any of the conclusions within the ornithology assessment of the EIA Report or Report to Inform Appropriate Assessment. We would welcome a meeting to discuss these, and any of the other responses provided in Annex D of this letter.

Yours sincerely,

[redacted]

Peter Moore
Highland Wind Ltd

[redacted]

Kim McEwen
Marine Sustainability Adviser
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PH1 3EW

BY EMAIL
[redacted]

18 November 2022

Dear Ms McEwen,

Subject: Pentland Floating Offshore Wind Farm – Section 36 and Marine Licences Application - Consultation
Ref: GBPNTD-PGM-PEN-CM-00017
Re. Response to NatureScot Comments on the PFOWF EIAR (excluding Ornithology)

Many thanks for providing your comments on the Pentland Floating Offshore Wind Farm (PFOWF) Section 36 and Marine Licence application.

Highland Wind Ltd (the Applicant) welcomes the response from NatureScot on the application. In particular, the agreement with the conclusion of the assessments presented within the Environmental Impact Assessment Report (EIAR) in relation to Marine Physical Processes, Benthic Ecology, Fish and Shellfish Ecology, Marine Mammals and Other Megafauna, and Climate Change and Carbon. Additionally, the Applicant welcomes the response that NatureScot agree with the conclusions of the Marine Mammals and Migratory Salmon assessments presented within the Habitat Regulations Appraisal (HRA): Report to Inform Appropriate Assessment (RIAA).

This letter seeks to provide a more detailed response to comments where acknowledgement or clarification on aspects of the aforementioned assessments is required, based on the comments received from NatureScot. These points are structured around a number of topic specific headings that are drawn from the recent response received from NatureScot.

A separate letter containing responses relevant to the Marine Ornithology aspects of the EIAR and RIAA was sent to NatureScot on the 4th November 2022 (GBPNTD-PGM-PEN-CM-00012) and these points are not covered within this letter.

Seascape, Landscape and Visual Impacts

A number of comments were raised by NatureScot in relation to the Seascape, Landscape and Visual Impact Assessment. The Applicant welcomes the fact that the response received from NatureScot generally presents agreement to the findings of the SLVIA, albeit with some variance in terms of the extents over which significant effects are considered to occur. The most important agreement relates to the absence of significant effects on the National Scenic Areas (NSAs) and Wild Land Areas (WLAs) in the SLVIA Study Area, although NatureScot's concerns regarding potentially significant effects on East Halladale Flows WLA are noted, along with the overall conclusion that these effects do not amount to a matter of National Interest.

The Applicant welcomes the opportunity to continue consultation post consent, to enable NatureScot and other relevant consultees the opportunity to comment on the refinement of the final design.

Marine Mammals and Other Megafauna

The Applicant welcomes agreement of the conclusions of the Marine, Mammal and Other Megafauna assessment presented within the EIAR. A detailed response to comments contained within Appendix 3: Marine

Mammals and other Megafauna Assessment has been provided by the Applicant and is attached at the end of this letter.

Marine Physical Processes

The Applicant welcomes agreement from NatureScot on the Marine Physical Processes assessment conclusions of no significant effects. The Applicant notes this considers the location of the proposed area, the low sensitivity of the affected seabed and the choice of landfall location and method. The Applicant notes the following comment raised by NatureScot and this has been considered and responded to below:

> *"The following error causes under-estimation of hydrodynamic change, which may result in under-estimation of effects on receptors, both for physical processes and other receptors, such as benthic ecology. Table 7.19 deals with predicted reduction in near-seabed tidal flow downstream of cable protection. The figures of between 0.01 and 0.03 in the 'percentage change' column are not actually percentages, but absolute changes. In fact the reductions in tidal flow predicted within the table are up to three orders of magnitude higher, at ca.10%. This has the most potential to be substantive within the export corridor, where seabed sediment is more mobile due to shallower depths. We advise that Table 7.19 is updated with the correct figures, and further consideration is given to the conclusions for receptors that may be impacted and included within the post consent cable plan for the array area and export cable corridor."*

Due to the water depths present across the Offshore Site (20 – 102 mLAT), and the maximum 1 m height associated with the cable protection, variations in water levels, downstream and above the cable protection would be indiscernible from water levels upstream. This is still the case at the shallowest point along the offshore export cable corridor, at around 20 mLAT near the HDD exit point. As the cable protection would be entirely submerged, it was analysed as a low dam based on vertical closure empirical formulae from the Construction Industry Research and Information Association (CIRIA) rock manual (CIRIA, 2007), subcritical flow. As there will be no variation to water levels with respect to the crest of the cable protection, upstream or downstream of the protection, there will be no alteration to flow speeds. As a result, the Applicant acknowledges the error made within Chapter 7 of the EIAR and provides clarification that Chapter 7; Table 7.19 of the EIAR should correctly read as follows:

Location	Analysed water depths (mLAT)	Flow speed (m/s)[1]		Spring [2]		Neap [2]	
		Spring	Neap	Downstream flow speed	Percentage change	Downstream flow speed	Percentage change
OECC	20, 45 and 70	0.31	0.10	0.31	No Change	0.10	No Change
PFOWF Array Area	66 and 102	0.54	0.30	0.54	No Change	0.30	No Change

[1]: Flow speed across the Offshore Site, informed by the baseline characterisation (Section 7.4.4.7); and

[2]: Assessed changes to flow speeds as a result of the 1 m high scour or remedial protection.

On the basis that there is *no change* to the flow speeds with the cable protection in place, the impact assessment completed and presented within the EIAR is still applicable and the conclusions remain the same.

Benthic Ecology

The Applicant welcomes the agreement of the Benthic Ecology assessment findings presented within the EIAR. The Applicant notes the following comment raised by NatureScot and this has been considered and responded to below:

> *"Our understanding of electromagnetic field (EMF) effects is poor as highlighted in Section 9.5.6, especially around subsea and dynamic cables associated with floating wind farms. We are*

> *aware of Marine Scotland proposals to carry out infield measurement of EMF to better understand impacts on benthic and fish species. Therefore, any input this project could assist with, either from project measurements or contributions to this wider work, that can validate the assumptions in the EIA Report and inform future assessments would be very beneficial."*

The Applicant acknowledges that data gaps and uncertainties exist with respect to EMF effects on benthic ecology, particularly in relation to floating offshore wind. The assessments have been conducted using best information available at the time of the assessment. Based on this information, and in conjunction with the scale of the Offshore Development, and the implementation of embedded mitigation measures, no significant effects have been identified. The EMF emissions from the Offshore Development are expected to be minimal, reducing to 0 micro-Tesla within 5 m of the buried or dynamic cables, as described in the EIAR. Therefore, as detailed in the EIAR, the impacts are expected to be localised, and are not anticipated to have significant effects.

The Applicant will continue to engage with Marine Scotland, NatureScot and other stakeholders as research in these fields develops and is open to exploring the value and feasibility of potential monitoring opportunities.

Fish and Shellfish Ecology

The Applicant welcomes the agreement with the Fish and Shellfish Ecology assessment findings presented within the EIAR and the agreement with the conclusions of the migratory salmon assessment presented within the HRA: RIAA.

Climate Change and Carbon

The Applicant welcomes NatureScot's approval of and agreement with the conclusions of the Climate Change and Carbon chapter (Chapter 20), including the blue carbon, carbon and in-combination assessments presented. The Applicant notes the following comments raised by NatureScot and these have been considered and responded to below:

> *"Removal of marine growth is mentioned as an embedded mitigation measure specific to climate resilience. If the removal of marine growth is required, and the growth is released into the environment, then further advice should be sought from Marine Scotland as this may require a licence."*

The Applicant wishes to confirm that if the removal of marine growth is required for the Offshore Development, further advice will be sought from NatureScot, MS-LOT and other relevant consultees as required.

> *"Although we agree with the conclusions of the blue carbon assessment, which considers impacts to kelp beds and peat deposits, it is worth noting that released carbon may not be integrated into the sediment transport regime in the long term. Furthermore, although the proposal is unlikely to affect the carbon sequestration potential of the immediate seabed and associated habitats, there will be loss of carbon from the disturbance of these habitats / deposits, which would affect the blue carbon assessment."*

Chapter 7: Marine Physical processes, states that should peat be encountered during drilling operations for pin piles, peat may be extruded and deposited in the immediate vicinity of the drill hole as large clasts or completely disaggregated and dispersed as a plume. The most likely scenario is that the drilled and deposited peat will be between the described range, and therefore, not all of the carbon released would be dispersed as part of a plume in the first instance. Should any peat clasts be deposited on the seabed, it is considered that in time, these would be winnowed down and incorporated into the sediment transport regime across the Pentland Firth.

In Chapter 20: Climate Change and Carbon, Section 20.8.5, the potential loss of carbon from disturbance or loss of kelp beds is assessed. There would be a small area of disturbance or loss throughout the lifetime of the Offshore Development, and therefore, any carbon lost is assessed as being not significant (as discussed in Section 20.8.5). The carbon lost through disturbance or loss of kelp beds would not be dispersed as part of the sediment regime but would also be re-distributed in time.

In response to NatureScot's comment regarding opportunities for demonstration. The Applicant confirms it is committed to promoting biodiversity benefit and developing understanding and reducing knowledge gaps in the development of floating offshore wind farms and the opportunity to discuss such opportunities with NatureScot as project design development continues is welcomed.

The Applicant is hopeful that this response provides sufficient clarification on the specific points raised during the consultation and welcomes the opportunity to continue engagement with NatureScot on post consent requirements.

Best regards,

[redacted]

Peter Moore
Highland Wind Ltd.

[redacted]

Appendix 3: Marine Mammals and other megafauna Responses

The Applicant wishes to thank NatureScot for its detailed comments and advice provided in Appendix 3. The Applicant welcomes the agreement from NatureScot, in terms of the EIAR and HRA conclusions, for both this project alone and when considered cumulatively with other plans and projects.

The Applicant acknowledges NatureScot's advice that the following may be required:

- Piling strategy and Marine Mammal Mitigation Plan (MMMP) for piling
- UXO clearance Marine Licence, including MMMP and noise monitoring plan which adheres to the most recent National Physical Laboratory (NPL) Protocol
- EPS licenses for disturbance and potential injury (depending on the nature of any UXO clearance required)
- Confirmation that potential impacts of geophysical survey work are consistent with the EIA should equipment characteristics vary from those assessed in the EIA.
- Post-consent monitoring for operational noise and potential entanglement.

The Applicant welcomes ongoing dialogue with NatureScot (along with MS-LOT and Marine Scotland Science) on these pre-construction assessments and plans, and the potential need for post-consent monitoring as the project progresses.

Responses and clarifications to specific comments presented in Appendix 3, where required, are presented below.

Underwater Noise Modelling Clarifications

The Applicant notes that NatureScot have no substantive comments on the underwater noise modelling that would affect the conclusions of the EIAR. However, for completeness, the Applicant provides clarification to the detailed advice provided by NatureScot below.

> *"It is not explained (Figure 1.1, Appendix 10.1) why the modelling location at the furthest point offshore was chosen for the model. Choosing this location potentially may underestimate noise levels towards the north coast."*

This location was chosen as it represents the deepest, most exposed location which will lead to the largest impact ranges, and thus the worst case scenario for area affected and potential impact on marine mammal and fish populations.

While it is acknowledged that selecting a modelling location at the furthest point from shore may result in lower predicted noise levels along the north coast than a location closer to shore (i.e. due to transmission loss across this distance), the relative variation in sound levels are expected to be offset by the increased sound propagation associated with greater depths with distance from shore. Moreover, potential differences in sound propagation across the offshore site are expected to be minor when considering the small area encompassing the PFOWF Array. Furthermore, the Applicant notes that uniform density values were applied to all cetaceans (vs a density surface). The selected modelling location results in a larger predicted impact area than one closer to shore, due to the aforementioned quality of having increased sound propagation levels, and therefore represents a worst case in terms of the number of animals predicted to be impacted using these uniform density values. While a density surface was used for harbour and grey seals, these data do not indicate higher densities of animals closer to the coast while at-sea. As such, the selected modelling location is considered the most precautionary, in terms of the number of animals predicted to be impacted, based on the anticipated spreading of sound in the deepest parts of the offshore Array area.

> *"Other activities (non-piling) have been assessed using simple spreading equations. Table 5.2 (Appendix 10.1) details the information used. It is not clear why different transmission loss*

> *equations have been used. Our understanding is that the 'N' reflects the environment, and therefore should be representative of the location of the proposed activity."*

The variable, N, used within the noise modelling provides a complex characterisation of the effect of environmental conditions on the noise source as it spreads. It will be affected on location by the shape and size of the source, and how it radiates the sound, which is complex and hard to predict in theory. This will be most relevant when relatively close to the source, as is the case when this class of noise source is under consideration (unlike piling, where the ranges of interest can be many kilometers). The SPEAR model is empirical and based on measurements Subacoustech have taken of these sources directly, as such, the coefficients in the predictions are based on real measurements.

> *"Table 5.3 (Appendix 10.1) details the reduction in source level from the unweighted level. It is not clear how these dB reductions have been calculated. The results from the modelling of cable laying, suction dredging, trenching, rock placement and vessel noise, is that any marine mammal would need to be within 100m from the noise source to accumulate enough noise dose to induce PTS. TTS is considered unlikely.*

These dB reductions represent the effect of the weightings defined in Southall *et al.* (2019) on the overall source level. Table 5.3 of Appendix 10.1 illustrates the before-and-after reduction in the overall source level generated by the direct application of these weightings on the frequency spectra shown in Figure 5-1; Appendix 10.1.

Operational Noise Monitoring

> *"We are still at early stage in understanding the operational noise from floating offshore wind farms. It has been postulated that noise from floating wind turbines may not be less than fixed foundations, due to the floatation structures resonating. It is likely operational noise monitoring will be required to inform knowledge in this area."*

The Applicant is grateful for the details of ongoing monitoring of operational noise that was provided. The Applicant understands that operational noise monitoring data from the Kincardine and Hywind (Scotland) are also likely to become available in the coming months. The Applicant will consider these information sources alongside any additional relevant information when considering the need for operational noise monitoring and the development of a project-specific monitoring plan. The Applicant also welcomes ongoing dialogue with NatureScot (along with MS-LOT and Marine Scotland Science) the potential need for post-consent monitoring as the project progresses.

Marine Mammals Data Sources

> *"HiDef conducted aerial surveys for the baseline study, but density estimates have been taken from SCANS III - Block S or K. Where densities have not been available, SMRU used Waggitt et al. (2020). SMRU carefully considered the use of Waggitt et al. (2020), as this is not generally considered appropriate --for quantitative assessment due to uncertainty in weighting and averaging of data, but was used where it was the most cautious estimate. On that basis, with the caveats stated, we consider this to be a sensible compromise."*

Chapter 11: Marine Mammals and Other Megafauna, concluded that it was inappropriate to use the Waggitt *et al.* (2020) values for the quantitative assessment of common dolphins. In addition to the various caveats of these data contributing to their inappropriateness for this purpose, the values (which were up to 0.0932 individuals/km^2 for monthly means) were also considered to be unsupported by the evidence of common dolphin occurrence in the Offshore Site from other data sources. As stated in Section 11.4.4.1.5 of the EIAR chapter:

> *"No sightings of common dolphins were confirmed during the 2015 and 2016 dedicated aerial surveys and no common dolphins were observed in the SCANS-III survey of Block S, or adjacent Block K or T, nor in waters north of Scotland in the SCANS-II survey conducted in 2005. Overall, there are very low sightings rates across the Offshore Site from both historical and contemporary data, as well as low predicted densities from analyses across multiple datasets, with caveats*

> *raised regarding their application to quantitative assessment. Therefore, the average density value of 0.012 individuals/km2 from the most recent dedicated aerial surveys (HiDef, 2021) is considered the most representative of the Offshore Site and was taken forward for the quantitative impact assessment."*

The Applicant acknowledges that this section erroneously refers to the Waggitt *et al.* (2020) being taken forward for assessment. The Applicant can confirm that the number of animals predicted to be impacted as presented throughout both Chapter 11 and Appendix 11.1: Underwater Noise Impact Assessment, reflect the density value of 0.012 individuals/km^2, which is the average density from the most recent dedicated site-specific surveys (HiDef, 2021).

The Applicant maintains that the value of 0.012 individuals/km^2 is the most appropriate density of common dolphins to be used in the assessment. Nonetheless, for completeness and to provide further clarification, the Applicant has illustrated here how changing the density estimate from the preferred HiDef estimate (0.012 individuals/km^2) to the Waggitt estimate (0.0932 individuals/km^2) would affect the assessment conclusions.

Applying the higher density value of 0.0932 individuals/km^2 would result in an increase in the number of common dolphins predicted to be impacted, but the conclusions of the assessment would remain unchanged. For example, of the potential impacts assessed, the largest number of common dolphins predicted to be impacted are 18 individuals disturbed from high-order UXO detonation assuming a 26 km EDR, representing 0.02% of the relevant MU and assessed as of negligible magnitude and negligible impact significance. Were a maximum mean monthly density value of 0.0932 individuals/km^2 from Waggitt et al. (2020) to be used, this would rise to 138 common dolphins impacted, representing 0.13% of the relevant MU, and so also of negligible magnitude and impact significance. For all other impact pathways, which result in lesser numbers of common dolphins predicted to be impacted, the proportion of the MU impacted would be < 0.02% and therefore also of negligible magnitude and impact significance. Applying a higher density value of 0.0932 individuals/km^2 to the highly conservative cumulative impact assessment of disturbance from piling increases the maximum daily number of impacted animals from 2,150 (2.1% MU) to 2,204 (2.1% MU) and so does not change the conclusion of the cumulative impact assessment.

Marine Mammal Management Units (MUs)

> *"The assessment of significance under EIA Regulations is done by comparison with the marine mammal management units (MUs). This is in keeping with the IAMMWG paper15 definition of MUs. However, our view is that many of the MUs are UK wide, and therefore unrealistic in terms of management. Since scoping we have started to advise that the UK portion of the MUs as detailed in IAMMWG 2022 is used as the reference population. Our view is that the MUs as described are predominantly based on biologically relevant population units, which are not necessarily practical as a management unit. The use of the UK portion of the MUs would increase the percentage of the population at risk. Nonetheless, it is likely that the percentage of the reference population impacted from this activity would still be low. Therefore, we agree with the conclusions of significance of effects as summarised in Chapter 11 of the EIA Report, Tables 11.34 and 11.35."*

This advice is noted, as is the acknowledgement that the entire MUs (without consideration of administrative boundaries) are those which are biologically relevant population units. For future pre-construction marine mammal assessments (e.g., piling strategy, EPS risk assessments), The Applicant will present the number of animals predicted to be impacted as a % of both the MU and UK portion of the MU, although it is emphasised that it is the entire MU which is of biological relevance when assessing impact significance.

Post -Consent Requirements

> *"We note that potential max PTS ranges for piling as predicted by the noise modelling (whilst we appreciate the layering of precaution) are at concerning ranges (Max LF cetacean PTS onset 27km) and will require revisiting in the Piling Strategy once the project envelope is refined in terms of appropriate mitigation."*

The comment is noted and will be considered by the Applicant when assessing the potential impacts of piling in the Piling Strategy (if piling of anchors is pursued) and the development of the associated MMMP.

> *"Likewise for the UXO predictions. These are based on commonly used modelling methodology, again with associated uncertainty relating to age and condition of any UXO target, and resting on the seabed and degree of burial. This also will need to be revisited in the event of UXO clearance being required. We highlight current joint UXO clearance guidance in terms of low noise alternatives to be used in preference to high order techniques."*

This comment is noted, and will be considered by the Applicant when assessing the potential impacts of any UXO clearance required and the development of the associated MMMP in support of UXO Marine Licence and EPS Licence applications. The Applicant is aware of the joint position statement on UXO clearance and preference for low order alternatives to high-order clearance, and will give full consideration to this advice should any UXO clearance be required.

> *"Whilst the impact of UXO clearance may be low in EIA terms, we do not agree with the conclusion of low based on the frequency content. Robinson et al. 202018, shows that there is energy potentially beyond 100 kHz. NPL protocol, as referenced above, suggests that at a minimum the nominal frequency range of the measurement kit should be 20Hz to 20kHz, but also mentions that this should cover the frequency range of the receptor of concern."*

This comment is noted, and will be considered by the Applicant when assessing the potential impacts of any UXO clearance required in support of UXO Marine Licence and EPS Licence applications. In that assessment, the Applicant will consider all relevant available information on the frequency content of UXO clearance.

Entanglement

> *"The EIA Report concedes that there is uncertainty regarding entanglement. The applicant suggests that they will be checking the moorings at a 'high frequency' initially, but conclude that there will be negligible impact due to entanglement. We tend to agree, but acknowledge the uncertainty, and although the theory and proxies suggest that the risk of entanglement is negligible, we are still at the very early stages of understanding the potential impacts from floating wind technologies. Entanglement is further considered in Section 13.6.2.3 in Chapter 13. This focuses on the potential for gear to be snagged onsite by active fishing, rather than ghost gear, i.e. abandoned, lost discarded fishing gear drifting on the currents becoming snagged. We consider the risk of entanglement in ghost gear is a potential issue, and welcome the willingness to continue discussion on monitoring."*

The Applicant is in agreement with NatureScot's comments on entanglement and the uncertainties in the understanding of entanglement due to ghost gear with respect to floating wind technologies. The Applicant is amenable to continue discussions on the monitoring requirements for the PFOWF in regard to ghost gear with relevant consultees including NatureScot.

HRA advice

> *"Table 3.4 of the HRA Report details the Special Areas of Conservation (SACs) scoped in for assessment. All are screened in due to location within the relevant management unit to the development and the species. The approach is well presented and uses all relevant and up to date understanding. We agree with the conclusions for all marine mammals considered (bottlenose dolphin, harbour porpoise, harbour seal and grey seal) that there is no adverse effect on site integrity.*
>
> *For the bottlenose dolphin of the Moray Firth SAC, harbour seal of Sanday SAC, and grey seal of Faray and Holm of Faray SAC, iPCoD modelling was conducted to provide assurance that there would be no detrimental impact to the populations, and in all cases there was no difference in the population trajectories. Harbour seals in the Orkney area are in decline. However, Sanday SAC is 117km from the development site, and assessment of tagging data show limited connectivity to the development. We agree with the considerations put forward throughout."*

The Applicant is appreciative of the positive feedback on the marine mammal assessment aspects of the HRA: RIAA and welcomes the agreement of NatureScot regarding the conclusions presented within the assessment.

Catherine Kelham
Senior Marine Conservation Planner
Royal Society for the Protection of Birds (RSPB) Scotland

BY EMAIL
[redacted]

30 November 2022

Dear Ms Kelham

Application for consent under Section 36 of the Electricity Act 1989 for the Pentland Floating Offshore Wind Farm
Application for Marine Licence under Part 4 of the Marine Scotland Act (2010) to construct and operate the Pentland Floating Offshore Wind Farm
Application for Marine Licence under Part 4 of the Marine Scotland Act (2010) to construct and operate the Pentland Floating Offshore Wind Farm offshore transmission infrastructure

Ref: GBPNTD-PGM-PEN-CM-00018

Thank you for providing RSPB Scotland's holding response (dated 5 October 2022) on the Pentland Floating Offshore Wind Farm (PFOWF) Section 36 and Marine Licence applications. It was useful to pick up these matters in discussion at our recent meeting on Friday 11 November, and hopefully this has helped explain our approach to the marine ornithological assessment. This letter provides Highland Wind Limited's (the Applicant) reply to the four key matters raised by RSPB Scotland and is copied to Marine Scotland for information. The PVA modelling requested by RSPB Scotland at the meeting (for displacement matrix outputs) is being provided by email under separate cover.

Query 1: Validity of results of in-combination assessment obtained from combining matrix and SeabORD approaches

SeabORD was requested for assessment of PFOWF project-alone displacement impacts by NS and MSS and advised as 'best available evidence' in their email dated 31 March 2022. However, displacement assessment for the consented Moray Firth wind farms had been based on use of matrices, which at the time of their assessment was the best available approach advised by NS and MSS.

SeabORD outputs are being relied upon for PFOWF as 'best available evidence' and a more robust and meaningful estimate of likely risk from this small-scale demonstrator project (up to seven turbines).

While the schemes in the Moray Firth are much larger, they lie at greater distance from North Caithness Cliffs SPA (92km 'at sea' from the Melvich SPA sub-site to Beatrice) and if it had been feasible for the applicant to undertake SeabORD modelling for these projects, it is likely that it would also have demonstrated no great risk of displacement mortality to the auks and kittiwake at thisSPA.

Displacement mortality estimates from use of matrices for the Moray Firth wind farms can therefore also be considered precautionary, especially if higher displacement mortality rates are being used above those adopted by MS-LOT in their original consenting decisions.

In terms of cumulative impact assessment across PFOWF and Moray Firth wind farms, there has been no obvious alternative suggested other than summing the mortality estimates from SeabORD (more realistic) and matrix (worst case) approaches. All the relevant advice was followed in so doing – SeabORD gives an annual mortality estimate of breeding adults only, whereas matrix outputs are for 'all birds' and have to be summed across breeding and non-breeding seasons (apportioned against the SPA according to the relevant methodologies for each season).

Note that matrix mortality estimates do not include any measure of uncertainty whereas those from SeabORD modelling do. SeabORD provides mean mortality estimates with associated standard deviations (SDs). But this information could not be used in the PFOWF population modelling as the matrix estimates do not include SDs. Therefore, SeabORD displacement mortalities were input into the NE PVA tool without the use of SDs.

This limitation to assessment is already acknowledged by all parties and, in the absence of any obvious alternatives, it is currently accepted practice simply to sum the mortality estimates (without SDs) from the different approaches (as is done when combining outputs from stochastic collision risk modelling with those from displacement matrices).

Query 2: Application of the matrix approach to describe impacts on juvenile birds which is contrary to the Statutory Nature Conservation Bodies (SNCB) advice (see Joint SNCB Interim Displacement Advice Note)

The PFOWF displacement matrices are based on 'all birds' (all age-classes) not 'adults only'. Displacement impacts derived from these matrices are then apportioned across adults and juveniles for inclusion in the population modelling and all age-classes (with their associated impacts) have been modelled under PVA, none have been excluded.

This approach does follow the advice given in the SNCB (2017) displacement guidance (and in the PFOWF scoping advice from NatureScot):

> "Where possible, the ratio of detected age classes should be reported… While separation of age classes is not directly used in the 'Matrix Approach' (the matrix should include abundance figures that relate to all birds in the project area, across all age classes), it can be crucial for later stages in the assessment process (e.g., when applying appropriate biologically relevant population scales and making assessments of population-level impacts)."

Query 3: Exclusion of buffer for some species, contrary to SNCB advice (see Joint SNCB Interim Displacement Advice Note)

This query relates specifically to puffin where the displacement estimates for the PFOWF array area alone were presented alongside those for the array area plus 2km buffer (Technical Appendix A.12.4 Marine Ornithology: Displacement Analysis). As noted above, SeabORD is being relied upon as 'best available evidence' for PFOWF project-alone impacts and indicates substantial over-estimation of potential displacement impacts from use of the matrix approach.

Query 4: Divergence from displacement mortalities recommended during the pre-application process in the matrix models (despite being provided in the displacement analysis – Appendix 12.4)

Technical Appendix A.12.4 Marine Ornithology: Displacement Analysis fully discusses the issues around displacement assessment for the technical reader. As discussed at the meeting on 11 November, decision-makers tend to prefer simple reporting; it is also less confusing for the general public who do still remain a key audience. This being the case, it was decided that the emphasis of the displacement assessment presented in the EIA Chapter and the Report to Inform Appropriate Assessment should be on the SeabORD model outputs (as the most realistic estimate of likely risk) and the displacement mortality rates most closely corresponding to these.

It was considered that presenting the full range of assessment optionality was not helpful in these over-arching summary documents and could also be misleading given the obvious over-estimation of displacement impacts at the 3% and 5% mortality rates (for auks during the breeding season).

NatureScot and Marine Scotland Science gave no supporting explanation as to why the displacement mortality rates were being increased for PFOWF for use in the matrix approach, and available information from the Strategic Environmental Assessment North Sea Energy' (SEANSE) modelling undertaken by the Centre for Ecology and Hydrology (Searle *et al.*, 2020) does not seem to support such an increase; please see **Annex A**.

Yours sincerely,

[redacted]

Peter Moore
Highland Wind Limited

[redacted]

Ms Clare Pritchett
Planning Service, SEPA
Angus Smith Building
6 Parklands Avenue
Eurocentral
Holytown
North Lanarkshire
ML1 4WQ

BY EMAIL
[redacted]

23 November 2022

Dear Ms Pritchett,

Application for consent under Section 36 of the Electricity Act 1989 for the Pentland Floating Offshore Wind Farm
Application for Marine Licence under Part 4 of the Marine Scotland Act (2010) to construct and operate the Pentland Floating Offshore Wind Farm
Application for Marine Licence under Part 4 of the Marine Scotland Act (2010) to construct and operate the Pentland Floating Offshore Wind Farm offshore transmission infrastructure

SEPA Reference 6301
Ref: GBPNTD-PGM-PEN-CM-00019

Many thanks for providing the Scottish Environment Protection Agency's (SEPA) response (dated 29 September 2022) on the Pentland Floating Offshore (PFOWF) Section 36 and Marine Licence applications.

We note that SEPA wishes to object to the proposed development and in its response has raised a number of concerns relating to radioactive substances and suitable mitigation and management. Highland Wind Limited (the Applicant) would like to thank members of SEPA for their time during the meeting held on 16 November 2022. The meeting provided a useful opportunity to discuss the proposed development, the current status of the application and the various concerns raised in SEPA's response, and to discuss potential mitigation and management measures to ensure appropriate management of the existing radioactivity risk during construction and operation of the PFOWF.

As discussed during the meeting, a formal scoping exercise was undertaken for the PFOWF and the Scoping Report was submitted to Marine Scotland's Licensing and Operations Team (MS-LOT) in December 2020. Comments were requested at this time from relevant consultees by MS-LOT and all comments received were provided by MS-LOT within its Scoping Opinion which the Applicant received in September 2021. Due to changes in project design, a Scoping Addendum Report was submitted in December 2021 and SEPA's comments on this report were considered within the Scoping Opinion Addendum issued by MS-LOT in May 2022. The Environmental Impact Assessment (EIA) Report was drafted with consideration of the Scoping Opinion and was submitted in final format in August 2022 to support the Section 36 and Marine Licence applications for the proposed development. Therefore, with scoping complete, amendments to the EIA Report are not possible at this stage. However, as discussed during the meeting, the Applicant would like to take this opportunity to provide responses to those concerns raised by SEPA within its representation. Table 1 (Response to SEPA comments on the PFOWF application), attached to this letter, provides further clarification in each case.

It is noted that a number of SEPA's concerns relate to the potential disturbance of existing radioactive contamination during the construction and operation of the proposed development and the associated risk of increased numbers of particles being recovered onshore. As discussed during the meeting, the Applicant is content to accept a condition in agreement with SEPA (and other relevant consultees) for the development of a Particles Management Plan to ensure this risk is managed during and after construction activities.

It is noted that precedent for this type of condition exists within the existing Dounreay Tri Project consent, which is located within the same area as the PFOWF and which has consent for the same cable route as that sought by PFOWF's current application. The wording of this consent condition is presented below to provide a basis for the development of a similar condition for the PFOWF:

> ***"Offshore Construction Method Statement Consent Condition***
>
> *The Company must, no later than 6 months prior to the Commencement of the Development, or at such a time as agreed with the Scottish Ministers, submit an Offshore Construction Method Statement ("OffCMS"), in writing, to the Scottish Ministers for their written approval. Such approval may only be granted following consultation by the Scottish Ministers with SNH, SEPA, THC, OIC, Dounreay Site Restoration Limited ("DSRL") and any such other advisors or organisations as may be required at the discretion of the Scottish Ministers. The OffCMS must include, but not be limited to, the following:*
>
> - *the construction procedures and good working practices for installing the Development; details of the roles and responsibilities,*
> - *chain of command and contact details of company;*
> - *personnel, any contractors or sub-contractors involved during the construction of the Development;*
> - *details of how the construction related mitigation steps proposed in the ES are to be delivered;*
> - *a waste management plan for the construction phase of the Development; and*
> - *continuous monitoring of radioactive particles.*
>
> *The OffCMS must adhere to the construction methods assessed in the Application and ES. The OffCMS must also, so far as is reasonably practicable, be consistent with the Design Statement ("DS"), the Offshore Environmental Management Plan ("OffEMP"), the Vessel Management Plan ("VMP"), the Navigational Safety Plan ("NSP"), and conditions contained within Marine Licences 06178/17/0 and 06174/17/0."*

As discussed at our meeting, the consented SHET HVAC cable from Orkney to mainland Scotland (the SHET Cable) also crosses the FEPA Zone and makes landfall at Dounreay. The proposed installation methods for the SHET Cable are similar to those proposed for the PFOWF export cable: Horizontal Directional Drilling (HDD) at landfall and then burial along the cable route wherever possible. However, on review, the development does not appear to have any consent condition for monitoring of radioactive particles attached to its Marine Licence.

I trust that the information set out within this letter provides SEPA with the necessary reassurance regarding radioactivity risk and how this will be managed during construction and operation of the PFOWF. It should be noted that, as set out in Table 1, this does not constitute new information, nor does it change any of the assessment conclusions within the EIA Report.

Highland Wind Limited would welcome a further meeting to discuss the responses provided and the formation of a suitable condition if this would be helpful.

Yours sincerely,

[redacted]

Peter Moore
Highland Wind Limited

[redacted]

Table 1 Response to SEPA comments on the PFOWF application

SEPA Comment	Applicant Response
1. Section 8.4.5.5 a. The particle retrieval exercises undertaken by DSRL at the Dounreay site is a requirement of the Environmental Authorisations (Scotland) 2018 permit (and formerly RSA 93 Authorisation) for the site and is not deemed remediation. **We request that the text is amended.**	In information published by DSRL for Dounreay available at *Radioactive particles in the environment around Dounreay* government website[1], and the *Particles Retrieval Advisory Group (Dounreay)* report from 2012[2], the particle retrieval exercises were described as "remediation", with further monitoring being part of ongoing remediation plans / programme. Although, it is recognised that the ongoing retrievals are part of the Environmental Authorisations (Scotland) 2018 permit, the terminology applied within the Environmental Impact Assessment Report (EIAR) is in line with all publicly available documents and information. No change is required to the EIAR. However, any further discussion of the topic by the Applicant (Highland Wind Ltd (HWL) will ensure to make the distinction between remediation and particle retrieval exercises in line the Environmental Authorisations (Scotland) 2018 permit.
2. Section 8.4.5.5.5 a. Eighteen samples were sent for analysis for radioactivity content. It is not clear whether these samples are representative statistically for the area under consideration for construction and disturbance. **We request that the sampling rationale is detailed.**	The primary purpose of these grab samples was to enable benthic characterisation and were selected on the basis of the EUNIS groups / biotypes present (informed through site geophysical data), with the aim of capturing as many biotypes as possible, in line with NatureScot advice. No seabed grab samples were collected at <2 km of coast within the Dounreay radioactive FEPA zone, due to the absence of a SEPA permit for these 2021 activities. Instead only video transects were taken in the nearshore area, to capture the presence of any rocky substrate, to ensure these could be characterised. The survey methodology is detailed within Offshore EIAR (Volume 3) Appendix 9.1 for further details. Sampling of radioactive particles was not proposed within the Scoping Report or Scoping Report Addendum and nor was it requested in the Scoping Opinion or Scoping Opinion Addendum. Therefore, samples were not taken for the purpose of providing a statistical representation across the Offshore Site in relation to radioactive particles originating from historical Dounreay discharges and are therefore not intended to be statistically representative. Instead radioactivity analyses were completed on behalf of the Applicant at each grab sample location to inform Health and Safety Executive requirements, due to the location of the Offshore Site to Dounreay facilities and known historic contamination sources. It is also noted that, although general Pre-Application Advice was received by SEPA in March 2020, no comment was provided from SEPA on the Scoping Report in the September 2021 Scoping Opinion, issued by MS-LOT, on the scope of the assessment as refined since the pre-application

[1]Radioactive particles in the environment around Dounreay corporate reports available at https://www.gov.uk/government/publications/radioactive-particles-in-the-environment-around-dounreay

[2] Particles Retrieval Advisory Group (Dounreay) 2012 Report available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/696375/PRAGD_Dounreay-2012-report.pdf

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	advice or guidance on the analytical survey requirements. Comments from SEPA on the Scoping Addendum Report did not raise any concerns with radioactivity.
b. The radiochemical suite analysed for was more akin to a suite for Naturally Occurring Radioactive Material (NORM) and not specific to the Dounreay fragments of irradiated nuclear fuel fingerprint. **We request that the sampling rationale is detailed.**	For the 18 grab sample locations, as discussed above, Nuvia undertook real-time monitoring onboard vessels to ensure that the samples did not inadvertently include Dounreay radioactive particles. The limit of detection of this monitoring was typically 10 kbq screening onboard for core samples (which is below transport thresholds). As part of the initial screening, samples were sent to a nuclear radiochemical laboratory for analysis prior to being sent to the environmental laboratory. The purpose was to provide reassurance that any radioactivity present was at environmental levels (i.e. Naturally Occurring Radioactive Materials, NORM), and such that the samples could be further analysed in a non-radiochemical laboratory. On acceptance of the samples at the nuclear radiochemical lab, high resolution gamma spectrometry (HRGS), including Gross Alpha and Gross Beta, were requested for analyses, which acted as an initial "screening" to determine if any of the samples would benefit from further analyses for additional radioactive isotopes. The results of the initial screening analyses confirmed that all radioactivity was at environmental levels, and as such no further analysis was requested as the purpose of the analysis for HSE had been fulfilled. However, as discussed during the consultation meeting on 16 November 2022, the Applicant requested the results against the Dounreay irradiated nuclear fuel fingerprint ("Dounreay fingerprint") to provide further confidence in the results. The results are summarised below: • All 18 sediment samples have been subject to High Resolution Gamma Spectrometry and gross alpha and gross beta analysis, with the HRGS spectrum being compared to the Dounreay radionuclide library; • Only Naturally Occurring Radioactive Materials (NORM) at activity concentrations typically expected in nature were detected in all of the samples, with one exception; • One sample (sample 16, located ~2 km from shore, i.e. immediately adjacent to the Dounreay radioactive FEPA zone) gave a result that included 0.0064 Bq/g of the man-made radionuclide Am-241; • There were no other man-made radionuclides associated with this positive result (typically we may expect Cs-137 to also be present as a fission product); • The "out of scope" threshold for Am-241 in the Environmental Authorisations (Scotland) Regulations (EASR) 2018 is 0.1 Bq/g, therefore this radioactivity level is approximately 15 times below the threshold for being considered radioactive under the relevant legislation.

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c. It is stated that radioactive particles were detected. **We request that it is clarified whether these particles were segregated out from the surrounding sediment matrix.**	Reference to radioactivity within the EIAR are only with respect to NORM activity reported and are not with respect to radionuclides characteristics to the Dounreay fingerprint. As described in response to comment 2b above, the principal safeguarding provided by Nuvia onboard the vessel, associated with the initial screening for HRSG, Gross Alpha and Gross Beta, means any radioactivity were within NORM environmental levels. Further analysis undertaken to clarify these results, as discussed during the meeting, shows that only one positive result from an anthropogenic source was detected (Am-241) and this positive result was below the 'out of scope' thresholds within the EASR (2018) legislation and therefore is not considered radioactive. The methodology applied for the HRGS is detailed within the lab report in support of the application sent to SEPA following the consultation meeting held on 16 November 2022. In conclusion, no particles of the activity magnitude akin to those which are monitored and reported on by DSRL were found or analysed.
d. Whilst the analysis has been compared to the DPAG criteria, **we request that it is clarified whether the number of samples analysed are statistically significant in relation to the area under consideration and as such each classification is per particle and not for the area as a whole.**	As stated in response to Comment 2a, grab samples were only obtained for the purpose of benthic characterisation and not to provide a statistical representation of the Offshore Site in relation to radioactive particles originating from historical Dounreay discharges. The completed initial screening for NORM at environmental levels was considered to be an additional benefit demonstrating the limited radioactivity at environmental levels only. The Dounreay fingerprint analysis also confirms this.
e. This section refers to a Radiation Risk Assessment (NUVIA, 2021b) for the Offshore Site. The section states 'The assessment concludes that it is very unlikely that contamination will arise and spread due to the wind farm construction activities'. **We request that this documentation and underlying methodology is made available to SEPA for review so we can**	The Radiation Risk Assessment was completed under CDM 2015 guidelines, primarily to inform the project team and contractors of the potential radioactivity risks. Should further risk assessments pertaining to radioactivity be developed for HSE purposes, the Applicant can provide these to SEPA for comment. Independent of the EIAR submission, HWL have been in correspondence with SEPA in relation to the recent surveys completed under the EASR (2018) permit.

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comment on whether the opinions expressed within that document are valid.	
3. Section 8.4.6 a. This section states 'With respect to the potential for radioactive particles, the situation is more likely to improve in the future, due to the potential identification and remedial works, associated with the ongoing monitoring programme near the Dounreay Nuclear Facility'. Please refer to Comment 1a. Also the inventory of particles is not known and as such to state that 'the situation is more likely to improve in the future' cannot be said to be 'more likely'. **We request that the text is amended.**	The completed sediment sampling including the initial screening analyses for NORM at environmental levels and further analysis against the Dounreay fingerprint, and additionally the principal safeguarding provided by Nuvia on board the vessel, all support the interpretation of little radioactivity, with any occurring only as NORM or at environmental levels, as presented within the EIAR. The Applicant agrees with the statement that the total inventory of radioactive particles (characteristic to the Dounreay fingerprint) is unknown. However, it is considered to still be the case that the potential occurrence of manmade radionuclides that originated from Dounreay would reduce into the future as also discussed in the Particles Retrieval Advisory Group (Dounreay) 2012 Report. The primary reasons being: • The closure of the historic LEDS, which was the historic source of contamination; • The active removal of radioactive particles from the offshore area within the radioactive plume footprint; and • The ongoing offshore and beach monitoring and particle recovery / retrieval programme being completed by DSRL near the Dounreay Nuclear Facility, which actively removes radioactive particles from the environment.
4. Section 8.4.8 a. This section states 'There are not considered to be any residual uncertainties associated with the potential for contaminants and radioactive particles across the Offshore Site'. Given that there are only 18 samples in the entire area and the concerns expressed in Comments 2 & 3 above this cannot	No grab samples were obtained from within the Dounreay FEPA radioactive zone as set out in response to Comment 2a above. In order to characterise the potential for radioactivity in the nearshore area, information was obtained from a range of publicly available data sources, which included: • Particles Retrieval Advisory Group (Dounreay) Reports from 2012, 2008 and 2006; • Annual monitoring and reporting of radioactive particle finds, published by DSRL[3]. All available information up to the most recent 2021 monitoring report were considered and used to develop the baseline understanding and inform the impact assessment; and • Annual Radioactivity in Food and Environment (RIFE) reports for the Dounreay site[4]. Reports between 2016 and 2021 were reviewed in order to characterise the potential for radioactivity

[3] Regular beach monitoring of the Dounreay Foreshore and Sandside Beach is completed, with reportable finds documented and avaialble from https://www.gov.uk/government/publications/radioactive-particles-in-the-environment-around-dounreay

[4] Annual monitoring reports available from https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-rife-reports.

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be concluded. **We request that the text is amended.**	within the Offshore Site. It was discussed within the EIAR that although RIFE reports were mostly in relation to terrestrial sources, it also did consider marine ecological sources that were considered to be useful indicators to inform the EIAR. As stated in response to Comment 2b, the sediment grab samples were not collected for the purpose of characterising any radioactivity across the Offshore Site, so the acquired information supplemented the understanding developed from the publicly available data sources. Based on the range of information used to characterise the baseline environment, there is considered to be adequate understanding to support the impact assessment.
5. Section 8.5.2.2.3 a. This section covers 'Changes in water and sediment quality due to increased suspended sediment concentrations during operation, associated with the movement of moorings, and maintenance of cables'. It states that 'This impact is scoped out because, as described for the construction activities in Section 8.5.2.1, increases in turbidity from installation activities would be localised, transient and temporary. The same is considered to apply to the movement of moorings during operational and the repair of cables, should it be required'. However, given the uncertainties and concerns expressed in Comments 2-4, **we request this is reconsidered and scoped in.**	As stated in Section 8.5.2.2.3 of the EIAR, the impact "*Changes in water and sediment quality due to increased suspended sediment concentrations during operation, associated with the movement of moorings, and maintenance of cables"* was not raised during the Scoping process. Nonetheless, for completeness, the impact was identified, evaluated and scoped out when considering Marine Scotland's comment regarding the assessment of water quality impacts from operational cleaning activities. Based on Marine Scotland's comments, the additional impact of "*Changes in water quality due to operational cleaning and painting*" was included and assessed in Section 8.6.2.1 of the EIAR. However, it was deemed that impacts to water and sediment quality (from increased suspended sediment concentrations) during operation would be less than that determined for construction activities, which had been assessed and scoped out within the Scoping Report and agreed by MS-LOT in its Scoping Opinion. As presented in responses to Comments 2-4 above, there is no publicly available information to indicate the presence of radioactive particles in the offshore area covering the PFOWF Array Area. The initial screening completed by the Applicant indicates the radioactivity present were at environmental levels (NORM), and subsequent clarification highlights only one positive result for an anthropogenic radionuclide, Am-241, which was at levels 15 times less than the 'out of scope' threshold, at the edge of the Dounreay radioactive FEPA zone (i.e. well beyond the PFOWF Array Area). Chapter 7: Marine Physical Processes of the EIAR assessed the potential increase and dispersion of suspended sediments as a result of Project activities within the Offshore Site. The completed assessment was based on analytical spreadsheet calculations of sediment dispersion under peak spring flood and ebb flows (informed by observed tidal observations within the PFOWF Array Area and hindcast tidal timeseries within the offshore export cable corridor). Within Chapter 7 of the EIAR, the potential increases in suspended sediment concentrations associated with the operational movement of moorings were found to be localised and transient along the mooring line associated with the rise and fall of the tide. The assessment showed that when

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	considering the worst case mooring system, it is the same sediment that would nominally be disturbed and resettled within the mooring swept area. Due to the temporary and localised nature of any disturbance the assessment concluded that this effect is unlikely to lead to changes to water and sediment quality within the PFOWF Array Area. As per the assessment in the EIAR, with respect to the potential suspended sediment associated with operational maintenance of the cables, any disturbance and associated increases in suspended sediment concentration would be localised to the area of the works as calculated through the dispersion modelling. Chapter 7 concludes that sediment displaced during the repair would quickly be redeposited to the seabed, with coarser sediment being deposited within the first 500 m and only finer sands and silt potentially being transported as a plume, but at low concentrations, up to a distance of around 2 or 3 km for an ebb or flood release, respectively. Despite the potential requirement for operational repair of cables within the Dounreay radioactive FEPA zone, the likelihood of encountering significant radioactive particles is considered to be low, particularly in light of any permitting protocols required for activities in this area. As concluded in the EIAR, the potential requirement for operational works for the cable are not considered sufficient to ultimately lead to changes in water or sediment quality. Despite the low likelihood, as discussed in the EIAR there is a pathway for suspended sediment disturbed within the first few kilometres of the export cable route from the HDD exit point, to reach the Dounreay foreshore. Therefore, in direct response to this potential pathway, the Applicant is amenable to developing a further Particles Management Plan as detailed further in response to Comment 7. This requirement can be secured as a condition and developed once the full scope of the construction activities are known ahead of construction. For the reasons discussed above, it is considered that the impact '*Changes in water and sediment quality due to increased suspended sediment concentrations during operation, associated with the movement of moorings, and maintenance of cables'* was sufficiently considered within the EIAR and does not require further assessment.
6. Section 8.6 a. Given comments 1-5 above and the uncertainties identified, we do not agree with the assessment of risk given within this section. **We request this section is re evaluated in relation to radioactive contaminants.**	The completed impact assessment discussed within Section 8.6 of the EIAR draws on all available publicly available datasets, with the additional site specific radioactivity screening as described in response to Comment 2b. The completed radioactivity analysis of the 18 sediment grab samples confirmed that any radioactivity present within the samples was at environmental levels or below 'out of scope' thresholds of the EASR 2018 regulations. In addition, the potential and risk for radioactive particles within the Offshore Site was considered to be extremely unlikely as considered by Nuvia (2021a; 2021b).

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	The various risk assessments undertaken by Nuvia have been provided to SEPA for the separate EASR permit activities and will continue to be provided for further offshore works pertaining to potential interaction with radioactive particles. Therefore, with reference to the available information used to complete the assessment at the time of writing, it is considered that the potential risk for radioactivity within the Offshore Site has been adequately considered and assessed within the EIAR.
7. **We request that consideration is given to the impact onshore of any disturbance of radioactive contamination offshore and how this will be assessed or demonstrated.** For example, additional monitoring or measurements of sediment disturbance on local beaches. For the avoidance of doubt, SEPA are concerned that the work offshore may alter the current mechanism that determines the arrival rate and composition of fragments of irradiated nuclear fuel on the Dounreay foreshore and Sandside beaches.	The completed Radiation Risk Assessment (NUVIA, 2021b) for the Offshore Site evaluated the potential for encountering, disturbing and spreading of radioactive particles associated with construction and operation activities. The assessment concluded that it was very unlikely that contamination will arise and spread due to the very low potential across the PFOWF Array Area. It was stated that, should radioactive particles be encountered (be it large or small particles), they would be discrete insoluble items, similar in size to a grain of sand, and although they can break up into smaller particles this would not result in widespread contamination but would be localised around the particle, as has been the case with previous particle finds. Nuvia (2021a; 2021b) further described that there had been no evidence of the spread of radioactive contamination associated with previous recovery of particles from the shoreline. The Nuvia risk assessments will continue to be provided to SEPA for further works, as required. As presented within the EIAR, mitigation commitments through protocols and procedures have been incorporated into the Project design, which mitigates the potential for disturbing or spreading radioactive particles during construction and operation activities. Monitoring commissioned by DSRL to date indicates that the significant radioactive particle finds have been confined to within 1 km of the historic LEDS, which is beyond the point where the export cable will be placed/ buried on the seabed. Due to the low potential of radioactive particles occurring within the Offshore Site and the protocols and procedures in place to further mitigate the risk of encountering such particles, it is considered unlikely that radioactive particles will be disturbed. Chapter 7 of the EIAR details the sediment transport pathways across the Offshore Site and shows that sediment disturbed within the PFOWF Array Area will not reach the coast. The chapter also details that the only pathway for disturbed sediment to reach the coast and foreshore is in relation to construction works in the first few kilometres of the export cable beyond the HDD exit point. As discussed during the consultation meeting 16 November 2022, to further mitigate the risk, particularly in the FEPA Zone, the Applicant is content to accept a condition requiring the development of a Particles Management Plan in agreement with DSRL's Particle Management Team and SEPA, to ensure the risk is managed during and after construction activities. This requirement

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	can be secured as a condition and developed once the full scope of the construction activities are known ahead of construction. As precedent for this type of condition, the Applicant highlights the existing Dounreay Tri consent (which is located within the same area as the PFOWF Project). The scope of the offshore condition is presented within the introduction to this letter for consideration by SEPA. It is noted, however, that that Marine Licence for the SHET HVAC cable from Orkney to mainland Scotland (the SHET Cable), which also crosses the Dounreay radioactive FEPA Zone and makes landfall at Dounreay, does not appear to include any such condition despite the proposed installation methods being similar to those proposed for the PFOWF export cable.
8. **We request that Food Standards Scotland are consulted specifically in relation to the FEPA Order area.** The FEPA order is designed to protect the food chain, however the impact of the actions of survey and construction may result in the remobilisation of more deeply buried fragments and could result in the amendment of the FEPA order area.	Available information from monitoring to date indicate that the largest radioactive particles are within 1 km of the historic LEDS, while the 2 km Dounreay radioactive FEPA zone, is precautionary to protect the food chain. Although the offshore export cable route is within the zone, it is more than 1 km from the historic LEDS. The potential for sediment and particle mobilisation is described in response to Comment 7 and is also relevant here. The Applicant consulted Food Standards Scotland ahead of geotechnical and geophysical surveys commencing in 2021. Food Standards Scotland will be consulted post consent on the development of the Particles Management Plan and specific mitigation requirements to be adhered to in the FEPA zone.
Given that the radioactive particles are existing contamination, if the works are insufficiently mitigated and result in an increase in particles recovered onshore, the developer could be considered under the Radioactive Contaminated Land Regulations as a Polluter, known as an Appropriate Person with respect to Part IIA of the Environmental Protection Act 1990 Section 78F (ref: 78F (2) below).	All works undertaken to date and future works proposed will be in line with SEPA permitting and advice. SEPA will be a key consultee in the development of post consent management plans pertaining to radioactivity to ensure that all proposed future works are adequately mitigated, and the Applicant adheres to the specific legislation, advice and protocols.

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78F (2) Subject to the following provisions of this section, any person, or any of the persons, who caused or knowingly permitted the substances, or any of the substances, by reason of which the contaminated land in question is such land to be in, on or under that land is an appropriate person.	

Appendix B: NatureScot Requested Information

Annex A: CRM Option 2 Outputs

Table 1 CRM option 2 outputs for great black-backed gull and herring gull

Turbine scenario	Monthly mortalities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Great black-backed gull													
14 MW	Mean density CRM mortalities *(+/- 0.2% avoidance)*	1 *(1-2)*	0 *(0)*	1 *(1-1)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(1-1)*
14 MW	Max density CRM mortalities *(+/- 0.2% avoidance)*	3 *(2-3)*	1 *(1-1)*	2 *(2-3)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(1-1)*	2 *(1-2)*
18 MW	Mean density CRM mortalities *(+/- 0.2% avoidance)*	1 *(1-1)*	0 *(0)*	1 *(1-1)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(1-1)*
18 MW	Max density CRM mortalities *(+/- 0.2% avoidance)*	2 *(2-2)*	1 *(1-1)*	2 *(2-2)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(1-1)*	1 *(1-2)*
Herring gull													
14 MW	Mean density CRM mortalities *(+/- 0.2% avoidance)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*
14 MW	Max density CRM mortalities *(+/- 0.2% avoidance)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(1-1)*	0 *(0)*	0 *(0)*
18 MW	Mean density CRM mortalities *(+/- 0.2% avoidance)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*
18 MW	Max density CRM mortalities *(+/- 0.2% avoidance)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	1 *(0-1)*	0 *(0)*	0 *(0)*

Annex B: Puffin, scaled SeabORD outputs

The NatureScot advice on puffin is noted. Previously, the count of puffins had been multiplied by a conversion factor of 0.67 to estimate the number of breeding pairs. SeabORD then doubles the number of pairs to estimate the number of individuals for input into the modelling.

However, NatureScot advise that the 0.67 conversion factor should not have been applied to puffin. Therefore, the SeabORD outputs for this species have been updated, as requested, using a scaling factor to revert the 0.67 conversion factor previously applied. Use of this conversion factor has meant that only a proportion of the correct (recalculated) number of puffins were modelled so application of a scaling factor will help correct for this.

The information used to calculate the appropriate scaling factor is presented in Table 2.

Table 2 Calculation of SeabORD scaling factor for Puffin

SPA sub-site	SPA Count	Original SeabORD individuals[1]	Recalculated SeabORD individuals[2]	% of recalculated population used	Scaling Factor
Duncansby	18	24	36	67	1/0.67
Dunnet	1,604	2,150	3,208	67	1/0.67
Holborn	60	80	120	67	1/0.67
Melvich	1,354	1,814	2,708	67	1/0.67
Stroma	17	24[3]	34	70	1/0.70

[1] Count x 0.67 x 2
[2] Count x 2
[3] Application of the 0.67 conversion factor to the Stroma SPA count results in a figure of 11.39. A decision was made to round this figure up to the nearest whole number (12 pairs as reported in Table 1 of the Displacement Technical Appendix, doubled to 24 individuals for input into SeabORD).
Without this rounding decision (i.e., applying 0.67 x 2 directly to the Stroma count of 17 puffin) the figure would be 22.78 individuals and if this value is compared to the recalculated SeabORD numbers it would result in a scaling factor of 1/0.67, the same as for the other sub-sites. So, the fact that it is different relates to these rounding matters.

Table B4.1 of TA:12.4 Marine Ornithology: Displacement Analysis presented the original SeabORD mortality estimates for puffin. Table 3 below presents those original outputs with the scaling factor applied.

The original (unscaled) displacement mortality estimate from SeabORD used in PVA was **1.80 puffin** for a ‘moderate prey year’.

The updated (scaled) estimates remodelled under PVA are **1.49 puffin** for a ‘good prey year’ and **2.69 puffin** for a ‘moderate prey year’. The outputs are presented in Table 7 and Table 8 in Appendix A; Annex C of this document.

Table 3 SeabORD annual puffin mortalities, non-scaled and scaled

Sub-site	PVA baseline adult mortalities	Environmental Conditions	Adults not surviving the year						Difference in non-scaled mortalities between scenarios	Difference in scaled mortalities between scenarios
			Baseline (no wind farm)			Wind farm present				
			Mean	Scaled mean	SD	Mean	Scaled mean	SD		
Dunnet Head	151	Poor	356.70	532.39	22.97	356.80	532.54	23.04	0.10	0.15
		Moderate	252.40	376.72	15.94	252.90	377.46	15.96	0.50	0.75
		Good	123.70	184.63	12.04	123.60	184.47	11.97	0.10	0.15
Duncansby Head	2	Poor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Moderate	5.00	7.46	0.00	5.00	7.46	0.00	0.00	0.00
		Good	1.00	1.49	0.00	1.00	1.49	0.00	0.00	0.00
Holburn Head	6	Poor	16.10	24.03	0.32	16.10	24.03	0.32	0.00	0.00
		Moderate	7.00	10.77	1.16	7.00	10.77	1.16	0.00	0.00
		Good	4.80	7.38	0.42	4.80	7.38	0.42	0.00	0.00
Melvich	127	Poor	378.60	565.07	11.76	381.20	568.96	12.11	2.60	3.89
		Moderate	311.70	465.22	8.73	313.00	467.16	9.56	1.30	1.94
		Good	157.30	234.78	4.06	158.20	236.12	4.44	0.90	1.34
Stroma	2	Poor	5.40	7.71	0.52	5.40	7.71	0.52	0.00	0.00
		Moderate	4.70	6.71	1.34	4.70	6.71	1.34	0.00	0.00
		Good	1.00	1.43	0.00	1.00	1.43	0.00	0.00	0.00

Annex C: PVA outputs for 25-year modelled impact periods

Table 4 Metrics and counterfactuals (with 95% Confidence Intervals (CI)) for 1,000 simulations of the kittiwake PVA at the end of 25 years of impact (2027-2052)

Kittiwake scenarios	Mortality - relative rate		Median pop. size at end of modelled period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
Baseline 25yr	-	-	4,205	-	-
1 – PFOWF SeabORD and CRM mean densities	0.83×10^{-3}	0.03×10^{-3}	4,126	0.999 *(0.997-1.002)*	0.981 *(0.909-1.061)*
2 - PFOWF SeabORD and CRM max densities	1.22×10^{-3}	0.06×10^{-3}	4,087	0.999 *(0.996-1.002)*	0.975 *(0.898-1.045)*
3 - PFOWF SeabORD and CRM mean densities; Moray Firth (matrix 30% / 2%) and CRM mean densities	1.82×10^{-3}	0.26×10^{-3}	4,027	0.998 *(0.996-1.001)*	0.960 *(0.891-1.039)*
4 - North Sea wind farm non-breeding CRM mean densities (excluding PFOWF and Moray Firth)	4.13×10^{-3}	4.16×10^{-3}	3,655	0.995 (0.992-0.997)	0.873 *(0.807-0.939)*
5 - Scenarios 3 and 4 together	5.95×10^{-3}	4.41×10^{-3}	3,534	0.993 *(0.990-0.996)*	0.840 *(0.773-0.910)*

[1]CGR = Counterfactual Growth Rate.
[2]CPS = Counterfactual Population Size.

Table 5 Metrics and counterfactuals (with 95% Confidence Intervals (CI)) for 1,000 simulations of the guillemot PVA at the end of 25 years of impact (2027-2052)

Guillemot scenarios	Mortality - relative rate		Median pop. size at end of modelled period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
Baseline 25yr	-	-	114,310	-	-
1 - PFOWF SeabORD	0.10×10^{-3}	0	113,951	1.000 *(0.999-1.000)*	0.997 *(0.982-1.013)*
2 - PFOWF SeabORD and Moray Firth (matrix 60% / 1%, breeding and non-breeding)	0.31×10^{-3}	0.21×10^{-3}	113,348	1.000 *(0.999-1.000)*	0.992 *(0.976-1.008)*

[1]CGR = Counterfactual Growth Rate.
[2]CPS = Counterfactual Population Size

As set out in Annex B above, the SeabORD model outputs have been scaled for puffin to address NatureScot's request. Table 6 provides these updated puffin mortality estimates, relevant to impact scenarios 1, 2, 6 and 7. Impact scenario 3 is also modelled to address NatureScot's comments on considering matrix displacement estimates for the PFOWF Array Area plus 2km buffer.

Table 6 Modelled impact scenarios for puffin

Scenario	Impacts modelled *(breeding season, displacement)*	Absolute mortalities[2]			Relative mortality rates[3]	
		Total	Adults	Immatures	Adults	Immatures
1	PFOWF SeabORD (moderate prey year)	2.69	2.69	0	1.12 x 10-3	0
2	PFOWF SeabORD (good prey year)	1.49	1.49	0	0.62 x 10-3	0
3	PFOWF Array Area + 2km buffer (matrix 60% / 1%)[1]	27.22	14.44	12.78	6.02 x 10-3	6.02 x 10-3
4	Moray Firth (matrix 60% / 1%)[1]	19.91	10.55	9.36	4.40 x 10-3	4.40 x 10-3
5	Moray Firth (matrix 60% / 2%)[1]	39.83	21.11	18.72	8.81 x 10-3	8.81 x 10-3
6	PFOWF SeabORD (moderate prey year) and Moray Firth (matrix 60% / 1%)[1]	22.60	13.25	9.35	5.52 x 10-3	4.40 x 10-3
7	PFOWF SeabORD (good prey year) and Moray Firth (matrix 60% / 1%)[1]	21.40	12.05	9.35	5.02 x 10-3	4.40 x 10-3

1. *% in brackets refer to the displacement and mortality parameters used to estimate mortality).*
2. *Absolute mortalities = estimated annual number of bird mortalities.*
3. *Relative mortality rates = absolute mortalities as a proportion of the 2027 baseline adult and immature North Caithness Cliffs SPA population estimates*

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Table 7 Metrics and counterfactuals (with 95% Confidence Intervals (CI)) for 5,000 simulations of the puffin PVA at the end of the 25 years of impact (2027-2052)

Puffin scenarios	Mortality - relative rate		Median pop. size at end of modelled period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
Baseline 25yr	-	-	1,310	-	-
1 - PFOWF SeabORD (moderate prey year)	1.12 x 10^{-3}	0	1,270	0.999 *(0.994-1.003)*	0.966 *(0.854-1.092)*
2 - PFOWF SeabORD (good prey year)	0.62 x 10^{-3}	0	1,289	0.999 *(0.995-1.004)*	0.982 *(0.867-1.111)*
3 - PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	6.02 x 10^{-3}	6.02 x 10^{-3}	1,088	0.993 *(0.989-0.997)*	0.831 (0.733-0.944)
4 - Moray Firth (matrix 60% / 1%, breeding)	4.40 x 10^{-3}	4.40 x 10^{-3}	1,151	0.995 *(0.990-0.999)*	0.875 *(0.769-0.986)*
5 - Moray Firth (matrix 60% / 2%, breeding)	8.81 x 10^{-3}	8.81 x 10^{-3}	1,005	0.990 *(0.985-0.994)*	0.764 *(0.670-0.866)*
6 - PFOWF SeabORD (moderate prey year) and Moray Firth (matrix 60% / 1%, breeding)	5.52 x 10^{-3}	4.40 x 10^{-3}	1,110	0.994 *(0.989-0.998)*	0.844 *(0.740-0.965)*
7 - PFOWF SeabORD (good prey year) and Moray Firth (matrix 60% / 1%, breeding)	5.02 x 10^{-3}	4.40 x 10^{-3}	1,129	0.994 *(0.990-0.999)*	0.857 *(0.756-0.970)*

[1]CGR = Counterfactual Growth Rate.
[2]CPS = Counterfactual Population Size.

Table 8 Metrics and counterfactuals (with 95% Confidence Intervals (CI)) for 5,000 simulations of the puffin PVA at the end of the 30 years of impact (2027-2057)

Puffin scenarios	Mortality - relative rate		Median pop. size at end of modelled period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
Baseline 30yr	-	-	1,173	-	-
1 - PFOWF SeabORD (moderate prey year)	1.12×10^{-3}	0	1,125	0.999 *(0.995-1.003)*	0.958 *(0.840-1.101)*
2 - PFOWF SeabORD (good prey year)	0.62×10^{-3}	0	1,151	0.999 *(0.995-1.003)*	0.977 *(0.853-1.118)*
3 - PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	6.02×10^{-3}	6.02×10^{-3}	939	0.993 *(0.989-0.997)*	0.803 *(0.695-0.920)*
4 - Moray Firth (matrix 60% / 1%, breeding)	4.40×10^{-3}	4.40×10^{-3}	999	0.995 *(0.991-0.999)*	0.852 *(0.738-0.973)*
5 - Moray Firth (matrix 60% / 2%, breeding)	8.81×10^{-3}	8.81×10^{-3}	848	0.990 *(0.985-0.994)*	0.723 *(0.625-0.832)*
6 - PFOWF SeabORD (moderate prey year) and Moray Firth (matrix 60% / 1%, breeding)	5.52×10^{-3}	4.40×10^{-3}	959	0.993 *(0.989-0.998)*	0.817 *(0.705-0.940)*
7 - PFOWF SeabORD (good prey year) and Moray Firth (matrix 60% / 1%, breeding)	5.02×10^{-3}	4.40×10^{-3}	975	0.994 *(0.990-0.998)*	0.833 *(0.723-0.954)*

[1]CGR = Counterfactual Growth Rate.
[2]CPS = Counterfactual Population Size

Annex D- Addressing NS queries in Appendix 1 – Ornithology

The HiDef advice below is presented in the order in which the queries were raised by NatureScot in 'Appendix 1 – Ornithology' of their response letter dated 13 October 2022. While comments are not repeated verbatim the specific issue that is being addressed should be clear from the topic headings (most of which are those used by NatureScot).

1. Combining connectivity and apportioning

The apportioned values are all correct in the Technical Appendices (TAs) and in the Report to Inform Appropriate Assessment (RIAA). Confirmed figures for the six mistakes (typos/oversights) identified by NatureScot are provided on page 1 of this letter.

The HRA long list included all SPAs where connectivity with PFOWF was determined using the updated foraging range information in Woodward *et al.* (2019) and based on 'at sea' measurements of distance. The RIAA is therefore based on this unscreened long list of SPAs, and any inconsistency in the listings between the EIA Report Chapter, Technical Appendices and RIAA results from this (from the large number of SPAs being included for assessment).

Note that the SPA tables in the EIA Report Chapter were included only for context as part of the species summary descriptions and have no bearing on the assessments presented in Sections 11.6 or 11.7 of this Chapter. It is confirmed that all modelling was carried out correctly and that the conclusions presented in the EIA Report and RIAA remain valid.

In this regard, inclusion of the Seas off St Kilda SPA for gannet in Table 9.13 of the RIAA is a mistake from an earlier draft. It is confirmed that marine SPAs did not form part of any of the HRA apportioning calculations undertaken for assessment – as noted by NatureScot, this process only applies to the SPA breeding seabird colonies.

EIA Report – Chapter 12

Regional population trends

Regional population trends were obtained from the JNCC website for the Seabird Monitoring Programme (SMP): https://jncc.gov.uk/our-work/smp-report-1986-2019/.

However, it is clarified that, for the SMP, Scotland is classified as a region and therefore 'regional' in this context means 'Scottish'. Information on each species trend can be obtained by clicking on the links on the overview page.

Interpretation of trend relates to the SMP data and graphs on annual abundance, rather than to those specifically on breeding productivity.

Highly Pathogenic Avian Influenza (HPAI)

NatureScot's comments are noted.

Wildfowl and waders

NatureScot's comments are noted.

Petrels and shearwaters

NatureScot's comments around artificial lighting and seabird attraction are noted. As stated in Table 12.20 of the EIA Report chapter, the wind farm Lighting and Marking Plan will adopt good practice on this issue as recommended by NatureScot (2020a). The applicant is also happy to investigate possibilities for reducing lighting requirements on construction vessels working at night.

Collision risk modelling (CRM)

As requested, CRM option 2 outputs are provided for herring gull and great black-backed in **Annex A**.

NatureScot's understanding is correct; in Table 2 biometric parameters for Arctic tern are taken from Alerstam *et al.* (2007) and fulmar and great skua are from Pennycuick (1997). Advice had been requested at pre-application stage (HiDef assessment methodology paper, 17 August 2021) on whether or not to include these species in a quantitative CRM but the matter was never clarified. They were therefore included in the modelling on a precautionary basis.

NatureScot correctly identify a formatting error in the column titles of Table 9.5 of the RIAA. The correct headings are as follows:

Table 9.5 Annual collision mortality estimates for each season. Numbers in brackets represent mortality estimates based on maximum densities but not used in assessments

Species	Breeding Season	BDMPS[1]		
		Autumn Migration	Non-breeding	Spring Migration
Kittiwake	7 (12)	1 (3)	Not applicable[2]	0
Fulmar	0	0	0	0
Gannet	2 (4)	0	Not applicable	0
Great skua	0	0	0	0

[1] Furness (2015) defines species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season.
[2] "Not-applicable" means that the season is not defined as such for a particular species by Furness (2015)

Displacement

'Adult survival at end of the breeding season' is one of the outputs given by SeabORD and is presented in Table B1.2 (kittiwake), Table B2.2 (guillemot), Table B3.2 (razorbill) and Table B4.2 (puffin) of Technical Appendix A.12.4 Marine Ornithology: Displacement Analysis. This is the information then referenced in the main body of the report, noting that there is 100% predicted adult survival for all four species at the end of the breeding season. Possibly this should not have been described as a rate, however, it was clearly stated that it related to the breeding season, not to annual survival.

It is clarified that the 'displacement values' referred to in Table 9.6 of the RIAA are 'displacement mortalities' (estimated numbers of birds killed) as predicted by SeabORD modelling. Note that the figure quoted for guillemot is in relation to a 'good prey year' and not a 'moderate' one.

All SPAs on the long list have been included for assessment under HRA and are reported in the RIAA.

Puffin

The updated PVAs for puffin now include a modelled impact scenario for the PFOWF Array Area plus 2km buffer, please see Error! Reference source not found. and **Table 8** in **Annex C**. Scaling of the puffin displacement mortalities predicted by SeabORD is addressed in **Annex B**.

Offshore Export Cable

Information on the potential duration and location of the cable installation is provided in Chapter 12, with further detail provided in the Project Description (Chapter 5) of the EIA Report.

For the ornithological assessment, as the project programme is not confirmed, an indicative number of days for installation during the bird breeding season was included to allow for the assessment to be carried out. Table 12.19 notes 'the total indicative duration of offshore ops related to the cable-laying will be up to one month between May and August 2025 or 2026 (Q2/Q3)'. Section 12.6.1.1.2 notes 'Horizontal Direction Drill (HDD) commencing in spring/summer 2024 with the cable installation in May or June 2025'.

This represents an indicative time period until greater understanding of the programme is known. Should the project receive consent, further information will be provided within the Construction Environmental Management Plan (CEMP), Cable Plan (CaP) and Cable Burial Risk Assessment (CBRA) for approval.

Due to the weather and sea conditions off the north coast of mainland Scotland, the construction programme is scheduled to only be undertaken in the summer months. This will enable the installation to be carried out as quickly as possible with minimal weather down time.

As the digital aerial survey work did not cover the full extent of the cable corridor and landfall (and the North Caithness Cliff SPA) (see Figure 12.1 and Section 12.4.4.14), monthly vantage point (VP) surveys were undertaken during May to August 2021. This information was used to inform the assessment as detailed in Sections 12.4.4.14, 12.6.1.1 (sub-section 12.6.1.1.2) and 12.6.2.6.2. Key species recorded from the VP survey were noted in section 12.4.4.14 and included kittiwake, guillemot, razorbill, puffin and fulmar, all qualifying interests of the SPA, as well as red-throated diver; European shag, black guillemot and Arctic tern.

The VP report (Jackson, 2022) is provided alongside this letter as EIA/HRA supporting information offered by the Applicant as part of the submission.

Available information on benthic ecology along the offshore cable route has been informed by desk top assessment and by specific site investigation works. The site-specific survey effort is shown in Figure 9.2 of EIA Report Chapter 9 (Benthic Ecology), and the sediment type shown in Figure 9.3. Habitats are also provided in Technical Appendix A.9.1, Environmental Baseline Report, please refer to Figure 14.

As advised in Section 12.6.2.6.2, the main consideration of potential habitat loss along the cable route relates to any required cable protection installed during the operational period of the wind farm and this will be minimised as much as possible, to be addressed in the CaP and CBRA noted above. Section 9.10.2.1 of the RIAA confirms the minimal amount of overall habitat loss associated with the cable where it passes through the SPA, and it is considered that this should not result in any indirect impacts (or population-level consequences) on the SPA seabird interests.

Population Viability Analyses (PVA)

PVA outputs for a 25-year modelled impact period are provided in **Annex C.** Those for a 50-year modelled impact period have been sent directly on to NatureScot for their information.

HRA comments

The comment on SPA conservation objectives (COs) was made solely with reference to the SPA seabird breeding colonies included for assessment, and it is acknowledged that the title for Table 9.3 could have been drafted more clearly to indicate this.

In-combination/cumulative impacts

The NatureScot comments here are noted. As explained in Section 9.10.3.3 of the RIAA, the Hornsea 4 figures (65 kittiwake mortalities) have been modelled in the submitted PVAs for PFOWF (as they were the most recently published figures) and the major discrepancies with Moray West information (as presented Table 9.18) were realised only after the modelling had been completed.

Appendix C: RSPB Requested Information

Annex A: Raw outputs from SeabORD simulations

The following tables present the raw outputs from SeabORD simulations for kittiwake, guillemot, razorbill and puffin. Scaling factors were not applied to guillemot or puffin which had 65% and 167% of the populations included in the simulations respectively.

Applying scaling factors will not impact the additional mortality (%) reported in each table as although the number of mortalities and therefore difference in mortalities between the scenarios will be altered, the population size used to calculate the additional mortality (see below) will also be altered using the same scaling factor.

$$Additional\ mortality\ (\%) = \left(\frac{difference\ in\ mortalities\ between\ scenarios}{Population\ Size}\right) x\ 100$$

Table 1 Estimated impacts of the proposed developments on kittiwake.

Project	SPA/sub-site	Year type	Population size	Baseline mortalities	Scenario mortalities	Difference in mortalities	Additional mortality (%)
Seanse	Forth Islands	Poor	2,798	1,098.70	1,130.50	31.80	1.14
		Moderate		698.40	721.70	23.30	0.83
		Good		418.80	434.90	16.10	0.58
	St. Abbs to Fast Castle	Poor	4,208	1,584.50	1,621.20	36.70	0.87
		Moderate		1,088.60	1,116.60	28.00	0.67
		Good		620.40	640.40	20.00	0.48
	Fowlsheugh	Poor	5,794	2,346.80	2,385.70	38.90	0.67
		Moderate		1,587.00	1,613.10	26.10	0.45
		Good		930.70	950.20	19.50	0.34
	Buchan Ness to Collieston Coast	Poor	6,890	2,660.10	2,665.40	5.30	0.08
		Moderate		1,767.80	1,778.00	10.20	0.15
		Good		1,034.90	1,041.30	6.40	0.09
HiDef	Dunnet Head	Poor	4,040	1,439.40	1,440.30	0.90	0.02
		Moderate		955.80	956.50	0.70	0.00
		Good		517.50	518.10	0.60	0.00
	Duncansby Head	Poor	1,168	423.80	423.70	-0.10	0.00
		Moderate		277.60	277.80	0.20	0.00
		Good		163.20	163.10	-0.10	0.00
	Holburn Head	Poor	110	41.20	41.20	0.00	0.00
		Moderate		22.70	22.70	0.00	0.00
		Good		18.00	18.00	0.00	0.00
	Melvich	Poor	5,554	2,410.80	2,413.70	2.90	0.00
		Moderate		1,633.30	1,634.90	1.60	0.00
		Good		1,039.20	1,040.50	1.30	0.00
	Stroma	Poor	274	102.50	102.50	0.00	0.00
		Moderate		57.00	57.00	0.00	0.00
		Good		36.30	36.30	0.00	0.00

Table 2 Estimated impacts of the proposed developments on guillemot.

Project	SPA/sub-site	Year type	Population size	Baseline mortalities	Scenario mortalities	Difference in mortalities	Additional mortality (%)
Seanse	Forth Islands	Poor	4,618	777.80	798.00	20.20	0.00
		Moderate		366.80	379.50	12.70	0.00
		Good		284.30	290.50	6.20	0.00
	St. Abbs to Fast Castle	Poor	6,442	1,735.80	1,724.0	-11.80	0.00
		Moderate		921.30	912.90	-8.40	0.00
		Good		731.40	720.50	-10.90	0.00
	Fowlsheugh	Poor	8,196	1,853.40	1,891.30	37.90	0.01
		Moderate		945.10	973.00	27.90	0.00
		Good		681.40	695.80	14.40	0.00
	Buchan Ness to Collieston Coast	Poor	4,710	955.60	955.90	0.30	0.00
		Moderate		431.90	432.00	0.10	0.00
		Good		367.20	364.60	-2.60	0.00
HiDef	Dunnet Head	Poor	8,422	1,980.50	1,981.40	0.90	0.00
		Moderate		1,017.40	1,018.30	0.90	0.00
		Good		758.80	760.30	1.50	0.00
	Duncansby Head	Poor	16,734	3,608.70	3,609.60	0.90	0.00
		Moderate		1,766.20	1,767.50	1.30	0.00
		Good		1,454.70	1,455.80	1.10	0.00
	Holburn Head	Poor	434	106.20	106.30	0.10	0.00
		Moderate		53.90	53.70	-0.20	0.00
		Good		43.20	43.20	0.00	0.00
	Melvich	Poor	2,186	604.40	609.00	4.60	0.00
		Moderate		329.80	331.80	2.00	0.00
		Good		274.40	274.90	0.50	0.00
	Stroma	Poor	6,104	1,278.60	1,278.50	-0.10	0.00
		Moderate		644.90	646.10	1.20	0.00
		Good		484.60	485.10	0.50	0.00

Table 3 Estimated impacts of the proposed developments on razorbill.

Project	SPA/sub-site	Year type	Population size	Baseline mortalities	Scenario mortalities	Difference in mortalities	Additional mortality (%)
Seanse	Forth Islands	Poor	8790	1,525.80	1,595.90	70.10	0.01
		Moderate		837.00	877.40	40.40	0.00
		Good		405.40	430.40	25.00	0.00
	St. Abbs to Fast Castle	Poor	4684	1,251.60	1,275.80	24.20	0.01
		Moderate		694.90	718.50	23.60	0.01
		Good		369.50	387.00	17.50	0.00
	Fowlsheugh	Poor	10360	3,144.90	3,268.90	124.00	0.01
		Moderate		1,800.70	1,883.70	83.00	0.01
		Good		983.20	1,040.20	57.00	0.01
HiDef	Dunnet Head	Poor	758	193.30	193.70	0.40	0.00
		Moderate		100.30	100.50	0.20	0.00
		Good		65.40	65.50	0.10	0.00
	Duncansby Head	Poor	2452	571.60	571.40	-0.20	0.00
		Moderate		294.90	295.00	0.10	0.00
		Good		157.90	158.20	0.30	0.00
	Holburn Head	Poor	92	23.90	23.90	0.00	0.00
		Moderate		14.60	14.60	0.00	0.00
		Good		6.70	6.70	0.00	0.00
	Melvich	Poor	820	263.80	264.90	1.10	0.00
		Moderate		144.70	145.50	0.80	0.00
		Good		89.30	90.60	1.30	0.00
	Stroma	Poor	736	162.60	162.20	-0.40	0.00
		Moderate		92.60	92.70	0.10	0.00
		Good		36.60	37.10	0.50	0.00

Table 4 Estimated impacts of the proposed developments on puffin.

Project	SPA/sub-site	Year type	Population size	Baseline mortalities	Scenario mortalities	Difference in mortalities	Additional mortality (%)
Seanse	Forth Islands	Poor	9,0010	17,071.30	17,553.60	482.30	0.01
		Moderate		11,965.60	12,375.00	409.40	0.00
		Good		6,713.30	6,948.50	235.20	0.00
HiDef	Dunnet Head	Poor	2,150	356.70	356.80	0.10	0.00
		Moderate		252.40	252.90	0.50	0.00
		Good		123.70	123.60	-0.10	0.00
	Duncansby Head	Poor	24	0.00	0.00	0.00	0.00
		Moderate		5.00	5.00	0.00	0.00
		Good		1.00	1.00	0.00	0.00
	Holburn Head	Poor	80	16.10	16.10	0.00	0.00
		Moderate		7.00	7.00	0.00	0.00
		Good		4.80	4.80	0.00	0.00
	Melvich	Poor	1,814	378.60	381.20	2.60	0.00
		Moderate		311.70	313.00	1.30	0.00
		Good		157.30	158.20	0.90	0.00
	Stroma	Poor	24	5.40	5.40	0.00	0.00
		Moderate		4.70	4.70	0.00	0.00
		Good		1.00	1.00	0.00	0.00

Table 5 Comparison of the expected mortality rates from Horswill & Robinson (2015) and the outputs generated by SeabORD for kittiwake. All SeabORD values are taken from moderate years and scaled values are calculated using 1/proportion of total population.

Project	SPA/sub-site	Horswill & Robinson (2015)				SeabORD							Difference in baseline mortalities	Difference in baseline mortality rates (%)
		SPA counts (AON)	SPA counts (Individuals)	Expected mortality rate (%)	Expected baseline mortalities	Simulated population (Individuals)	Proportion of total population	Simulated baseline mortalities	Calculated mortality rate (%)	Scaled population	Scaled baseline mortalities	Scaled mortality rate (%)		
Seanse	Forth Islands	2,798	5,596	14.5	811.42	2,798	0.30	698.40	24.96	9,327	2,328.00	24.96	1,516.58	10.46
	Fowlsheugh	4,208	8,416	14.5	1,220.32	4,208	0.30	1,088.60	25.87	14,027	3,628.67	25.87	2,408.35	11.37
	St. Abbs Head to Fast Castle	5,794	11,588	14.5	1,680.26	5,794	0.30	1,587.00	27.39	19,313	5,290.00	27.39	3,609.74	12.89
	Buchan Ness to Collieston Coast	6,890	13,780	14.5	1,998.10	6,890	0.30	1,767.80	25.66	22,967	5,892.67	25.66	3,894.57	11.16
HiDef	Dunnet Head	2,020	4,040	14.5	585.80	4,040	1.00	1,439.40	35.63	4,040	1,439.40	35.63	853.60	21.13
	Duncansby Bay	584	1,168	14.5	169.36	1,168	1.00	423.80	36.28	1,168	423.80	36.28	254.44	21.78
	Holburn Head	55	110	14.5	15.95	110	1.00	41.20	37.45	110	41.20	37.45	25.25	22.95
	Melvich	2,777	5,554	14.5	805.33	5,554	1.00	2,410.80	43.41	5,554	2,410.80	43.41	1,605.47	28.91
	Stroma	137	274	14.5	39.73	274	1.00	102.50	37.41	274	102.50	37.41	62.77	22.91

Table 6 Comparison of the expected mortality rates from Horswill & Robinson (2015) and the outputs generated by SeabORD for guillemot. All SeabORD values are taken from moderate years and scaled values are calculated using 1/proportion of total population.

Project	SPA/sub-site	Horswill & Robinson (2015)			SeabORD							Difference in baseline mortalities	Difference in baseline mortality rates (%)
		SPA counts (Individuals)	Expected mortality rate (%)	Expected baseline mortalities	Simulated population (Individuals)	Proportion of total population	Simulated baseline mortalities	Calculated mortality rate (%)	Scaled population	Scaled baseline mortalities	Scaled mortality rate (%)		
Seanse	Forth Islands	46,180	7.3	3371.14	4,618	0.10	366.80	7.94	46,180	3668.00	7.94	296.86	0.64
	Fowlsheugh	64,420	7.3	4702.66	6,442	0.10	921.30	14.30	64,420	9213.00	14.30	4510.34	7.00
	St. Abbs Head to Fast Castle	81,960	7.3	5983.08	8,196	0.10	945.10	11.53	81,960	9451.00	11.53	3467.92	4.23
	Buchan Ness to Collieston Coast	47,100	7.3	3438.30	4,710	0.10	431.90	9.17	47,100	4319.00	9.17	880.70	1.87
HiDef	Dunnet Head	9,669	7.3	705.84	8,422	0.65	1017.40	12.08	12,957	1565.23	12.08	859.39	4.78
	Duncansby Bay	19,212	7.3	1402.48	16,734	0.65	1766.20	10.55	25,745	2717.23	10.55	1314.75	3.25
	Holburn Head	499	7.3	36.43	434	0.65	53.90	12.42	668	82.92	12.42	46.50	5.12
	Melvich	2,510	7.3	183.23	2,186	0.65	329.80	15.09	3,363	507.38	15.09	324.15	7.79
	Stroma	7,008	7.3	511.58	6,104	0.65	644.90	10.57	9,391	992.15	10.57	480.57	3.27

Table 7 Comparison of the expected mortality rates from Horswill & Robinson (2015) and the outputs generated by SeabORD for razorbill. All SeabORD values are taken from moderate years.

Project	SPA/sub-site	Horswill & Robinson (2015)			SeabORD				Difference in baseline mortalities	Difference in baseline mortality rates (%)
		SPA counts (individuals)	Expected mortality rate (%)	Expected baseline mortalities	Simulation population (individuals)	Proportion of total population	Simulated baseline mortalities	Estimated mortality rate (%)		
Seanse	Forth Islands	8,790	9	791.10	8,790	1.00	837.00	9.52	45.90	0.52
	Fowlsheugh	4,684	9	421.56	4,684	1.00	694.90	14.84	273.34	5.84
	St. Abbs Head to Fast Castle	10,360	9	932.40	10,360	1.00	1,800.70	17.38	868.30	8.38
HiDef	Dunnet Head	565	9	50.85	758	1.00	100.50	13.26	49.65	4.26
	Duncansby Bay	1,815	9	163.35	2,452	1.00	295.00	12.03	131.65	3.03
	Holburn Head	68	9	6.12	92	1.00	14.60	15.87	8.48	6.87
	Melvich	612	9	55.08	820	1.00	144.70	17.65	89.62	8.65

Project	SPA/sub-site	Horswill & Robinson (2015)			SeabORD				Difference in baseline mortalities	Difference in baseline mortality rates (%)
		SPA counts (individuals)	Expected mortality rate (%)	Expected baseline mortalities	Simulation population (individuals)	Proportion of total population	Simulated baseline mortalities	Estimated mortality rate (%)		
	Stroma	549	9	49.41	736	1.00	92.70	12.60	43.29	3.60

Table 8 Comparison of the expected mortality rates from Horswill & Robinson (2015) and the outputs generated by SeabORD for puffin. All SeabORD values are taken from moderate years.

Project	SPA/sub-site	Horswill & Robinson (2015)				SeabORD							Difference in baseline mortalities	Difference in baseline mortality rates (%)
		SPA counts (pairs)	SPA counts (individuals)	Expected mortality rate (%)	Expected baseline mortalities	Simulated population (Individuals)	Proportion of total population	Simulated baseline mortalities	Calculated mortality rate (%)	Scaled population	Scaled baseline mortalities	Scaled mortality rate (%)		
Seanse	Forth Islands	NA	90,010	9.00	8,100.90	90,010.00	1.00	17,071.30	18.97	90,010	17,071.30	18.97	8,970.40	9.97
HiDef	Dunnet Head	1,604	3,208	9.00	288.72	2,150.00	0.67	252.40	11.74	3,209	376.72	11.74	88.00	2.74
	Duncansby Bay	18	36	9.00	3.24	24.00	0.67	5.00	20.83	36	7.46	20.83	4.22	11.83
	Holburn Head	60	120	9.00	10.80	80.00	0.67	7.00	8.75	119	10.45	8.75	-0.35	-0.25
	Melvich	1,354	2,708	9.00	243.72	1,814.00	0.67	190.20	10.49	2,707	283.88	10.49	40.16	1.49
	Stroma	17	34	9.00	3.06	24.00	0.70	4.70	19.58	34	6.71	19.58	3.65	10.58

Annex B: Displacement Matrix PVA for RSPB

KITTIWAKE

Table 1 **PFOWF and Moray Firth kittiwake displacement mortalities, breeding, Moray Firth from Moray West EIA Addendum (Table 3.23) (MOWWL, 2018b)**

Wind Farms	Kittiwake MSPs	Kittiwake displacement mortalities			MS breeding apportioning weightings for NCC	Kittiwake displacement mortalities apportioned against NCC		
		30% / 1%	30% / 2%	30% / 3%		30% / 1%	30% / 2%	30% / 3%
PFOWF	546	2	3	5	0.717	1.43	2.15	3.59
Moray West	6,902	21	41~	62	0.015	0.32	0.62	0.93
Moray East	*4,000**	12	24	36	0.023	0.28	0.55	0.83
Beatrice	*2,167**	7	13	20	0.026	0.18	0.34	0.52
					Moray Firth total	0.77	1.51	2.28

**As noted in paragraphs 11 and 12 of Annex A of Technical Appendix 12.5 Marine Ornithology: Population Modelling, it has not been possible to establish from the Moray West submission (MOWWL, 2018a; 2018b) what calculations were carried out to estimate kittiwake displacement mortalities arising from Moray East or Beatrice, as apportioned to North Caithness Cliffs SPA. In this regard, mean seasonal peak (MSP) estimates of kittiwake are not readily available for Moray East or for Beatrice, instead the figures noted in Table 1 above (presented in italics because they are uncertain) are a back calculation from Table 3.23 in the Moray West EIA Addendum (MOWWL, 2018b).*

~41 kittiwake is the correct figure here; the 83 presented in Technical Appendix A.12.5 was a mistake (typo/oversight).

Table 2 PFOWF kittiwake displacement mortalities, non-breeding

Wind Farms	Kittiwake MSPs	Kittiwake displacement mortalities			MS non-breeding apportioning weightings for NCC	Kittiwake displacement mortalities apportioned against NCC		
		30% / 1%	30% / 2%	30% / 3%		30% / 1%	30% / 2%	30% / 3%
PFOWF	5,568	0	1	1	0.023	0	0.02	0.02

Please note that it was not possible to ascertain any figures for non-breeding kittiwake displacement mortalities for Moray Firth wind farms from the Environmental Statement (ES) or other information submitted for Moray West.

Kittiwake collision mortality estimates

For PFOWF, these are taken from TA:12.3 Marine Ornithology: Collision Risk Modelling (CRM), and for Moray Firth, they are taken from TA:12.5 Marine Ornithology: Population Modelling.

As the modelling has been re-run for RSPB, the opportunity has been taken to model a scenario of an estimated 45 kittiwake collision mortalities in the non-breeding season (scenario 7 below). This is the cumulative total for other North Sea wind farms in the non-breeding season as presented in the Moray West ES and discussed in section 9.10.3.3 of the Report to Inform Appropriate Assessment (it compares to a figure of 65 birds used in the original PVAs which was based on information given in the Hornsea project four ES (Orsted, 2021).

PFOWF CRM mean densities (apportioned to NCC): breeding 5.02, non-breeding 0.02 = **5.04** kittiwake mortalities

Moray Firth CRM mean densities (apportioned to NCC), breeding: 4.65, non-breeding 2.70 = **7.35** kittiwake mortalities

Kittiwake age-class apportioning

As noted in paragraph 8 of Annex A of Technical Appendix 12.5 Marine Ornithology: Population Modelling, the kittiwake breeding season age-class proportion is based on that observed during survey work (0.95 adults / 0.05 immatures), while the non-breeding season proportion is derived from a stable-age population model using the NE PVA tool (0.55 adults / 0.45 immatures).

Table 3 Modelled impact scenarios for kittiwake

Scenario	Impacts modelled *(annual impacts, displacement and collision risk)*	Absolute mortalities[1]			Relative mortality rates[2]	
		Total	Adults	Immatures	Adults	Immatures
1	PFOWF (matrix 30% / 1%) and mean density CRM	6.47	6.15	0.32	0.69×10^{-3}	0.04×10^{-3}
2	PFOWF (matrix 30% / 2%) and mean density CRM	7.21	6.84	0.37	0.77×10^{-3}	0.05×10^{-3}
3	PFOWF (matrix 30% / 3%) and mean density CRM	8.58	8.21	0.44	0.92×10^{-3}	0.06×10^{-3}
4	PFOWF (matrix 30% / 1%) and mean density CRM; Moray Firth (matrix 30% / 1%) and mean density CRM	14.59	12.79	1.80	1.44×10^{-3}	0.25×10^{-3}
5	PFOWF (matrix 30% / 2%) and mean density CRM; Moray Firth (matrix 30% / 2%) and mean density CRM	16.07	14.18	1.89	1.60×10^{-3}	0.26×10^{-3}
6	PFOWF (matrix 30% / 3%) and mean density CRM; Moray Firth (matrix 30% / 3%) and mean density CRM	18.28	16.29	1.99	1.83×10^{-3}	0.28×10^{-3}
7	North Sea wind farm mean density CRM non-breeding (excluding PFOWF and Moray Firth). Figures from Moray West ES.	45	24.75	20.25	2.80×10^{-3}	2.80×10^{-3}

1. *Absolute mortalities = estimated annual number of bird mortalities.*
2. *Relative mortality rates = absolute mortalities as a proportion of the 2027 baseline adult and immature North Caithness Cliffs SPA population estimates*

PENTLAND FLOATING OFFSHORE WIND FARM

Table 4 Metrics and counterfactuals (with 95% Confidence Intervals (CI)) for 5,000 simulations of the kittiwake PVA over 25, 30 and 50 years

Kittiwake scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
25 year					
1 - PFOWF (matrix 30% / 1%)[1] and mean density CRM	0.69×10^{-3}	0.04×10^{-3}	3,917	0.999 *(0.997-1.000)*	0.986 *(0.910-1.070)*
2 - PFOWF (matrix 30% / 2%) and mean density CRM	0.77×10^{-3}	0.05×10^{-3}	3,899	0.999 *(0.996-1.000)*	0.983 *(0.908-1.060)*
3 - PFOWF (matrix 30% / 3%) and mean density CRM	0.92×10^{-3}	0.06×10^{-3}	3,893	0.999 *(0.996-1.000)*	0.980 *(0.907-1.060)*
4 - PFOWF (matrix 30% / 1%) and mean density CRM; Moray Firth (matrix 30% / 1%) and mean density CRM	1.44×10^{-3}	0.25×10^{-3}	3,826	0.999 *(0.996-1.000)*	0.968 *(0.895-1.050)*
5 - PFOWF (matrix 30% / 2%) and mean density CRM; Moray Firth (matrix 30% / 2%) and mean density CRM	1.60×10^{-3}	0.26×10^{-3}	3,813	0.999 *(0.996-1.000)*	0.964 *(0.891-1.040)*
6 - PFOWF (matrix 30% / 3%) and mean density CRM; Moray Firth (matrix 30% / 3%) and mean density CRM	1.83×10^{-3}	0.28×10^{-3}	3,793	0.998 *(0.996-1.000)*	0.960 *(0.887-1.040)*
7 - North Sea wind farm mean density CRM non-breeding (excluding PFOWF and Moray Firth). Figures from Moray West ES.	2.80×10^{-3}	2.80×10^{-3}	3,606	0.997 *(0.994-0.999)*	0.914 *(0.842-0.988)*
30 year					
1 - PFOWF (matrix 30% / 1%)[1] and mean density CRM	0.69×10^{-3}	0.04×10^{-3}	3,331	0.999 *(0.997-1.000)*	0.984 *(0.899-1.080)*
2 - PFOWF (matrix 30% / 2%) and mean density CRM	0.77×10^{-3}	0.05×10^{-3}	3,311	0.999	0.979

Kittiwake scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
				(0.997-1.000)	*(0.897-1.070)*
3 - PFOWF (matrix 30% / 3%) and mean density CRM	0.92 x 10^{-3}	0.06 x 10^{-3}	3,329	0.999 *(0.997-1.000)*	0.977 *(0894-1.070)*
4 - PFOWF (matrix 30% / 1%) and mean density CRM; Moray Firth (matrix 30% / 1%) and mean density CRM	1.44 x 10^{-3}	0.25 x 10^{-3}	3,246	0.999 *(0.996-1.000)*	0.963 *(0.879-1.050)*
5 - PFOWF (matrix 30% / 2%) and mean density CRM; Moray Firth (matrix 30% / 2%) and mean density CRM	1.60 x 10^{-3}	0.26 x 10^{-3}	3,225	0.999 *(0.996-1.000)*	0.958 *(0.876-1.050)*
6 - PFOWF (matrix 30% / 3%) and mean density CRM; Moray Firth (matrix 30% / 3%) and mean density CRM	1.83 x 10^{-3}	0.28 x 10^{-3}	3,222	0.998 *(0.996-1.000)*	0.953 *(0.872-1.040)*
7 - North Sea wind farm mean density CRM non-breeding (excluding PFOWF and Moray Firth). Figures from Moray West ES.	2.80 x 10^{-3}	2.80 x 10^{-3}	3,040	0.997 *(0.994-0.999)*	0.898 *(0.820-0.982)*
50 year					
1 - PFOWF (matrix 30% / 1%)[1] and mean density CRM	0.69 x 10^{-3}	0.04 x 10^{-3}	1,749	0.999 *(0.997-1.000)*	0.972 *(0.851-1.110)*
2 - PFOWF (matrix 30% / 2%) and mean density CRM	0.77 x 10^{-3}	0.05 x 10^{-3}	1,755	0.999 *(0.997-1.000)*	0.967 *(0.842-1.110)*
3 - PFOWF (matrix 30% / 3%) and mean density CRM	0.92 x 10^{-3}	0.06 x 10^{-3}	1,738	0.999 *(0.997-1.000)*	0.962 *(0.832-1.100)*
4 - PFOWF (matrix 30% / 1%) and mean density CRM; Moray Firth (matrix 30% / 1%) and mean density CRM	1.44 x 10^{-3}	0.25 x 10^{-3}	1,703	0.999 *(0.996-1.000)*	0.940 *(0.815-1.080)*
5 - PFOWF (matrix 30% / 2%) and mean density CRM; Moray Firth (matrix 30% / 2%) and mean density CRM	1.60 x 10^{-3}	0.26 x 10^{-3}	1,687	0.999 *(0.996-1.000)*	0.933 *(0.817-1.070)*

Kittiwake scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
6 - PFOWF (matrix 30% / 3%) and mean density CRM; Moray Firth (matrix 30% / 3%) and mean density CRM	1.83×10^{-3}	0.28×10^{-3}	1,662	0.998 *(0.996-1.000)*	0.924 *(0.805-1.070)*
7 - North Sea wind farm mean density CRM non-breeding (excluding PFOWF and Moray Firth). Figures from Moray West ES.	2.80×10^{-3}	2.80×10^{-3}	1,516	0.997 *(0.994-0.999)*	0.838 *(0.727-0.960)*

[1] CGR = Counterfactual Growth Rate.
[2] CPS = Counterfactual Population Size

GUILLEMOT

Table 5 Guillemot displacement mortalities, breeding

Wind Farms	Guillemot MSPs breeding	Guillemot displacement mortalities			MS breeding apportioning weightings for NCC	Guillemot displacement mortalities apportioned against NCC		
		60% / 1%	60% / 3%	60% / 5%		60% / 1%	60% / 3%	60% / 5%
PFOWF	1,146	7	21	34	0.695	4.87	14.60	23.63
Moray West	24,426	146.56	439.67	732.78	0.029	4.25	12.75	21.25
Moray East	*9,820*	58.92	176.76	294.6	0.051	3.00	9.01	15.02
Beatrice	*13,610*	81.66	244.98	408.30	0.051	4.16	12.49	20.82
					Moray Firth total	11.41	34.25	57.09

Table 6 Guillemot displacement mortalities, non-breeding

Wind Farms	Guillemot MSPs non-breeding	Guillemot displacement mortalities		MS non-breeding apportioning weightings for NCC	Guillemot displacement mortalities apportioned against NCC	
		60% / 1%	60% / 3%		60% / 1%	60% / 3%
PFOWF	650	4	12	0.159	0.64	1.91
Moray West	38,174	229.04	687.13	0.041	9.32	27.95
Moray East	*1,245*	7.47	22.41	0.041	0.31	0.92
Beatrice	*2,755*	16.53	49.59	0.041	0.67	2.02
				Moray Firth total	10.30	30.89

Guillemot age-class apportioning

As noted in paragraph 29 of Annex A of Technical Appendix:12.5 Marine Ornithology: Population Modelling, the proportion of adults to immatures for guillemot (both breeding and non-breeding season) is derived from a stable-age population model using the NE PVA tool, a proportion of 0.52 adults / 0.48 immatures.

Table 7 Modelled impact scenarios for guillemot

Scenario	Impacts modelled *(annual impacts, displacement)*	Absolute mortalities[1]			Relative mortality rates[2]	
		Total	Adults	Immatures	Adults	Immatures
1	PFOWF (matrix 60% / 1% breeding, 1% non-breeding)	5.51	2.86	2.65	0.05×10^{-3}	0.05×10^{-3}
2	PFOWF (matrix 60% / 3% breeding, 1% non-breeding)	15.24	7.92	7.31	0.15×10^{-3}	0.15×10^{-3}
3	PFOWF (matrix 60% / 3% breeding, 3% non-breeding)	16.51	8.58	7.92	0.16×10^{-3}	0.16×10^{-3}
4	PFOWF (matrix 60% / 5% breeding, 3% non-breeding)	25.54	13.28	12.26	0.25×10^{-3}	0.25×10^{-3}
5	Moray Firth (matrix 60% / 3%, breeding, 3% non-breeding)	65.14	33.87	31.27	0.63×10^{-3}	0.63×10^{-3}
6	Moray Firth (matrix 60% / 5%, breeding, 3% non-breeding)	87.98	45.75	42.23	0.85×10^{-3}	0.85×10^{-3}
7	PFOWF and Moray Firth (matrix 60% / 1%, breeding, 1% non-breeding)	27.22	14.15	13.07	0.26×10^{-3}	0.26×10^{-3}
8	PFOWF and Moray Firth (matrix 60% / 3%, breeding, 3% non-breeding)	81.65	42.46	39.19	0.79×10^{-3}	0.79×10^{-3}

1. *Absolute mortalities = estimated annual number of bird mortalities.*
2. *Relative mortality rates = absolute mortalities as a proportion of the 2027 baseline adult and immature North Caithness Cliffs SPA population estimates*

Table 8 Metrics and counterfactuals (with 95% CI) for 5,000 simulations of the guillemot PVA over 25, 30 and 50 years

Guillemot scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
25 year					
1 - PFOWF (60% / 1% breeding, 1% non-breeding)	0.05×10^{-3}	0.05×10^{-3}	113,965	1.000 *(0.999-1.000)*	0.998 *(0.983-1.010)*
2 - PFOWF (60% / 3% breeding, 1% non-breeding)	0.15×10^{-3}	0.15×10^{-3}	113,725	1.000 *(0.999-1.000)*	0.996 *(0.980-1.010)*
3 - PFOWF (60% / 3% breeding, 3% non-breeding)	0.16×10^{-3}	0.16×10^{-3}	113,619	1.000 *(0.999-1.000)*	0.995 *(0.980-1.010)*
4 - PFOWF (60% / 5% breeding, 3% non-breeding)	0.25×10^{-3}	0.25×10^{-3}	113,386	1.000 *(0.999-1.000)*	0.993 *(0.978-1.010)*
5 - Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.63×10^{-3}	0.63×10^{-3}	112,064	0.999 *(0.999-1.000)*	0.982 *(0.967-0.997)*
6 - Moray Firth (60% / 5%, breeding, 3% non-breeding)	0.85×10^{-3}	0.85×10^{-3}	111,365	0.999 *(0.999-1.000)*	0.976 *(0.960-0.991)*
7 - PFOWF and Moray Firth (60% / 1%, breeding, 1% non-breeding)	0.26×10^{-3}	0.26×10^{-3}	113,429	1.000 *(0.999-1.000)*	0.992 *(0.977-1.010)*
8 - PFOWF and Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.79×10^{-3}	0.79×10^{-3}	111,606	0.999 *(0.999-1.000)*	0.977 *(0.962-0.992)*
30 year					
1 - PFOWF (60% / 1% breeding, 1% non-breeding)	0.05×10^{-3}	0.05×10^{-3}	133,480	1.000	0.998

PENTLAND FLOATING OFFSHORE WIND FARM

Guillemot scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
				(0.999-1.000)	*(0.982-1.010)*
2 - PFOWF (60% / 3% breeding, 1% non-breeding)	0.15 x 10^{-3}	0.15 x 10^{-3}	132,850	1.000 *(0.999-1.000)*	0.995 *(0.979-1.010)*
3 - PFOWF (60% / 3% breeding, 3% non-breeding)	0.16 x 10^{-3}	0.16 x 10^{-3}	132,773	1.000 *(0.999-1.000)*	0.994 *(0.978-1.010)*
4 - PFOWF (60% / 5% breeding, 3% non-breeding)	0.25 x 10^{-3}	0.25 x 10^{-3}	132,351	1.000 *(0.999-1.000)*	0.992 *(0.976-1.010)*
5 - Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.63 x 10^{-3}	0.63 x 10^{-3}	130,632	0.999 *(0.999-1.000)*	0.978 *(0.963-0.994)*
6 - Moray Firth (60% / 5%, breeding, 3% non-breeding)	0.85 x 10^{-3}	0.85 x 10^{-3}	129,787	0.999 *(0.999-1.000)*	0.971 *(0.955-0.987)*
7 - PFOWF and Moray Firth (60% / 1%, breeding, 1% non-breeding)	0.26 x 10^{-3}	0.26 x 10^{-3}	132,383	1.000 *(0.999-1.000)*	0.991 *(0.975-1.010)*
8 - PFOWF and Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.79 x 10^{-3}	0.79 x 10^{-3}	129,998	0.999 *(0.999-1.000)*	0.973 *(0.958-0.989)*
50 year					
1 - PFOWF (60% / 1% breeding, 1% non-breeding)	0.05 x 10^{-3}	0.05 x 10^{-3}	241,522	1.000 *(1.000-1.000)*	0.997 *(0.980-1.010)*
2 - PFOWF (60% / 3% breeding, 1% non-breeding)	0.15 x 10^{-3}	0.15 x 10^{-3}	239,934	1.000 *(1.000-1.000)*	0.992 *(0.974-1.010)*
3 - PFOWF (60% / 3% breeding, 3% non-breeding)	0.16 x 10^{-3}	0.16 x 10^{-3}	239,559	1.000 *(1.000-1.000)*	0.991 *(0.973-1.010)*

Guillemot scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
4 - PFOWF (60% / 5% breeding, 3% non-breeding)	0.25×10^{-3}	0.25×10^{-3}	238,850	1.000 *(0.999-1.000)*	0.986 *(0.969-1.000)*
5 - Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.63×10^{-3}	0.63×10^{-3}	233,423	0.999 *(0.999-1.000)*	0.965 *(0.948-0.982)*
6 - Moray Firth (60% / 5%, breeding, 3% non-breeding)	0.85×10^{-3}	0.85×10^{-3}	230,532	0.999 *(0.999-0.999)*	0.953 *(0.936-0.970)*
7 - PFOWF and Moray Firth (60% / 1%, breeding, 1% non-breeding)	0.26×10^{-3}	0.26×10^{-3}	238,175	1.000 *(0.999-1.000)*	0.985 *(0.968-1.000)*
8 - PFOWF and Moray Firth (60% / 3%, breeding, 3% non-breeding)	0.79×10^{-3}	0.79×10^{-3}	231,208	0.999 *(0.999-0.999)*	0.956 *(0.939-0.973)*

[1] *CGR = Counterfactual Growth Rate*
[2] *CPS = Counterfactual Population Size.*

PUFFIN

Table 9 PFOWF and Moray Firth puffin displacement mortalities, breeding, Moray Firth taken from Moray West RIAA (MOWWL, 2018c)

Wind Farms	Puffin MSP	Puffin displacement mortalities			MS breeding apportioning weightings for NCC	Puffin displacement mortalities apportioned against NCC		
		60% / 1%	60% / 3%	60% / 5%		60% / 1%	60% / 3%	60% / 5%
PFOWF area	1,211	7	22	36	0.698	4.89*	15.36	25.13
PFOWF area + 2km buffer	6,521	39	117	196	0.698	27.22	81.67	136.81
Moray West	1,115	-	20.07	33.45	0.148	-	2.97	4.95
Moray East	2,795	-	50.31	83.85	0.775	-	38.99	64.98
Beatrice	2,858	-	51.44	85.74	0.346	-	17.80	29.67
					Moray Firth total	-	59.36	99.74

** Please note that this figure (4.89) is derived from applying the NCC apportioning weighting (0.698) to the rounded displacement matrix estimate of 7 puffin mortalities. If the NCC apportioning weighting is applied to the unrounded matrix figure of 7.27 it gives an apportioned estimate of 5.07 puffin mortalities, as previously modelled (puffin scenario 2, section A3.1 of TA:12.5 Marine Ornithology: Population Modelling).*

Puffin age-class apportioning

As noted in paragraph 37 of Annex A of TA:12.5 Marine Ornithology: Population Modelling, the proportion of adults to immatures for puffin (both breeding and non-breeding season) is derived from a stable-age population model using the PVA tool, a proportion of 0.53 adults / 0.47 immatures.

Table 10.10 Modelled impact scenarios for puffin

Scenario	Impacts modelled *(annual impacts, displacement and collision risk)*	Absolute mortalities[1]			Relative mortality rates[2]	
		Total	Adults	Immatures	Adults	Immatures
1	PFOWF Array Area (matrix 60% / 1%, breeding)	4.89	2.59	2.30	1.08×10^{-3}	1.08×10^{-3}
2	PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	27.22	14.43	12.79	6.02×10^{-3}	6.02×10^{-3}
3	PFOWF Array Area (matrix 60% / 3%, breeding)	15.36	8.14	7.22	3.40×10^{-3}	3.40×10^{-3}
4	PFOWF Array Area + 2km buffer (matrix 60% / 3%, breeding)	81.67	43.29	38.38	18.06×10^{-3}	18.06×10^{-3}
5	PFOWF Array Area (matrix 60% / 5%, breeding)	25.16	13.33	11.83	5.56×10^{-3}	5.56×10^{-3}
6	PFOWF Array Area + 2km buffer (matrix 60% / 5%, breeding)	136.81	72.51	64.30	30.25×10^{-3}	30.25×10^{-3}
7	Moray Firth (matrix 60% / 3%, breeding)	59.76	31.66	28.09	13.12×10^{-3}	13.12×10^{-3}
8	Moray Firth (matrix 60% / 5%, breeding)	99.60	52.79	46.81	22.02×10^{-3}	22.02×10^{-3}

3. *Absolute mortalities = estimated annual number of bird mortalities.*
4. *Relative mortality rates = absolute mortalities as a proportion of the 2027 baseline adult and immature North Caithness Cliffs SPA population estimates*

Table 11 Metrics and counterfactuals (with 95% CI) for 5,000 simulations of the puffin PVA over 25, 30 and 50 years

Puffin scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
25 year					
1 - PFOWF Array Area (matrix 60% / 1%, breeding)	1.08×10^{-3}	1.08×10^{-3}	1,309	0.999 *(0.994-1.000)*	0.967 *(0.854-1.090)*
2 - PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	6.02×10^{-3}	6.02×10^{-3}	1,122	0.993 *(0.988-0.997)*	0.830 *(0.732-0.939)*
3 - PFOWF Array Area (matrix 60% / 3%, breeding)	3.40×10^{-3}	3.40×10^{-3}	1,222	0.996 *(0.992-1.000)*	0.902 *(0.793-1.020)*
4 - PFOWF Array Area + 2km buffer (matrix 60% / 3%, breeding)	18.06×10^{-3}	18.06×10^{-3}	774	0.979 *(0.974-0.983)*	0.573 *(0.496-0.650)*
5 - PFOWF Array Area (matrix 60% / 5%, breeding)	5.56×10^{-3}	5.56×10^{-3}	1,142	0.993 *(0.989-0.998)*	0.843 *(0.741-0.954)*
6 - PFOWF Array Area + 2km buffer (matrix 60% / 5%, breeding)	30.25×10^{-3}	30.25×10^{-3}	526	0.964 *(0.959-0.969)*	0.389 *(0.331-0.448)*
7 - Moray Firth (matrix 60% / 3%, breeding)	13.21×10^{-3}	13.21×10^{-3}	902	0.984 *(0.980-0.989)*	0.665 *(0.583-0.756)*
8 - Moray Firth (matrix 60% / 5%, breeding)	22.02×10^{-3}	22.02×10^{-3}	682	0.974 *(0.969-0.979)*	0.505 *(0.435-0.578)*
30 year					
1 - PFOWF Array Area (matrix 60% / 1%, breeding)	1.08×10^{-3}	1.08×10^{-3}	1,150	0.999 *(0.994-1.000)*	0.962 *(0.835-1.100)*

Puffin scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
2 - PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	6.02×10^{-3}	6.02×10^{-3}	962	0.993 *(0.989-0.997)*	0.802 *(0.696-0.919)*
3 - PFOWF Array Area (matrix 60% / 3%, breeding)	3.40×10^{-3}	3.40×10^{-3}	1,054	0.996 *(0.992-1.000)*	0.884 *(0.765-1.010)*
4 - PFOWF Array Area + 2km buffer (matrix 60% / 3%, breeding)	18.06×10^{-3}	18.06×10^{-3}	617	0.979 *(0.974-0.983)*	0.515 *(0.437-0.593)*
5 - PFOWF Array Area (matrix 60% / 5%, breeding)	5.56×10^{-3}	5.56×10^{-3}	980	0.993 *(0.989-0.998)*	0.816 *(0.705-0.940)*
6 - PFOWF Array Area + 2km buffer (matrix 60% / 5%, breeding)	30.25×10^{-3}	30.25×10^{-3}	388	0.964 *(0.959-0.969)*	0.325 *(0.269-0.381)*
7 - Moray Firth (matrix 60% / 3%, breeding)	13.21×10^{-3}	13.21×10^{-3}	735	0.984 *(0.980-0.989)*	0.616 *(0.528-0.707)*
8 - Moray Firth (matrix 60% / 5%, breeding)	22.02×10^{-3}	22.02×10^{-3}	531	0.974 *(0.969-0.979)*	0.442 *(0.371-0.516)*
50 year					
1 - PFOWF Array Area (matrix 60% / 1%, breeding)	1.08×10^{-3}	1.08×10^{-3}	716	0.999 *(0.995-1.000)*	0.936 *(0.766-1.140)*
2 - PFOWF Array Area + 2km buffer (matrix 60% / 1%, breeding)	6.02×10^{-3}	6.02×10^{-3}	527	0.993 *(0.989-0.997)*	0.694 *(0.561-0.857)*
3 - PFOWF Array Area (matrix 60% / 3%, breeding)	3.40×10^{-3}	3.40×10^{-3}	623	0.996 *(0.992-1.000)*	0.815 *(0.665-0.994)*
4 - PFOWF Array Area + 2km buffer (matrix 60% / 3%, breeding)	18.06×10^{-3}	18.06×10^{-3}	254	0.979 *(0.974-0.983)*	0.334 *(0.257-0.419)*

Puffin scenarios	Mortality - relative rate		Median pop. size at end of model period (adult individuals)	Median counterfactuals	
	Adult	Immature		CGR[1] (95% CIs)	CPS[2] (95% CIs)
5 - PFOWF Array Area (matrix 60% / 5%, breeding)	5.56×10^{-3}	5.56×10^{-3}	545	0.993 *(0.990-0.997)*	0.714 *(0.581-0.877)*
6 - PFOWF Array Area + 2km buffer (matrix 60% / 5%, breeding)	30.25×10^{-3}	30.25×10^{-3}	119	0.964 *(0.958-0.970)*	0.156 *(0.110-0.208)*
7 - Moray Firth (matrix 60% / 3%, breeding)	13.21×10^{-3}	13.21×10^{-3}	344	0.984 *(0.980-0.988)*	0.448 *(0.354-0.560)*
8 - Moray Firth (matrix 60% / 5%, breeding)	22.02×10^{-3}	22.02×10^{-3}	197	0.974 *(0.968-0.979)*	0.260 *(0.193-0.336)*
[1] *CGR = Counterfactual Growth Rate.* [2] *CPS = Counterfactual Population Size.*					

Appendix D: SEPA Requested Information

Annex A: Analysis of Sediment Samples for the 'Dounreay Fingerprint'

Analysis of Sediment Samples

Document No.	GBPNTD-ENV-STC-RP-00001
Contractor No.	21-0722
Project:	Pentland Floating Offshore Windfarm
Originator Company	Socotec
Revision	01
Author	Kiran Bala
Date	14.11.2022

Revision History:

Revision	Date	Status	Author	Reviewed	Approved
01	14.11.2022	For Information	KIB	JAH	JAH



Analysis of Sediment Samples

Client:	Rob Cooke BSc (Hons) PhD FMinSoc, Principal Geologist In Situ site investigation Unit 17 Hastings Innovation Centre, HIghfield Drive, St Leonards on Sea, East Sussex, TN38 9UH, U.K.
Testing Facility:	SOCOTEC UK Unit 12, Moorbrook Southmead Industrial Park Didcot Oxfordshire OX11 7HP
Laboratory Reference:	21-0722
Customer Reference:	MAR01069
Quote Number:	ENR-ANU-10156Rev1
PO Number:	M1210107
Sample Received:	21 July 2021
Sample Condition:	Satisfactory; Ambient
Analysis Completed:	11 August 2021
Report Author:	[redacted]
Author's Name:	Kiran Bala
Job Title:	Analyst
Approved By:	[redacted]
Approver's name:	Jasper Hattink
Job Title:	Technical and commercial manager
Report Date:	14 November 2022

Revision 1 reports a larger set of radionuclides against a gamma spectrometry library including artificial radionuclides such as 137Cs, 241Am, 60Co. This report supersedes the previous versions.

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Sample Summary

Customer Reference	Laboratory Reference	Matrix	Sampling Date
MAR01069.001	NA5203	Sediment	21/07/2021 12:00
MAR01069.002	NA5204	Sediment	21/07/2021 12:00
MAR01069.003	NA5205	Sediment	21/07/2021 12:00
MAR01069.004	NA5206	Sediment	21/07/2021 12:00
MAR01069.005	NA5207	Sediment	21/07/2021 12:00
MAR01069.006	NA5208	Sediment	21/07/2021 12:00
MAR01069.007	NA5209	Sediment	21/07/2021 12:00
MAR01069.008	NA5210	Sediment	21/07/2021 12:00
MAR01069.009	NA5211	Sediment	21/07/2021 12:00
MAR01069.010	NA5212	Sediment	21/07/2021 12:00
MAR01069.011	NA5213	Sediment	21/07/2021 12:00
MAR01069.012	NA5214	Sediment	21/07/2021 12:00
MAR01069.013	NA5215	Sediment	21/07/2021 12:00
MAR01069.014	NA5216	Sediment	21/07/2021 12:00
MAR01069.015	NA5217	Sediment	21/07/2021 12:00
MAR01069.016	NA5218	Sediment	21/07/2021 12:00
MAR01069.017	NA5219	Sediment	21/07/2021 12:00
MAR01069.018	NA5220	Sediment	21/07/2021 12:00

Experimental

Gross Alpha/Beta

ANU/SOP/2005 – A portion of each sample was slurried in meths and then vacuum filtered onto glass fibre filter paper in a pre-calibrated geometry, to produce a source for counting. After air-drying, the sample was weighed, then counted on a Berthold LB770 low-level gas-flow proportional counter for an appropriate length of time.

Gamma Spectrometry

ANU/SOP/2029 – Each sample was placed in a container to match the appropriate calibration geometry and then measured by high-resolution gamma ray spectrometry.

The measurement technique is based on the use of high purity germanium (HPGe) detectors coupled to an Ortec gamma ray spectroscopy system. The gamma ray spectra are stored on a computer and analysed using the software programme Fitzpeaks for photopeak identification and quantification. The detectors are calibrated for efficiency using a mixed radionuclide standard, which covers an energy range of approximately 30-2000 keV. The efficiency of gamma rays between 30 keV and 120 keV are determined on an individual basis.

Application of decay corrections for the naturally occurring daughter radionuclides of uranium and thorium assumes that the series daughter radionuclides are all in secular equilibrium and therefore decay with the half-life of the first radionuclide in the series. (^{226}Ra is not UKAS accredited)

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Results

Results are presented in the following tables.

Any opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

The results in this test report relate only to the items tested, and test portions taken thereof. This test report must not be reproduced except in full, without written approval of the laboratory.

Results Summary – Gross Alpha/Beta

Customer Reference	Laboratory Reference	Analysis Date	Gross Alpha as Pu-242	Gross Beta as Cs-137	Gross Beta as K-40
MAR01069.001	NA5203	05/08/2021	<79	570 ± 140	450 ± 110
MAR01069.002	NA5204	05/08/2021	80 ± 56	620 ± 140	590 ± 140
MAR01069.003	NA5205	05/08/2021	<72	610 ± 140	740 ± 170
MAR01069.004	NA5206	05/08/2021	126 ± 79	510 ± 130	520 ± 130
MAR01069.005	NA5207	06/08/2021	130 ± 62	520 ± 130	400 ± 100
MAR01069.006	NA5208	06/08/2021	103 ± 69	550 ± 130	440 ± 110
MAR01069.007	NA5209	06/08/2021	73 ± 52	510 ± 120	530 ± 120
MAR01069.008	NA5210	06/08/2021	139 ± 70	269 ± 85	231 ± 73
MAR01069.009	NA5211	06/08/2021	77 ± 53	500 ± 130	394 ± 100
MAR01069.010	NA5212	06/08/2021	<75	620 ± 150	610 ± 140
MAR01069.011	NA5213	06/08/2021	<79	550 ± 140	430 ± 110
MAR01069.012	NA5214	06/08/2021	186 ± 76	1300 ± 280	1240 ± 260
MAR01069.013	NA5215	06/08/2021	<72	264 ± 95	320 ± 120
MAR01069.014	NA5216	06/08/2021	<110	520 ± 130	530 ± 130
MAR01069.015	NA5217	09/08/2021	93 ± 56	560 ± 130	580 ± 140
MAR01069.016	NA5218	09/08/2021	83 ± 59	510 ± 130	440 ± 110
MAR01069.017	NA5219	09/08/2021	<72	470 ± 120	370 ± 95
MAR01069.018	NA5220	09/08/2021	91 ± 57	690 ± 160	670 ± 160

Notes:
1. Results are presented as $Bq.kg^{-1}$ of dried and homogenised sample, relative to the analysis date.
2. Uncertainties are quoted at 2 s.d. and are based on a total uncertainty budget.

Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Be-7	K-40	Tl-208	Pb-210	Bi-212	Pb-212	Bi-214
MAR01069.001	NA5203	<12	356 ± 49	3.6 ± 1.3	<38	<21	5.1 ± 1.9	6.4 ± 2.5
MAR01069.002	NA5204	<7.1	291 ± 35	2.73 ± 0.78	58 ± 11	<13	6.8 ± 1.6	7.3 ± 1.8
MAR01069.003	NA5205	<12	309 ± 44	<1.6	<32	<20	5.8 ± 1.8	8.0 ± 2.7
MAR01069.004	NA5206	<11	327 ± 47	<1.6	<23	<20	6.0 ± 1.6	6.3 ± 2.3
MAR01069.005	NA5207	<9.8	243 ± 35	2.9 ± 1.0	<39	<17	5.2 ± 1.6	<3.1
MAR01069.006	NA5208	<11	359 ± 46	4.1 ± 1.1	<38	<19	9.6 ± 2.1	6.5 ± 2.6
MAR01069.007	NA5209	<8.3	347 ± 41	2.23 ± 0.88	45 ± 11	<14	6.3 ± 1.5	7.9 ± 2.1
MAR01069.008	NA5210	<12	90 ± 26	3.6 ± 1.2	<37	<21	7.3 ± 2.0	8.0 ± 2.7
MAR01069.009	NA5211	<12	388 ± 54	<1.7	<23	<20	6.8 ± 1.6	<3.5
MAR01069.010	NA5212	<12	324 ± 48	<1.6	<39	<20	6.6 ± 2.0	6.8 ± 2.7
MAR01069.011	NA5213	<11	355 ± 50	3.7 ± 1.1	<29	<20	7.1 ± 1.8	7.5 ± 2.5
MAR01069.012	NA5214	<7.6	725 ± 76	5.6 ± 1.0	<24	<14	17.2 ± 2.0	18.8 ± 2.5
MAR01069.013	NA5215	<6.8	226 ± 28	2.59 ± 0.77	45.5 ± 8.7	<12	5.6 ± 1.3	5.8 ± 1.6
MAR01069.014	NA5216	<12	364 ± 51	<1.6	<23	<21	5.6 ± 1.6	<3.5
MAR01069.015	NA5217	<12	385 ± 50	3.2 ± 1.2	<36	<20	7.7 ± 2.1	7.6 ± 2.5
MAR01069.016	NA5218	<11	371 ± 52	<1.7	<22	<20	6.2 ± 1.6	7.0 ± 2.5
MAR01069.017	NA5219	<11	316 ± 43	3.1 ± 1.0	<32	<19	7.5 ± 1.9	8.8 ± 2.5
MAR01069.018	NA5220	<7.4	400 ± 45	3.63 ± 0.88	<22	<13	8.4 ± 1.5	10.5 ± 2.1

Notes:

1. Results are presented as $Bq.kg^{-1}$ of dried and homogenised samples and are decay corrected to the sampling date.
2. Uncertainties are rounded to 2 significant figures; results are rounded to the same precision.
3. For results below the Limit of Detection, the LoD is rounded up to 2 significant figures.
4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.

Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Pb-214	Ra-223	Ra-224	Ra-226 *	Ac-228	Th-234	U-235
MAR01069.001	NA5203	8.1 ± 2.4	<12	<33	<30	<5.9	<30	<1.9
MAR01069.002	NA5204	9.3 ± 1.5	<8.0	<22	<25	<4.2	<14	<1.1
MAR01069.003	NA5205	7.6 ± 2.2	<12	<29	<23	<6.7	<21	<1.4
MAR01069.004	NA5206	6.9 ± 1.9	<8.2	<18	<19	<6.7	<17	<1.2
MAR01069.005	NA5207	<4.5	<9.9	<30	<26	<5.3	<25	<1.6
MAR01069.006	NA5208	9.2 ± 2.0	<11	<37	<28	11.0 ± 4.3	<28	<1.8
MAR01069.007	NA5209	9.0 ± 1.6	<8.5	<23	<26	10.5 ± 3.4	<15	<1.2
MAR01069.008	NA5210	9.8 ± 2.4	<12	<32	<25	<7.4	<22	<1.6
MAR01069.009	NA5211	<4.6	<9.1	<25	<21	<7.6	<18	<1.3
MAR01069.010	NA5212	<5.2	<12	<36	<30	<6.2	<30	<1.9
MAR01069.011	NA5213	8.0 ± 2.1	<11	<30	<22	<6.6	<20	<1.4
MAR01069.012	NA5214	21.6 ± 2.2	<8.9	<24	<26	18.3 ± 3.0	<16	<1.2
MAR01069.013	NA5215	7.3 ± 1.3	<7.3	<19	<22	<3.9	<13	<1.0
MAR01069.014	NA5216	<4.7	<8.8	<24	<20	<7.2	<18	<1.2
MAR01069.015	NA5217	9.7 ± 2.0	<11	<35	<28	<6.1	<28	<1.8
MAR01069.016	NA5218	<4.5	<8.8	<24	<20	<7.2	<17	<1.3
MAR01069.017	NA5219	9.8 ± 2.0	<10	<30	<22	<6.4	<19	<1.4
MAR01069.018	NA5220	12.7 ± 1.6	<7.8	<23	<18	8.2 ± 3.1	<14	<1.1

Notes:

1. An asterisk "*" indicates that the analysis is not covered by the laboratory's UKAS accreditation.
2. Results are presented as $Bq.kg^{-1}$ of dried and homogenised samples and are decay corrected to the sampling date.
3. Uncertainties are rounded to 2 significant figures; results are rounded to the same precision. For results below the Limit of Detection, the LoD is rounded up to 2 significant figures.
4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.
5. ^{226}Ra has only one gamma ray at 186 keV and the major gamma ray from ^{235}U also occurs at 186 keV. ^{235}U can be measured by the lower abundance gamma ray at 144 keV and if a positive result for ^{235}U is reported, the ^{226}Ra result will be unreliable and overestimated. However even if ^{235}U is below the LoD there may still be a contribution to the ^{226}Ra from ^{235}U and the ^{226}Ra result may be unreliable and overestimated. If an accurate result for ^{226}Ra is required this is better obtained by radiochemical analysis.

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Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Na-22	Sc-46	Cr-51	Mn-54	Co-58	Co-60	Zn-65
MAR01069.001	NA5203	<1.6	<2.0	<12	<1.4	<1.5	<1.8	<3.7
MAR01069.002	NA5204	<0.97	<1.4	<8	<0.90	<0.9	<1.1	<2.4
MAR01069.003	NA5205	<1.7	<2.3	<12	<1.4	<1.6	<1.9	<3.8
MAR01069.004	NA5206	<1.8	<2.3	<9.6	<1.5	<1.4	<1.8	<3.7
MAR01069.005	NA5207	<1.4	<1.6	<10	<1.2	<1.3	<1.5	<3.0
MAR01069.006	NA5208	<1.6	<1.8	<11	<1.4	<1.4	<1.7	<3.0
MAR01069.007	NA5209	<1.2	<1.4	<8.4	<0.92	<0.95	<1.2	<2.5
MAR01069.008	NA5210	<1.7	<2.3	<13	<1.5	<1.5	<1.6	<4.0
MAR01069.009	NA5211	<2.0	<2.4	<11	<1.6	<1.6	<1.9	<4.1
MAR01069.010	NA5212	<1.7	<2.0	<13	<1.4	<1.4	<1.7	<3.4
MAR01069.011	NA5213	<1.6	<2.2	<11	<1.4	<1.5	<1.7	<3.6
MAR01069.012	NA5214	<1.1	<1.5	<8.1	<0.91	<0.91	<1.2	<2.8
MAR01069.013	NA5215	<0.86	<1.2	<7.5	<0.81	<0.78	<0.85	<2.1
MAR01069.014	NA5216	<1.8	<2.3	<11	<1.6	<1.6	<1.9	<3.7
MAR01069.015	NA5217	<1.5	<1.9	<12	<1.3	<1.4	<1.8	<3.5
MAR01069.016	NA5218	<1.9	<2.3	<11	<1.5	<1.6	<1.8	<3.9
MAR01069.017	NA5219	<1.5	<2.0	<11	<1.3	<1.3	<1.6	<3.4
MAR01069.018	NA5220	<0.98	<1.4	<8.1	<0.88	<0.92	<0.98	<2.5

Notes:

1. An asterisk "*" indicates that the analysis is not covered by the laboratory's UKAS accreditation.
2. Results are presented as $Bq.kg^{-1}$ of dried and homogenised samples and are decay corrected to the sampling date.
3. Uncertainties are rounded to 2 significant figures; results are rounded to the same precision. For results below the Limit of Detection, the LoD is rounded up to 2 significant figures.
4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.

Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Nb-94	Nb-95	Zr-95	Ru-103	Rh-106	Ag-108m	Ag-110m
MAR01069.001	NA5203	<1.5	<1.7	<2.8	<1.4	<13	<1.5	<2.0
MAR01069.002	NA5204	<0.84	<1.1	<1.6	<0.88	<7.4	<0.91	<1.2
MAR01069.003	NA5205	<1.4	<1.7	<2.8	<1.4	<13	<1.5	<1.9
MAR01069.004	NA5206	<1.4	<1.7	<2.7	<1.3	<12	<1.4	<2.0
MAR01069.005	NA5207	<1.2	<1.4	<2.4	<1.2	<11	<1.3	<1.6
MAR01069.006	NA5208	<1.3	<1.6	<2.6	<1.3	<12	<1.4	<1.9
MAR01069.007	NA5209	<0.9	<1.2	<1.9	<0.99	<8.3	<0.96	<1.3
MAR01069.008	NA5210	<1.5	<1.8	<2.7	<1.5	<13	<1.5	<2.0
MAR01069.009	NA5211	<1.6	<1.7	<2.8	<1.4	<13	<1.6	<2.1
MAR01069.010	NA5212	<1.4	<1.6	<2.8	<1.4	<13	<1.5	<2.0
MAR01069.011	NA5213	<1.3	<1.6	<2.5	<1.4	<12	<1.5	<1.9
MAR01069.012	NA5214	<0.87	<1.2	<1.7	<0.93	<8.1	<0.96	<1.3
MAR01069.013	NA5215	<0.78	<0.94	<1.5	<0.77	<6.7	<0.85	<1.1
MAR01069.014	NA5216	<1.5	<1.6	<2.7	<1.4	<11	<1.5	<2.2
MAR01069.015	NA5217	<1.3	<1.6	<2.3	<1.4	<13	<1.4	<1.9
MAR01069.016	NA5218	<1.5	<1.7	<2.8	<1.4	<12	<1.5	<2.1
MAR01069.017	NA5219	<1.2	<1.5	<2.3	<1.3	<11	<1.4	<1.8
MAR01069.018	NA5220	<0.88	<1.1	<1.6	<0.88	<7.9	<0.91	<1.2

Notes:

1. An asterisk "*" indicates that the analysis is not covered by the laboratory's UKAS accreditation.
2. Results are presented as $Bq.kg^{-1}$ of dried and homogenised samples and are decay corrected to the sampling date.
3. Uncertainties are rounded to 2 significant figures; results are rounded to the same precision. For results below the Limit of Detection, the LoD is rounded up to 2 significant figures.
4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.

UKAS TESTING
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SOCOTEC

Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Sb-124	Sb-125	Ba-133	Cs-134	Cs-137	Ce-144	Eu-152
MAR01069.001	NA5203	<3.2	<6.7	<2.7	<1.8	<1.6	<5.9	<3.8
MAR01069.002	NA5204	<2.0	<4.6	<1.5	<0.98	<0.92	<4.3	<2.5
MAR01069.003	NA5205	<3.4	<7.1	<2.3	<1.8	<1.5	<5.9	<3.8
MAR01069.004	NA5206	<3.8	<6.4	<1.6	<1.7	<1.5	<4.4	<3.4
MAR01069.005	NA5207	<2.9	<6.0	<2.2	<1.5	<1.3	<5.2	<3.2
MAR01069.006	NA5208	<3.0	<6.4	<2.5	<1.7	<1.5	<5.9	<3.6
MAR01069.007	NA5209	<2.3	<4.9	<1.6	<0.98	<1.0	<4.6	<2.5
MAR01069.008	NA5210	<3.6	<6.8	<2.4	<1.9	<1.6	<6.3	<4.0
MAR01069.009	NA5211	<4.0	<6.6	<1.7	<2.0	<1.6	<4.6	<3.6
MAR01069.010	NA5212	<3.5	<7.3	<2.6	<1.8	<1.6	<6.3	<3.9
MAR01069.011	NA5213	<3.2	<6.6	<2.1	<1.7	<1.4	<5.6	<3.6
MAR01069.012	NA5214	<2.0	<4.7	<1.7	<1.1	<0.94	<4.6	<2.5
MAR01069.013	NA5215	<1.8	<4.0	<1.3	<0.88	<0.82	<3.9	<2.3
MAR01069.014	NA5216	<4.2	<6.6	<1.7	<1.8	<1.5	<4.6	<3.4
MAR01069.015	NA5217	<3.2	<6.8	<2.5	<1.6	<1.5	<5.8	<3.7
MAR01069.016	NA5218	<3.9	<6.7	<1.6	<1.8	<1.5	<4.4	<3.4
MAR01069.017	NA5219	<2.7	<6.2	<2.0	<1.6	<1.4	<5.4	<3.4
MAR01069.018	NA5220	<1.9	<4.5	<1.5	<1.1	<0.89	<4.4	<2.5

Notes:

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4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.

UKAS TESTING
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Results Summary – Gamma Spectrometry

Customer Reference	Laboratory Reference	Eu-154	Eu-155	Ta-182	Hg-203	Pa-231	Th-231	Pa-234m	Am-241
MAR01069.001	NA5203	<4.5	<3.0	<7.4	<1.2	<51	<99	<190	<3.7
MAR01069.002	NA5204	<2.7	<2.0	<4.3	<0.85	<36	<62	<120	<2.2
MAR01069.003	NA5205	<5.1	<2.9	<7.0	<1.2	<50	<83	<190	<3.1
MAR01069.004	NA5206	<5.3	<2.0	<7.5	<0.97	<41	<49	<190	<2.4
MAR01069.005	NA5207	<4.0	<2.5	<6.0	<1.1	<44	<85	<170	<3.6
MAR01069.006	NA5208	<4.7	<2.9	<6.4	<1.2	<48	<99	<190	<3.6
MAR01069.007	NA5209	<3.3	<2.1	<4.7	<0.9	<37	<66	<130	<2.2
MAR01069.008	NA5210	<5.0	<3.0	<6.4	<1.3	<54	<88	<180	<3.6
MAR01069.009	NA5211	<5.9	<2.3	<8.4	<1.1	<46	<53	<190	<2.6
MAR01069.010	NA5212	<5.1	<3.0	<6.8	<1.3	<51	<110	<210	<3.8
MAR01069.011	NA5213	<4.6	<2.6	<6.9	<1.1	<48	<77	<170	<3.0
MAR01069.012	NA5214	<2.9	<2.2	<4.9	<0.87	<37	<70	<120	<2.7
MAR01069.013	NA5215	<2.4	<1.8	<3.9	<0.78	<32	<54	<110	6.4±1.2
MAR01069.014	NA5216	<5.5	<2.1	<7.4	<0.99	<43	<52	<200	<2.3
MAR01069.015	NA5217	<4.3	<2.8	<7.1	<1.2	<48	<96	<190	<3.7
MAR01069.016	NA5218	<5.7	<2.1	<7.4	<1.1	<43	<51	<180	<2.4
MAR01069.017	NA5219	<4.5	<2.7	<6.4	<1.1	<46	<79	<160	<3.2
MAR01069.018	NA5220	<2.8	<2.0	<4.1	<0.84	<35	<61	<120	<2.3

Notes:
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3. Uncertainties are rounded to 2 significant figures; results are rounded to the same precision. For results below the Limit of Detection, the LoD is rounded up to 2 significant figures.
4. Detector calibrations are based upon homogeneous standard solutions. For quantification purposes the sample is assumed to be homogeneous.

- End of Test Report -

Annex B: Nuvia 2021 Radioactive Risk Assessment

Pentland Floating Offshore Wind Farm
Radiation Risk Assessment

Radiation Risk Assessment for the Pentland Floating Offshore Wind Farm Installation

Document No.	GBPNTD-HSE-NUV-RP-00001
Project:	Pentland Floating Offshore Wind Farm
Originator Company	Nuvia
Revision	01
Classification	Internal
Author	Jonathan Wright
Date	07.12.2021

Revision History:

Revision	Date	Status	Author	Reviewed	Approved
1	07.12.2021	Internal	JW	DS	LSE



1 Cover Note

Due to the historical activities on the Dounreay Nuclear site, it is well publicised through SEPA advisory groups and reports that radioactive particles have been previously discharged into the environment off the coast of Caithness. In 2021, Highland Wind Limited appointed Nuvia to complete a Radiation Risk Assessment (RRA) for the planned survey and installation activities on the Pentland Floating Offshore Wind Farm (PFOWF).

The purpose of this RRA was to consider the radiological hazards to those involved in the offshore activities associated with the installation of the floating wind farm from potential exposure to the radioactive particles with the primary purpose to ensure that appropriate arrangements are identified to mitigate any radiological risk to people working on the PFOWF. While this RRA focuses on direct potential hazards to those working on site, the potential effect of the construction of the PFOWF on disturbance or wider release of contaminated sediments or radioactive particles in sediment has been considered in the Environmental Impact Assessment Report (EIAR) – Chapter 7: Marine Physical Processes, Chapter 8: Water and Sediment Quality and Chapter 21: Risk of Major Accidents and/ or Disasters.

The focus of this RRA was an overarching assessment to inform the project team of the risk to workers involved in the offshore works associated with the wind farm including offshore geotechnical surveys, surface grab sampling, seabed cone penetration tests, vibrocore and borehole sampling, anchor installation, mooring installation, horizontal directional drilling, export cable installation, cable route and boulder clearance activities and cable trenching activities.

Further activity-specific risk assessments have been and will be completed ahead of each scope of work commencing.

		72944/RRA/001 Issue: Issue 1 Date: December 2021
NUVIA	**RADIATION RISK ASSESSMENT**	
Radiation Risk Assessment for the Pentland Offshore Wind Farm Installation		

Prepared by: **Jonathan Wright (Nuvia Limited Radiation Protection Adviser)** [redacted]	**Date: 07/12/2021**
Checked by: **David Spencer (Nuvia Limited Radiation Protection Engineer)** [redacted]	**Date: 07/12/2021**
Approved by: **Lee Senoussi (Highland Wind Engineering Manager)**	**Date:**

1	TASK INTRODUCTION

The Pentland Offshore Floating Wind Farm is an infrastructure project being undertaken cost to the Dounreay Nuclear Site in Caithness, North Scotland. The project involves the installation and operation of floating wind farm infrastructure, primarily comprising wind turbines on a floating foundation tethered to the seabed, at least 6.5 km from the shore, and associated cabling to connect the windfarm to an on-shore substation, which will be built immediately to the west of the Dounreay nuclear site.

Due to historical activities on the Dounreay Nuclear site, it is known that radioactive particles have previously been discharged into the environment, primarily from the Old Diffuser liquid discharge point several hundred metres out to sea [Ref. 1]. Although it is many years since particles are known to have been discharged through this route, and there has been significant amount of retrieval of radioactive particles both from the seabed and nearby beaches, there remains radioactive particles present in the wider environment that have not been recovered.

This Radiation Risk Assessment considers the radiological hazard to those involved in the installation of the floating wind farm from potential exposure to the radioactive particles, with the aim of determining the likelihood and consequences of radiological exposure to the particles, and ensuring that appropriate arrangements are identified to mitigate any radiological risk. It is noted that some of the installation work will be undertaken on the seabed within the “FEPA zone”, which is an area of sea, of 2 km radius centred on the old Dounreay discharge point, where fishing is prohibited to prevent the possibility of radioactive particles present on the seabed within this location ending up in the food chain.

Described below are the seven primary tasks involved with the construction of the project that have been considered by this radiation risk assessment:

Offshore Geotechnical Surveys (wind farm, cable corridor including in the FEPA zone)

A variety of survey techniques will be used to provide geotechnical information at the locations of the wind farm installation and cable, such as:

- ***Surface Grab Sampling****; using a grab bucket to take a physical sample of the first 2-3 m depth of the seabed and bringing this to the vessel, where it is emptied and sorted by technical staff for further transport to an onshore laboratory*

- ***Seabed Cone Penetration tests, vibrocore and borehole sampling****; lowering a landing frame to the seabed and pushing probes into the seabed from the vessel to either measure resistance to the force or to recover sediment samples within tubular casings (for either opening on the vessel or back on shore).*

The frame is then recovered and moved to the next location. There will be approximately 25 locations in the offshore windfarm footprint, with approximately 5 locations within the FEPA zone.

Anchor installation *(wind farm)*

Lowering a drilling frame to the seabed at the offshore location, at least 6.4 km from the edge of the FEPA zone, and drilling large diameter 30 to 40 m long tubular piles into the ground, with the drill itself being grouted in place. No sediment is removed during the operation. There will be approximately 5-7 anchors per turbine and up to 10 turbines.

Mooring installation *(wind farm)*

The mooring system connects the ground anchors (see above) to the floating foundation of the wind turbine and secures the floating foundation in place. The bottom, or ground, chain is pre-installed along with the anchors, and a mooring line is then deployed from a vessel and connected to the subsea chain section. The mooring line is then laid from the anchor towards the floating foundation (held in place by tugs) and transferred to the foundations built-in pull-in system.

Horizontal Directional Drilling (HDD) *(cable corridor within the FEPA zone)*

A horizontal hole will be drilled from onshore, to the west of the Dounreay nuclear site, by firstly excavating the ground to create an entry pit (several metres square and 2 m deep), then setting up drilling equipment to drill a 300 mm diameter hole under the seabed to 650 m to 700 m from the coastline. The drilling is stopped just prior to exit from the seabed, and the hole is then widened through a process called "reaming" to be 660 mm in diameter. A rock hole opener is then used to complete the drill at the exit point in the sea. All spoil and equipment is recovered back through the hole, and on completion a duct is installed which can be done from either direction by pushing or pulling into position. This work is undertaken on shore and the hole is drilled to its exit point within the FEPA zone and approximately 500 to 1000 m south west from its centre.

Export Cable Installation *(cable corridor and within the FEPA zone)*

Installation of an off-shore and on-shore cable connecting to the floating turbine through the horizontal directional drilling to the joint transition bay on-shore. The off-shore cable will be laid from the HDD exit point by a vessel through a pre-defined route to the floating foundation of the wind turbine, whilst simultaneously being pulled through the HDD via a winch on shore. The offshore cable is approximately 9.5 km long. The onshore cable is installed between a concrete joint transmission bay (JTB) to an on-shore substation, a length of approximately 5 km, which will be trenched and backfilled over the cable.

Cable route / boulder clearance activities *(wind farm and cable corridor)*

Sections of the subsea cable route may need to be cleared of cables and debris. This will be undertaken by various techniques, including a subsea grab which will be used to pick up and relocate subsea boulders, to using a plough towed along the cable route to provide a cleared area to lay the cable on.

Cable trenching activities *(wind farm and cable corridor)*

Burying the subsea cable to ensure it is protected from any activities that may compromise it's activity, for example fishing / trawling activities. The cable will be trenched post installation, from the HDD exit to the dynamic cable transition close to the floating foundation of the wind turbines.

All of the tasks described above may involve support of Remotely Operated Vehicles (ROVs) on the seabed to monitor the operations where appropriate.

	This document comprises a Radiation Risk Assessment (RRA) for the Offshore Floating Windfarm installation activities described above, and is intended to fulfil the requirements of paragraphs 70 and 71 of the Approved Code of Practice (ACoP) to the Ionising Radiations Regulations 2017 [Ref. 2]. The intention is for contractors involved in the wind farm installation work to develop their own RRAs relevant to their specific installation tasks, based on the contents of this overarching Radiation Risk Assessment, and also ensure that all recommendations identified within this RRA are incorporated into their system of work. As described in section 2.11, the potential radiation exposure routes have been identified, and the risks assessed in accordance with the following severity, frequency and risk rating tables in order to quantify the risk. In addition to the requirements of the Ionising Radiation Regulations, work within the FEPA zone is subject to the requirements of a permit issued under the Environmental Authorisations (Scotland) Regulations 2018 [Ref. 3] relating to the possibility of encountering radioactive materials. All contractors must ensure that they are aware of, and comply with, the requirements of this permit (although outside the scope of this RRA). Finally, in the unlikely event that a radioactive particle is inadvertently retrieved during the wind farm installation works, any onward transport of that particle needs to meet the requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 [Ref. 4].

2	RADIOLOGICAL INFORMATION AND RISK ASSESSMENT
2.1	***What is the nature of the sources of ionising radiation to be used, or likely to be present, including the accumulation of radon in the working environment?*** Nuclear fuel has historically been reprocessed at the Dounreay Nuclear Site, and as part of this process radioactive particles have previously been discharged into the environment in the environs of the site, primarily through the Low Active Drain (LAD) system. As part of the reprocessing activities undertaken at the site fuel elements were dismantled underwater in ponds, using processes that generated swarf (metal filings produced by milling). The processing ponds were connected to the LAD system, and some of this swarf, including radioactive particles, were discharged to sea between 1959 and the 1980s. The radioactive particles that were generated and discharged are grouped into the following categories: - Particles originating from the Dounreay Fast Reactor (DFR); - Particles originating from a Materials Test Reactor (MTR); - Particles comprising stainless steel, originating from Dounreay Fast Reactor or Prototype Fast Reactor (PFR) fuel cladding materials; - Particles containing uranium oxide, which are likely to have originated from MTR or DFR fuel. The radioactivity within the particles is a combination of fission products (primarily Cs-137 and Sr-90), activation products (primarily Co-60) and actinides (e.g. Am-241; U-238). Therefore, alpha, beta and gamma radiation is associated with the radioactive particles. A significant amount of clean up work has been undertaken to identify and remove particles (which are typically the size and density of a grain of sand), however it is known that some particles remain in the environment and could potentially be present in some of the locations where the wind farm installation work is to be carried out. Radon As some particles released into the environment contain uranium, then radon (a colourless, odourless radioactive gas formed as a decay product of uranium) may be present. Naturally occurring radon may also be present in seawater and in the general environment. However, as the work to install the floating wind farm infrastructure is to be undertaken outside, accumulation of radon in the working environment is not considered to be an issue and will not be discussed further within this RRA.

2.2	***What are the estimated radiation dose rates to which anyone can be exposed?*** The external gamma dose rates associated with the radioactive particles are dependent upon the radioactivity (and radionuclides) present in the individual particle. It is considered highly unlikely that individuals involved in the wind farm installation project will encounter any radioactive particles (see section 2.11 for detailed discussion of the likelihood of encountering a particle), but in the event that a radioactive particle was inadvertently recovered, the dose rates to which anybody could be exposed are likely to be very low (based on understanding of what radioactive particles are known to be in the environment). Calculated dose rates from radioactive particles found at Dounreay have been published in the Health Protection Agency reference document "Public Health Implications of Fragments of Irradiated Fuel; Module 4" [Ref. 5]. A gamma dose rate of 7.4 nSv/h at 1 m from a particle of 100 kBq Cs-137 activity (typical of the highest activity particles found at Sandside beach) has been calculated, which can be used to estimate dose rates from particles of different activities. Radioactive particles found in the environs of Dounreay have been categorised as "minor", "relevant" and "significant" depending upon their radioactivity levels. Minor particles are those with a Cs-137 below 100 kBq; relevant particles are those with a Cs-137 activity between 100 kBq and 1 MBq and significant particles are those with a Cs-137 activity greater than 1 MBq. The highest radioactivity particles detected had Cs-137 activity of 100 MBq. Based upon the published dose rate above therefore, the gamma dose rate associated with an unshielded "relevant" particle would therefore be up to 74 nSv/h at 1 m, with significant particles having dose rates between 74 nSv/h and 7.4 µSv/h at 1 metre. It should be emphasised that these dose rates are low, similar to background levels for minor and relevant particles, and would only be encountered if radioactive particles are either inadvertently retrieved from the seabed or encountered onshore during excavations for cable laying. In the unlikely event that particles were inadvertently retrieved from the seabed or with onshore excavations, they are most likely to be shielded by other sediment, spoil and materials, which would reduce the dose rates even further from these already low levels.
2.3	***What is the likelihood of contamination arising and being spread?*** It is very unlikely that contamination will arise and spread due to the wind farm installation work. Should radioactive particles be encountered they are discrete insoluble items, similar in size to a grain of sand, and although they can break up into smaller particles this would not result in widespread contamination, but would be localised around the particle, as has been the case with previous particle finds. There has been no contamination spread associated with previous recovery of particles from the shoreline, and contamination of equipment is not expected to be an issue. A more detailed consideration of the likelihood of encountering radioactive particles at all is given in section 2.11.

2.4	***What are the results of any previous personal dosimetry or area monitoring relevant to the proposed work?*** Radioactive particles have only ever been encountered during the monitoring and retrieval programme of operations specifically designed to locate and retrieve particles. There is therefore no dosimetry or monitoring data relevant to the proposed work. However, the personnel involved with the particles retrieval programme which removed particles from the seabed (from 2008 to 2012) and also the health physics surveyors involved in the ongoing beach monitoring programme (for retrieving, segregating and transporting radioactive particles) received low radiation doses whilst undertaking this work which included finding particles and segregating them.
2.5	***What is the advice from the manufacturer or supplier of equipment about its safe use and maintenance?*** All health physics (radiological monitoring) equipment used to detect or segregate radioactive particles will be calibrated and subject to annual maintenance. There is no other radiological equipment involved in this work, therefore this point does not really apply. All non-radiological equipment to be used will be subject to the mandatory inspections and maintenance.
2.6	***What engineering control measures and design features are already in place or planned?*** There are no engineering control measures or design features in place for any of the wind farm installation work. The radiological risk is considered to be sufficiently low that implementing engineering control measures and design features is considered unnecessary and to do so would not meet the As Low As Reasonably Practicable (ALARP) principle. In other words the potential benefits of any engineering control measures cannot be justified based on the potential radiological risks. Other control measures, such as radiation monitoring, safe systems of work etc (as described elsewhere in this RRA) will be sufficient to reduce any risk to negligible levels.
2.7	***Are there any planned systems of work? If so what?*** All work involved in the installation of the offshore floating wind farm should be subject to a safe system of work, which will detail all radiological safeguards as determined in this RRA, in addition to the radiological safeguards detailed in task specific RRAs completed by the installation contractors for their specific installation tasks. **Recommendation 1.** Ensure that a Safe System of Work (including a Method Statement, Risk Assessment and Local Rules) is completed for each individual wind farm installation task, and that the recommendations from this RRA and task specific RRAs are incorporated into this Safe System of Work. ***Installation Contractors***
2.8	***What are the estimated levels of airborne and surface contamination likely to be encountered?*** Airborne contamination is not likely to be encountered as part of this work. The radioactive particles are discrete items most likely to originate from the seabed, and not likely to become airborne. Surface contamination is also unlikely to be encountered. Although it is possible for particles to break up, the resultant particles also tend to be discrete particles found in the accompanying sediment. This does not lead to a spread of contamination.

2.9	***What is the effectiveness and suitability of PPE to be provided?*** In all situations where there is the potential for radioactive particles to be associated with materials either retrieved from the seabed or retrieved from on-site excavations, the following standard Personal Protection Equipment should be worn: - Robust impermeable protective gloves; - Coveralls; - Safety Glasses. This should ensure that there is no potential for stationary contact with the skin of any radioactive particles present. The same gloves and coveralls as required for conventional safety reasons will provide a dual purpose of preventing any direct skin contact with radioactive particles. **Recommendation 2.** Ensure that all personnel involved in retrieving equipment and samples from the seabed or onshore excavations are wearing protective gloves, safety glasses and coveralls during these tasks. ***Installation contractors*** **Recommendation 3.** Ensure that gloves and coveralls are monitored for radiation following contact with seabed or onshore sediment or spoil. ***Installation Contractors***
2.10	***What is the extent of unrestricted access to working areas where dose rates or contamination levels are likely to be significant?*** Dose rates or contamination levels are not likely to be significant with any of the wind farm installation work, as it is unlikely that radioactive materials will be encountered, and if they are encountered then the radiation dose rates at any reasonable distance from the particle (e.g. 1 m or greater) would not cause concern (see section 2.2). If radiation monitoring does reveal the presence of a radioactive particle, arrangements should be put in place to either segregate the material into an appropriate container, and store this container securely, in an isolated and low occupancy area, prior to transport and disposal at the DSRL site, or, if this is not practical, to use barriers / signage to segregate the area where the particle is located to restrict access to at least 1 metre from the particle or a dose rate of 7.5 microSv/h. **Recommendation 4.** Ensure that any radioactive particles encountered are either segregated and placed into an appropriate sealed and robust metal container and temporarily stored in a secure, isolated area of low occupancy prior to transfer to DSRL, or if this is not practicable, segregate the area with barriers and signage where required to a maximum dose rate of 7.5 microSv/h or 1 m from the particle's location. ***Installation contractors***

2.11 ***What are the possible accident situations, likelihood and potential severity?***

The reasonably foreseeable radiological accident scenarios associated with this work have been considered individually below (identified as ingestion, skin contact and remote exposure to different activities of particle), with severity factors, frequency factors and risk ratings assigned to each hazard in accordance with the following tables:

Severity Factor	Description (relevant to radiological hazards)
1	Limited radiological consequences e.g. minor spread of contamination **or** a negligible dose (< 1 µSv, which is less than the average daily background dose received by people in the UK)
2	Whole Body Effective Dose up to 1 milliSv (which is the annual public dose limit) **or** a significant spread of contamination
3	Whole Body Effective Dose between 1 milliSv and 20 milliSv (which is the annual occupational dose limit) **or** minor tissue effects (such as a temporary skin lesion that should heal naturally)
4	Effective dose likely to exceed any dose limit **or** an equivalent dose likely to result in significant tissue effects that would require medical treatment (such as skin ulceration or internal damage to digestive tract)
5	Effective Dose likely to be above tissue effect threshold, **or** potentially fatal equivalent radiation dose

Frequency Factor	Description
1	Extremely Unlikely Occurrence, **considered to be < 0.1% likely to occur during the project**
2	Unlikely / Possible Occurrence, **considered to be 0.1% to 10% likely to occur during the project**
3	Likely / Occasional occurrence, **considered to be 10% to 50% likely to occur during the project**
4	Very Likely / Frequent Occurrence, **considered to be 50% to 80% likely to occur during the project**
5	Almost certain / Regular Occurrence, **considered to be > 80% likely to occur during the project**

Risk Rating (RR) = Frequency Factor (FF) x Severity Factor (SF)

Risk Rating (RR)	Classification	Action Required
1-4	Low (L)	None or limited action
5-9	Medium (M)	Additional control measures should be used where reasonably practicable
≥10	High (H)	Redesign the task / operation if control measures do not control the risk

For ease of reference a summary of all the unmitigated severity factors, frequency factors and risk factors for the above exposure routes is given in Appendix 1 of this RRA.

Ingestion of a Radioactive Particle

One route of radiation exposure is inadvertent ingestion of a radioactive particle. The likelihood of ingesting a radioactive particle is considered to be incredibly small, as not only does the individual need to encounter a radioactive particle for this to occur, but they also need to ingest the particle.

The radiological consequences of ingestion of a radioactive particle depends upon a variety of factors, importantly including the level of radioactivity within the particle. Tissue effects from ingestion of a radioactive particle (damage to the colon in the digestive tract, which could result in death) are unlikely to occur for all but the most radioactive particles that have ever been discovered, and even with a particle of this level of radioactivity (100 MBq Cs-137) it is unlikely to be fatal [Ref. 5].

For stochastic effects, the radiation dose from ingestion of a "relevant" particle (100 kBq of Cs-137) is calculated to be 0.1 mSv, or 80 mSv for a particle of the highest activity ever found near Dounreay (100 MBq Cs-137).

Therefore, the *severity factor* for ingestion of a particle is determined to be "**4**" in the case of the most radioactive particles ever detected, and "**2**" for "relevant" particles or those of lower radioactivity.

Estimates of likelihood of ingesting a particle for the seven main areas of work (as described in section 1), and associated risk ratings, are given below:

Anchor Installation

Anchor installation is undertaken at the offshore site only, at least 6.4 km from the edge of the FEPA zone in a North Westerly direction. The particle footprint, which has been monitored by the extensive seabed ROV surveys undertaken over many years up to 2012, has been demonstrated to be within 1 km from the shore (figure 3.8 of Ref. 1). The larger sized particles, which are more likely to be "significant" in activity have not travelled far (a few hundred metres) from the diffuser where they were emitted. Smaller particles have been transported eastwards, with a very small proportion travelling westwards towards Sandside Bay. There is no evidence available of whether any particles had been transported further offshore, however this is not expected and would be contrary to the current monitoring data and modelling expectations.

No sediment is recovered from the seabed during the anchor installation, although the drilling frame is lifted between the seabed and the vessel, this is expected to occur approximately 50 times. The likelihood of a significant or minor particle being inadvertently retrieved when the drilling frame is lifted from the seabed to the vessel is difficult to quantify but considered to be vanishingly small. There are currently no restrictions on any activities (including fishing and trawling) in the area where this work is to be carried out.

The frequency factor for retrieving and ingesting a *significant* particle during anchor installation works is considered to be extremely unlikely.

The frequency factor for retrieving and ingesting a *relevant* or *minor* particle during anchor installation works is also considered to be extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during anchor installation)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during anchor installation)

Mooring Installation

The mooring installation will be undertaken in the same location as the anchor installation described above, with no intention to bring sediment to the surface.

The frequency factor for retrieving and ingesting a *significant* particle during mooring installation works is considered to be extremely unlikely.

The frequency factor for retrieving and ingesting a *relevant* or *minor* particle during mooring installation works is also considered to be extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during mooring installation)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during mooring installation)

Offshore Geotechnical Surveys

Grab samples, vibrocore and borehole sampling may be undertaken both in the offshore zone and also in the FEPA zone, at the location of the exit of the Horizontal Directional Drilling. These will involve the retrieval of sediment samples from the seabed, 7 or 8 locations in the FEPA zone and approximately 33 locations in the offshore zone.

For the **offshore zone** the likelihood of retrieving and ingesting a *significant*, *relevant* or *minor* particle during the geotechnical surveys, including when sediment is retrieved, is considered to be extremely unlikely.

Within the FEPA zone, the survey work and sampling will be close to the exit of the HDD, and at least 500 m west of the Old Diffuser. Figure 3.9 in Reference 1 shows that no significant particles were retrieved from the seabed at more than 500 m west of the Old Diffuser and approximately 10 relevant or minor particles were found in a segment between 400 and 600 m west of the diffuser, perpendicular to the main plume. The particles have all been found within 1 km of the shore, and therefore within a 200 m thick segment. This translates to a 1 in 40 000 likelihood of finding a particle in every m^2 around the location of the grab samples, borehole sampling and vibrocore sampling, assuming that the current inventory of particles in this location is similar to those that have been historically removed. With a total of 7 or 8 physical samples to be removed, assuming each sample represents 1 m^2 of the seabed, there is a 1 in 4000 chance of retrieving a relevant or minor particle from the seabed within the FEPA zone.

Again, assuming a 1 m^3 volume of sediment removed, the likelihood of going on to ingest a particle inadvertently retrieved is remote. This is difficult to quantify, but a likelihood of ingesting a particle from the sediment removed would be a fraction of 1% probability. Together with the low probability of retrieving a particle, this supports the conclusion that for the FEPA zone, the likelihood of retrieving and ingesting a significant, relevant or minor particles during the geotechnical surveys, including when sediment is retrieved, is considered to be extremely unlikely, even without any mitigation measures in place.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during geotechnical surveys)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during geotechnical surveys)

Export Cable Installation

The offshore cable installation will be laid from the HDD exit point, connected either by divers or ROV to a pre-installed pull in cable. From here the cable is laid directly onto the seabed along a pre-defined route to the floating turbine, and simultaneously pulled through the HDD via on on-shore pull-in winch. The likelihood of inadvertently retrieving a *significant*, *relevant* or *minor* particle during the offshore cable installation is considered to be much lower than in the sampling within the FEPA zone and therefore extremely unlikely.

The onshore cable installation involves taking the cable from the onshore joint transmissions bay, where it is connected to the offshore cable, and laying the cable into a trench to the onshore substation, which will be approximately 5 km away, but the location is not yet confirmed. The trench will then be backfilled to the original condition. These locations are not part of the mandatory surveying work and therefore no data exists on the prevalence of radioactive particles from Dounreay being present. However, the location is likely to be elevated from the seafront and therefore the likelihood of a radioactive particle migrating from the beach to this area is considered to be negligible. The HPA report considering the likelihood of encountering a fuel fragment on Sandside Beach [Ref. 6] provides some useful bounding statistics. There was assessed to be a probability of 1.8×10^{-11} /year likelihood of an adult bait digger inadvertently ingesting a particle, based on 324 hours per year occupancy. This is a greater occupancy that the expected time to install the onshore cable (which should take around 4 weeks) and also in a location far more likely to have particles present, and therefore can be considered bounding to the likelihood of ingesting as particle whilst installing the onshore cable. The likelihood of inadvertently retrieving a *significant*, *relevant* or *minor* particle during the onshore cable installation is considered to be therefore extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during export cable installation)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during export cable installation)

Horizontal Directional Drilling (HDD)

The only task with any conceivable risk of encountering a radioactive particle associated with the HDD is the initial digging of an entry pit. This will be undertaken some distance inland from the shoreline. The number of radioactive particles present on Sandside Beach at any one time has been calculated as 3.2×10^{-5} m^{-2}, although the area due to be used as the base for the HDD has not been subject to survey (and is to the east of Sandside bay and closer to the FEPA zone). Due to the fact that this is remote from the beach, a reduction in the likelihood of encountering a particle of a factor of 10 is conservatively assumed. This means, that for a working area footprint of 400 m^2 (20 m x 20 m), the likelihood of entering a particle would be approximately 1 in 1000 (without any mitigation). The likelihood of ingesting a particle following such an encounter can be assumed to be a fraction of 1%, and therefore the probability of ingesting a *minor*, *relevant* or *significant* particle during the Horizontal Directional Drilling is considered to be extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during Horizontal Directional Drilling)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during Horizontal Directional Drilling)

Cable Route / Boulder Clearance Activities

Boulder clearance activities involve moving boulders underwater, with no intention to bring them to the surface. This will not therefore result in any likelihood of encounter with a radioactive particle. The cable route clearance will involve equipment such as a subsea plough, which will be used to clear boulder fields (including within the FEPA zone). Although sediment will not intentionally be brought to the surface, there could be sediment held up within the plough when it does surface following such an operation. A 100 m wide corridor will be subject of the subsea clearance, which will be located at least 500 m west of the Old Diffuser discharge point. Approximately 10 relevant or minor particles have historically been found in this 200 m wide segment, therefore conservatively assuming a similar amount remain, a subsea plough could encounter up to half of these. However, as the plough is brought to the surface, any sediment is likely to be washed off, and it is still therefore unlikely that any radioactive particles encountered by the plough would be brought to the surface. It is important to note that during the retrieval of radioactive particles, using twin tracked ROVs over several years, no radioactive particles were inadvertently brought to the surface. It is therefore estimated that there is a < 1% likelihood of a particle being brought to the surface with this subsea equipment. The likelihood of ingesting such a particle is also conservatively considered to have a likelihood of < 1%, meaning that the frequency factor for retrieving and ingesting a *significant*, *relevant* or *minor* particle during the cable route / boulder clearance activities is assessed to be extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during cable route / boulder clearance activities)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during cable route / boulder clearance activities)

Trenching Activities

Trenching activities will involve using a specialist "trencher" to bury the offshore cable after it has been laid, including in the FEPA zone. The width of such a trench is estimated to be approximately 5 m, and therefore the likelihood of encountering a particle, and inadvertently bringing it to the surface is 10 times lower than for the boulder clearance activities described above. Therefore the frequency factor for retrieving and ingesting a *significant*, *relevant* or *minor* particle during trenching activities is assessed to be extremely unlikely.

Unmitigated Risk Rating: 4 (ingestion of 100 x Significant Particle during trenching activities)

Unmitigated Risk Rating: 2 (ingestion of Relevant or Minor Particle during trenching activities)

Skin Contact with a Radioactive Particle

A second route of potential radiation exposure is inadvertent skin contact with a radioactive particle.

The radiological consequences of skin contact with a radioactive particle depend upon a variety of factors, importantly including the level of radioactivity within the particle but also the duration of the contact. Tissue effects from direct skin contact of a 1 MBq Cs-137 "relevant" particle for between 2 and 5 hours would result in a small lesion to the skin that would take a few weeks to heal, longer contact than this is not considered a realistic scenario in the windfarm installation tasks. Direct skin contact with the most active particles ever found in the environs of Dounreay (100 MBq Cs-137) for several hours would lead to serious localised ulceration which would need several weeks to heal and is likely to need medical intervention.

A relevant particle of 1 MBq Cs-137 particle would give an equivalent dose of 0.1 mSv, which implies a fatal risk factor of one in 50 million when combined with the risk co-efficient for low dose rate exposure of the skin. Extrapolating this to the 100 MBq Cs-137 highest activity particles ever encountered in the environs of Dounreay, would imply a fatal risk factor of one in 500 thousand.

Therefore, the severity factor for direct skin contact of a particle is determined to be "**4**" in the case of the most radioactive particles ever detected, and "**3**" for "relevant" particles or those of lower radioactivity.

Anchor Installation

As described in the "ingestion" assessment above, the frequency factor for retrieving and having prolonged skin contact with a *significant* particle during anchor installation works is considered to be extremely unlikely.

	The frequency factor for retrieving and having prolonged skin contact with a *relevant* or *minor* particle during anchor installation works is also considered to be extremely unlikely. **Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during anchor installation)** **Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during anchor installation)** ***Mooring Installation*** The frequency factor for retrieving and having prolonged skin contact with a *significant* particle during mooring installation works is considered to be extremely unlikely. The frequency factor for retrieving and having prolonged skin contact with a *relevant* or *minor* particle during mooring installation works is also considered to be extremely unlikely. **Unmitigated Risk Rating: 4 (prolonged skin contact with of 100 x Significant Particle during mooring installation)** **Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during mooring installation)** ***Offshore Geotechnical Surveys*** For the **offshore zone** the likelihood of retrieving and having prolonged skin contact with a *significant*, *relevant* or *minor* particle during the geotechnical surveys (including when sediment is retrieved) is considered to be extremely unlikely. Within the **FEPA zone**, the likelihood of retrieving and having prolonged skin contact with a significant, relevant or minor particle during the geotechnical surveys (including when sediment is retrieved) is also considered to be extremely unlikely, even without any mitigation measures in place. **Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during geotechnical surveys)** **Unmitigated Risk Rating: 3 (prolonged skin contact with of Relevant or Minor Particle during geotechnical surveys)** ***Export Cable Installation*** The likelihood of inadvertently retrieving a *significant*, *relevant* or *minor* particle during the offshore cable installation is considered to be extremely unlikely. The onshore cable installation involves taking the cable from the onshore joint transmissions bay, where it is connected to the offshore cable, and laying the cable into a trench to the onshore substation, which will be approximately 5 km away, but the location is not yet confirmed. The trench will then be backfilled to the original condition. These locations are not part of the mandatory surveying work and therefore no data exists on the prevalence of radioactive particles from Dounreay being present. However, the location is likely to be elevated from the seafront and therefore the likelihood of a radioactive particle migrating from the beach to this area is considered to be negligible. The HPA report considering the likelihood of encountering a fuel fragment on Sandside Beach [Ref. 6] provides some useful bounding statistics. There was assessed to be a probability of 3.7 x 10^{-7} /year likelihood of an adult bait digger inadvertently having skin contact with a particle, based on 324 hours per year occupancy. This is a greater occupancy that the

expected time to install the onshore cable (which should take around 4 weeks) and also in a location far more likely to have particles present, and therefore can be considered bounding to the likelihood of having skin contact with a particle whilst installing the onshore cable. The likelihood of inadvertently retrieving a *significant*, *relevant* or *minor* particle during the onshore cable installation is considered to be therefore extremely unlikely.

Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during export cable installation)

Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during export cable installation)

Horizontal Directional Drilling (HDD)

The only task with any conceivable risk of encountering a radioactive particle associated with the HDD is the initial digging of an entry pit. This will be undertaken some distance inland from the shoreline. The number of radioactive particles present on Sandside Beach at any one time has been calculated as 3.2×10^{-5} m^{-2} [Ref 6], although the area due to be used as the base for the HDD has not been subject to survey (and is to the east of Sandside bay and closer to the FEPA zone). Due to the fact that this is remote from the beach, a reduction in the likelihood of encountering a particle of a factor of 10 is conservatively assumed. This means, that for a working area footprint of 400 m^2 (20 m x 20 m), the likelihood of encountering a particle would be approximately 1 in 1000 (without any mitigation). The likelihood of having prolonged skin contact with a particle following such an encounter can be assumed to be a fraction of 1%, and therefore the probability of prolonged skin contact with a *minor*, *relevant* or *significant* particle during the Horizontal Directional Drilling is considered to be extremely unlikely.

Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during Horizontal Directional Drilling)

Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during Horizontal Directional Drilling)

Cable Route / Boulder Clearance Activities

As described in the ingestion assessment above, it is estimated that there is a < 1% likelihood of a particle being brought to the surface with this subsea equipment. The likelihood of having prolonged skin contact with such a particle is also conservatively considered to have a likelihood of < 1%, meaning that the frequency factor for retrieving and ingesting a *significant*, *relevant* or *minor* particle during the cable route / boulder clearance activities is assessed to be extremely unlikely.

Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during cable route / boulder clearance activities)

Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during cable route / boulder clearance activities)

Trenching Activities

As described in the ingestion assessment above, the frequency factor for retrieving and having prolonged skin contact with a *significant*, *relevant* or *minor* particle during trenching activities is assessed to be extremely unlikely.

Unmitigated Risk Rating: 4 (prolonged skin contact with 100 x Significant Particle during trenching activities)

Unmitigated Risk Rating: 3 (prolonged skin contact with Relevant or Minor Particle during trenching activities)

Remote Exposure to a Radioactive Particle (without direct contact)

There is the potential for individuals to be exposed to external radiation from radioactive particles in their immediate vicinity, even without ingesting or having direct skin contact with such particles. The external dose rate at 1 m from a relevant particle of 100 kBq Cs-137 has been calculated to be 74 nSv/h [Ref. 7], and therefore the dose rate at 1 m from the highest activity particles ever found at Dounreay would be 7.4 µSv/h.

Assuming a few hours exposure from a shift at sea, then the severity factor for external exposure to a relevant particle (or below) would be "1", and that from a particle 100 X a significant particle would be "2".

Estimates of likelihood of being exposed to a radioactive particle, without direct contact, for the seven main areas of work (as described in section 1) are given below:

Anchor Installation

As described in the "ingestion" assessment above, the frequency factor for retrieving a *significant* particle during anchor installation works is considered to be extremely unlikely.

The frequency factor for retrieving a *relevant* or *minor* particle during anchor installation works is also considered to be extremely unlikely.

Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during anchor installation)

Unmitigated Risk Rating: 1 (remote exposure to Relevant or Minor Particle during anchor installation)

Mooring Installation

The frequency factor for retrieving a *significant*, *relevant* or *minor* particle during mooring installation works is considered to be extremely unlikely.

Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during mooring installation)

Unmitigated Risk Rating: 1 (remote exposure to Relevant or Minor Particle during mooring installation)

Offshore Geotechnical Surveys

For the **offshore zone** the likelihood of retrieving a *significant*, *relevant* or *minor* particle during the geotechnical surveys (including when sediment is retrieved) is considered to be extremely unlikely.

Within the **FEPA zone**, the likelihood of retrieving a significant particle during the geotechnical surveys (including when sediment is retrieved) is considered to be extremely unlikely, even without any mitigation measures in place.

With a total of 7 or 8 physical samples to be removed, assuming each sample represents 1 m^2 of the seabed, there is a 1 in 4000 chance of retrieving a relevant or minor particle from the seabed within the FEPA zone.

Therefore, the likelihood of retrieving a relevant or minor particle during the geotechnical surveys in the FEPA zone is considered to be extremely unlikely.

Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during geotechnical surveys)

Unmitigated Risk Rating: 1 (remote exposure to Relevant or Minor Particle during geotechnical surveys)

Export Cable Installation

The likelihood of inadvertently retrieving and being exposed to a *significant*, *relevant* or *minor* particle during the offshore cable installation is considered to be extremely unlikely.

The onshore cable installation involves taking the cable from the onshore joint transmissions bay, where it is connected to the offshore cable, and laying the cable into a trench to the onshore substation, which will be approximately 5 km away, but the location is not yet confirmed. The trench will then be backfilled to the original condition. These locations are not part of the mandatory surveying work and therefore no data exists on the prevalence of radioactive particles from Dounreay being present. However, the location is likely to be elevated from the seafront and therefore the likelihood of a radioactive particle migrating from the beach to this area is considered to be negligible. The HPA report considering the likelihood of encountering a fuel fragment on Sandside Beach [Ref. 6] provides some useful bounding statistics. There was assessed to be a probability of 3.9×10^{-7} /year likelihood of an adult bait digger inadvertently encountering a particle, based on 324 hours per year occupancy. This is a greater occupancy that the expected time to install the onshore cable (which should take around 4 weeks) and also in a location far more likely to have particles present, and therefore can be considered bounding to the likelihood of encountering a particle whilst installing the onshore cable. The likelihood of being exposed to a *significant*, *relevant* or *minor* particle during the onshore cable installation is considered to be therefore extremely unlikely.

Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during export cable installation)

Unmitigated Risk Rating: 1 (remote exposure to Relevant or Minor Particle during export cable installation)

Horizontal Directional Drilling (HDD)

The likelihood of encountering a particle has been estimated as approximately 1 in 1000 (without any mitigation). Therefore the likelihood of remote external exposure with a *minor*, *relevant* or *significant* particle during the Horizontal Directional Drilling is considered to be extremely unlikely.

Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during Horizontal Directional Drilling)

Unmitigated Risk Rating: 1 (remote exposure to Relevant or Minor Particle during Horizontal Directional Drilling)

Cable Route / Boulder Clearance Activities

As described in the ingestion assessment above, it is estimated that there is a < 1% likelihood of a minor or relevant particle being brought to the surface with this subsea equipment (negligible likelihood of retrieving a 100 x significant particle). The frequency factor for retrieving and being remotely exposed to a *100 x significant* particle during the cable route / boulder clearance activities is assessed to be extremely unlikely**,** with the frequency factor for retrieving and being remotely exposed to a *minor* or *significant* particle during the cable route / boulder clearance activities is assessed to be unlikely.

	Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during cable route / boulder clearance activities) **Unmitigated Risk Rating: 2 (remote exposure to Relevant or Minor Particle during cable route / boulder clearance activities)** ***Trenching Activities*** The frequency factor for retrieving and having remote exposure to a *100 x significant* particle during trenching activities is assessed to be extremely unlikely**,** with the frequency factor for retrieving and having remote exposure to a *minor* or *relevant* particle during trenching activities is assessed to be unlikely. **Unmitigated Risk Rating: 2 (remote exposure to 100 x Significant Particle during trenching activities)** **Unmitigated Risk Rating: 2 (remote exposure to Relevant or Minor Particle during trenching activities)**
2.12	***What are the consequences of possible failures of control measures – such as electrical interlocks, ventilation systems, and warning devices – or systems of work?*** The main control measures that will be in place for the wind farm installation works are the systems of work, comprising of a radiation monitoring protocol when sediments and or machinery that could hold up sediments are retrieved from the seabed, and radiation monitoring prior to and during onshore excavation work. In addition to radiation monitoring, conventional PPE should be worn (gloves, coveralls and safety glasses) when working on board a vessel that is retrieving materials from the seabed, or during excavation work for the onshore infrastructure. The consequences of failing to work with these control measures is a slight increase in the risk of exposure to radioactive particles, and less reassurance to operatives. Note that the risk factors assessed in paragraph 2.11 do not include these mitigations, but these are included and discussed in section 3.1 below.
2.13	***What are the steps to prevent identified accident situations, or limit their consequences?*** The step to prevent the identified accident situations, or limit their consequences, are identified in section 3.1 below.
3.0	**ACTIONS REQUIRED AS A RESULT OF RISK ASSESSMENT**
3.1	***What action is needed to ensure radiation exposure is ALARP?*** The potential routes for radiation exposure have been assessed in section 2.11 above. Mitigations to prevent these potential accident scenarios, or limit their consequences, are given below, noting that the risk ratings are already assessed as “low” for all identified unmitigated scenarios, whereby mitigation would not necessarily be required; however further mitigation should provide reassurance to operatives and reduce the risk levels even further. ***Anchor Installation*** Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance sensitive radiation monitoring as items are brought up to the vessel from the seabed.

Revised Post-Mitigation Risk Rating: *No change*

Mooring Installation

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance radiation monitoring as items are brought up to the vessel from the seabed.

Revised Post-Mitigation Risk Rating: *No change*

Offshore Geotechnical Surveys

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance radiation monitoring as items are brought up to the vessel from the seabed and whilst any sediment is handled. Segregation of any sediment with elevated radiation levels.

Revised Post Mitigation Risk Rating: *No change*

Export Cable Installation

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance radiation monitoring as items are brought up to the vessel from the seabed. Onshore, pre-work sensitive radiation survey (e.g. Groundhog^{TM}) of the excavation areas pre-excavation, and reassurance monitoring during excavation to identify and segregate any particles present.

Revised Post Mitigation Risk Rating: *No change*

Horizontal Directional Drilling (HDD)

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when excavating materials for the HDD work. Pre-work sensitive radiation survey (e.g. Groundhog^{TM}) of the work site and the entry pit location prior to excavating, and reassurance monitoring of spoil as it is excavated. Periodic reassurance monitoring of spoil excavated from the hole.

Revised Post Mitigation Risk Rating: *No change*

Cable Route / Boulder Clearance Activities

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance radiation monitoring as items are brought up to the vessel from the seabed and whilst they are handled.

Revised Post Mitigation Risk Rating: *No change*

Trenching Activities

Mitigation: Conventional PPE (gloves, safety glasses and coveralls) to be worn when working with materials that have been on the seabed. Reassurance radiation monitoring as items are brought up to the vessel from the seabed and whilst they are handled.

Revised Post Mitigation Risk Rating: *No change*

	Recommendation 5. Ensure that a radiation monitoring protocol is prepared and undertaken when retrieving sediments from the seabed in the FEPA zone and in the offshore zone (for reassurance). ***Installation Contractors*** **Recommendation 6.** Ensure that a sensitive surface gamma radiation survey (e.g. Groundhog™) is undertaken at all work areas onshore to be utilised for the Horizontal Directional Drilling, to identify and enable removal of any radioactive particles present. ***Installation Contractors*** **Recommendation 7**. Ensure that a sensitive surface gamma radiation survey (e.g. Groundhog™) is undertaken at all work areas onshore that are to be excavated for the export cable installation, to enable identification and removal of any radioactive particles present. ***Installation Contractors*** **Recommendation 8.** Ensure that a programme of reassurance radiation monitoring is instigated for spoil excavated during the onshore export cable installation to detect the presence of any radioactive particles. ***Installation Contractors***
3.2	***What steps are necessary to achieve this control of exposure by use of engineering controls, design features, safety devices, and warning devices and, in addition, by the development of systems of work?*** The planned systems of work, including the mitigation measures as described above is considered adequate to restrict both the likelihood and level of exposure to an insignificant level.
3.3	***Is it appropriate to provide PPE and if so what type would be adequate and suitable?*** Conventional safety gloves, coveralls and safety glasses should be worn when working with equipment and materials that could contain particles (e.g. items retrieved from the seabed, during onshore excavation activities). This is to prevent direct skin contact of radioactive particles. See Recommendation 2.
3.4	***Is it appropriate to establish dose constraints for planning or design purposes and if so what values should be used?*** There should not be any significant radiation doses associated with any of the work involved in the wind farm installation, and therefore dose constraints are not considered appropriate. In the unlikely event that radioactive particles are encountered, the simple mitigation measures discussed above should ensure that radiation exposures are negligible.
3.5	***Is there the need to alter the working conditions of any female employee who declares she is pregnant or is breastfeeding? If so what alterations are necessary?*** Ensure that any female employee who declares pregnancy is subject to a specific risk assessment to determine whether any alterations to her working conditions are necessary. **Recommendation 9.** Ensure that a specific risk assessment is undertaken for any female employee who declares they are pregnant, with advice from an RPA, to determine whether any alterations to her working conditions are necessary. ***Installation Contractors***

3.6	***What is an appropriate investigation level to check exposures are being restricted as far as reasonably practicable?*** Doses from all operations will be expected to be well below 1 mSv per year, and should be negligible. No routine investigation level is appropriate for these operations, but if any radioactive particles are inadvertently retrieved, then this should be investigated and an assessment of dose uptake included. **Recommendation 10.** Ensure that an investigation is undertaken should any radioactive particles be inadvertently retrieved, to confirm that the correct protocols were followed and assess all possible radiation dose uptakes to personnel. ***Installation Contractors***
3.7	***What maintenance and testing schedules are required for the control measures selected?*** All radiation monitoring instruments used for reassurance monitoring during the works should be maintained and subject to annual calibration.
3.8	***What contingency plans are necessary to address reasonably foreseeable accidents?*** The safe systems of work for all of the wind farm installation activities should include plans for what to do in the event of the following events: - Radioactive particle encountered (the particle should be segregated and securely stored); - Radioactive particle in contact with the skin (the particle should be located and removed as soon as possible); - Elevated dose rates due to significant radioactive particle inadvertently retrieved (the individual should be immediately transferred to a hospital and medical advice sought). **Recommendation 11**. Ensure that contingency plans for what actions to take in the case of encountering a radioactive particle, having direct particle contact with the skin or unexpectedly high radiation dose rates from a particle are included within the safe systems of work. ***Installation Contractors***
3.9	***What are the training needs of classified and non-classified employees?*** All personnel involved in the project should receive basic radiation awareness training to understand the radiological hazard, and the safeguards that are in place (for example, the specific radiation awareness training course reference 72944/TRG/001). Note that a classified person is an employee who is likely to receive an annual effective dose greater than 6 mSv. There will be no requirement for classified persons to work on this project, although some individuals may be classified due to other work they are involved in. **Recommendation 12**. Ensure that all personnel involved in the wind farm installation tasks receive radiation awareness training to understand the hazard from radioactive particles and the safeguards that are in place. ***Installation Contractors***

3.10	***Is there a need to designate specific areas as controlled or supervised areas and to specify local rules? If so what areas?*** The risk assessment has identified negligible likelihood of encountering a particle of sufficient radioactivity that it would require the designation of a controlled area, and therefore it is considered extremely unlikely that the radiological conditions for a controlled area will be met during the works. However, it is recommended that local rules are prepared as part of the system of work for each work front to summarise the radiological safeguards in place, and that the ability to set up a temporary controlled area (with signage and barriers) whilst segregating and / or storing a source. All vessels with any seabed penetration should include an appropriate secure storage location, with appropriate signage, to be prepared for the extremely unlikely event of encountering any radioactive particles. **Recommendation 13.** Ensure that a set of local rules is prepared for each work front to summarise the radiological safeguards in place, and that suitable signage / barriers to enable a controlled area to be set up are available. ***Installation Contractors***
3.11	***What are the actions needed to ensure restriction of access and other specific measures in controlled or supervised areas?*** Should any radioactive particles be encountered, they should be segregated and stored securely in a low occupancy area prior to being transferred to the Dounreay site for disposal. On all vessels where seabed works will be carried out this area should be identified and communicated to the crew with all containers, signage etc.
3.12	***Is there the need to designate certain employees as classified persons? If so who?*** There is no requirement to designate any personnel involved in the work as classified workers, as they are not likely to receive a dose in excess of 6 milliSv or the other equivalent dose thresholds given in regulation 21 of IRR17. Note that it is possible that any health physics surveyors utilised in this work will already be classified workers due to their other work with ionising radiation.

3.13	***What is the content of a suitable programme of dose assessments for employees designated as classified persons and for others who enter controlled areas?*** Extremity dosimetry (finger TLDs) and whole body dosimetry (TLDs) should be worn by personnel involved in processing sediment samples taken from within the FEPA zone, for reassurance purposes. **Recommendation 14**. Ensure that personnel involved in the processing of sediment samples taken within the FEPA zone are issued with whole body and extremity dosimetry for reassurance. ***Installation Contractors*** Extremity and whole body dosimetry should be available to be worn for any personnel who may be required to segregate any radioactive particles inadvertently encountered on any of the wind farm installation tasks. **Recommendation 15**. Ensure that whole body and extremity dosimetry is available to be worn, if radioactive particles are encountered and need to be segregated during the windfarm installation tasks. ***Installation Contractors*** With the exception of the above, there is no requirement for routine dosimetry as there should be no significant doses (internal or external). No programme of dose assessment is required. However, external dosimetry could be offered to personnel for reassurance purposes if required. **Recommendation 16.** Consider offering personnel whole body external dosimetry for reassurance purposes, particularly those working in the FEPA zone. ***Installation Contractors***
3.14	***What are the requirements for the leak testing of radioactive sources?*** There are no radioactive sources involved in this work, and therefore this point is not applicable.
3.15	***What are the responsibilities of managers for ensuring compliance with the regulations?*** The installation contractors are responsible for ensuring compliance with the ionising radiations regulations 2017, primarily by implementing the requirements of this overarching RRA, preparing detailed RRAs for specific tasks, appointing an RPA and following specific RPA advice. **Recommendation 17.** Appoint and consult a Radiation Protection Adviser to advise on regulatory compliance for the work on the wind farm installation tasks. ***Installation Contractors***
3.16	***What is an appropriate programme of monitoring or auditing of arrangements to check the requirements of Ionising Radiations Regulations are being met?*** Prior to site work commencing a readiness review should be undertaken to ensure that all appropriate radiation protection arrangements are in place, and the recommendations from this RRA have been carried out. This review should be repeated on least an annual basis for longer duration tasks. **Recommendation 18.** Undertake a "readiness review" prior to commencing site works to ensure that all radiation protection arrangements as specified in this RRA, and the detailed RRA for each task, have been put in place. ***Installation Contractors***

5.0 Summary of Recommendations

Recommendation 1. Ensure that a Safe System of Work (including a Method Statement, Risk Assessment and Local Rules) is completed for each individual wind farm installation task, and that the recommendations from this RRA and task specific RRAs are incorporated into this Safe System of Work. ***Installation Contractors***

Recommendation 2. Ensure that all personnel involved in retrieving equipment and samples from the seabed or onshore excavations are wearing protective gloves, safety glasses and coveralls during these tasks. ***Installation contractors***

Recommendation 3. Ensure that gloves and coveralls are monitored for radiation following contact with seabed or onshore sediment or spoil. ***Installation Contractors***

Recommendation 4. Ensure that any radioactive particles encountered are either segregated and placed into an appropriate sealed and robust metal container and temporarily stored in a secure, isolated area of low occupancy prior to transfer to DSRL, or if this is not possible segregate the area with barriers and signage where required to a maximum dose rate of 7.5 microSv/h or 1 m from the particle's location. ***Installation contractors***

Recommendation 5. Ensure that a radiation monitoring protocol is prepared and undertaken when retrieving sediments from the seabed in the FEPA zone and in the offshore zone (for reassurance). ***Installation Contractors***

Recommendation 6. Ensure that a sensitive surface gamma radiation survey (e.g. Groundhog^{TM}) is undertaken at all work areas onshore to be utilised for the Horizontal Directional Drilling, to identify and enable removal of any radioactive particles present. ***Installation Contractors***

Recommendation 7. Ensure that a sensitive surface gamma radiation survey (e.g. Groundhog^{TM}) is undertaken at all work areas onshore that are to be excavated for the export cable installation, to enable identification and removal of any radioactive particles present. ***Installation Contractors***

Recommendation 8. Ensure that a programme of reassurance radiation monitoring is instigated for spoil excavated during the onshore export cable installation to detect the presence of any radioactive particles. ***Installation Contractors***

Recommendation 9. Ensure that a specific risk assessment is undertaken for any female employee who declares they are pregnant, with advice from an RPA, to determine whether any alterations to her working conditions are necessary. ***Installation Contractors***

Recommendation 10. Ensure that an investigation is undertaken should any radioactive particles be inadvertently retrieved, to confirm that the correct protocols were followed and assess all possible radiation dose uptakes to personnel. ***Installation Contractors***

Recommendation 11. Ensure that contingency plans for what actions to take in the case of encountering a radioactive particle, having direct particle contact with the skin or unusually high radiation dose rates from a particle are included within the safe systems of work. ***Installation Contractors***

Recommendation 12. Ensure that all personnel involved in the wind farm installation tasks receive radiation awareness training to understand the hazard from radioactive particles and the safeguards that are in place. ***Installation Contractors***

Recommendation 13. Ensure that a set of local rules is prepared for each work front to summarise the radiological safeguards in place, and that suitable signage / barriers to enable a controlled area to be set up are available. ***Installation Contractors***

Recommendation 14. Ensure that personnel involved in the processing of sediment samples taken within the FEPA zone are issued with whole body and extremity dosimetry for reassurance. ***Installation Contractors***

Recommendation 15. Ensure that whole body and extremity dosimetry is available to be worn, if radioactive particles are encountered and need to be segregated during the windfarm installation tasks. ***Installation Contractors***

Recommendation 16. Consider offering personnel whole body external dosimetry for reassurance purposes, particularly those working in the FEPA zone. ***Installation Contractors***

Recommendation 17. Appoint and consult a Radiation Protection Adviser to advise on regulatory compliance for the work on the wind farm installation tasks. ***Installation Contractors***

Recommendation 18. Undertake a "readiness review" prior to commencing site works to ensure that all radiation protection arrangements as specified in this RRA, and the detailed RRA for each task, have been put in place. ***Installation Contractors***

6.0 References

1. Particles Retrieval Advisory Group (Dounreay). 2012 Report.

2. Ionising Radiations Regulations 2017 (incorporating Approved Code of Practice and Guidance).

3. Environmental Authorisations (Scotland) Regulations 2018.

4. The Carriage of Dangerous Goods and use of Transportable Pressure Equipment Regulations 2009.

5. Health Implications of fragments of irradiated fuel at the beach at Sandside Bay. Module 6 Overall results. Wilkins et al. RPD-EA-03-2006.

6. Public Health Implications of Fragments of Irradiated Fuel. Module 3: The likelihood of encountering a fuel fragment on Sandside beach. Smith et al. RPD-EA-9-2005.

7. Public Health Implications of Fragments of Irradiated Fuel. Module 4. External dose rates on Sandside beach and other miscellaneous information. RPD-EA-1-2006.

Appendix 1 –Risk Assessment Matrix

This appendix comprises a summary of the severity factors, frequency factors and risk ratings, bot pre-mitigation and post-mitigation, for the exposure routes identified in sections 2.11 and 3.1 of this RRA.

The severity factors specified for this risk assessment are as follows:

Severity Factor	Description (relevant to radiological hazards)
1	Limited radiological consequences e.g. minor spread of contamination **or** a negligible dose (< 1 μSv, which is less than the average daily background dose received by people in the UK)
2	Whole Body Effective Dose up to 1 milliSv (which is the annual public dose limit) **or** a significant spread of contamination
3	Whole Body Effective Dose between 1 milliSv and 20 milliSv (which is the annual occupational dose limit) **or** minor tissue effects (such as a temporary skin lesion that should heal naturally)
4	Effective dose likely to exceed any dose limit **or** an equivalent dose likely to result in significant tissue effects that would require medical treatment (such as skin ulceration or internal damage to digestive tract)
5	Effective Dose likely to be above tissue effect threshold, **or** potentially fatal equivalent radiation dose

The frequency factors specified for this risk assessment are as follows:

Frequency Factor	Description
1	Extremely Unlikely Occurrence, **considered to be < 0.1% likely to occur during the project**
2	Unlikely / Possible Occurrence, **considered to be 0.1% to 10% likely to occur during the project**
3	Likely / Occasional occurrence, **considered to be 10% to 50% likely to occur during the project**
4	Very Likely / Frequent Occurrence, **considered to be 50% to 80% likely to occur during the project**
5	Almost certain / Regular Occurrence, **considered to be > 80% likely to occur during the project**

The Risk Ratings specified in this risk assessment are as follows:

Risk Rating (RR)	Classification	Action Required
1-4	Low (L)	None or limited action
5-9	Medium (M)	Additional control measures should be used where reasonably practicable
≥ 10	High (H)	Redesign the task / operation if control measures do not control the risk

The information in the tables above feeds into the following risk matrix to determine whether more action needs to be taken to reduce risks further:

Severity Factor	**5**	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	**2**	**3**	**4**	**5**
		Frequency Factor				

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
1	Anchor installation	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
2	Anchor installation	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
3	Anchor installation	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
4	Anchor installation	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	3	1	3
5	Anchor installation	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
6	Anchor installation	Remote Exposure to a Relevant or Minor Particle	1	1	1	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	1	1	1
7	Mooring Installation	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
8	Mooring Installation	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
9	Mooring Installation	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
10	Mooring Installation	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	3	1	3
11	Mooring Installation	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
12	Mooring Installation	Remote Exposure to a Relevant or Minor Particle	1	1	1	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	1	1	1
13	Offshore Geotechnical Surveys	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	4	1	4
14	Offshore Geotechnical Surveys	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	2	1	2

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
15	Offshore Geotechnical Surveys	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	4	1	4
16	Offshore Geotechnical Surveys	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	3	1	3
17	Offshore Geotechnical Surveys	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	2	1	2
18	Offshore Geotechnical Surveys	Remote Exposure to a Relevant or Minor Particle	1	1	1	Reassurance radiation monitoring of items retrieved from the seabed. Radiation monitoring protocol for dealing with sediments. PPE (coveralls, gloves, safety glasses).	1	1	1
19	Export Cable Installation	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	4	1	4

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
20	Export Cable Installation	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	2	1	2
21	Export Cable Installation	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	4	1	4
22	Export Cable Installation	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	3	1	3
23	Export Cable Installation	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	2	1	2
24	Export Cable Installation	Remote Exposure to a Relevant or Minor Particle	1	1	1	Reassurance radiation monitoring of items retrieved from the seabed. Pre-works radiation survey of onshore excavation locations. PPE (coveralls, gloves, safety glasses).	1	1	1

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
25	Horizontal Directional Drilling	Ingestion of a 100 x Significant Particle	4	1	4	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	4	1	4
26	Horizontal Directional Drilling	Ingestion of a Relevant or Minor Particle	2	1	2	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	2	1	2
27	Horizontal Directional Drilling	Skin Contact with a 100 x Significant Particle	4	1	4	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	4	1	4
28	Horizontal Directional Drilling	Skin Contact with a Relevant of Minor Particle	3	1	3	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	3	1	3
29	Horizontal Directional Drilling	Remote Exposure to a 100 x Significant Particle	2	1	2	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	2	1	2
30	Horizontal Directional Drilling	Remote Exposure to a Relevant or Minor Particle	1	1	1	Pre-works radiation survey of onshore excavation locations. Reassurance monitoring of spoil. PPE (coveralls, gloves, safety glasses).	1	1	1

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
31	Cable Route / Boulder Clearance Activities	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
32	Cable Route / Boulder Clearance Activities	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
33	Cable Route / Boulder Clearance Activities	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
34	Cable Route / Boulder Clearance Activities	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	3	1	3
35	Cable Route / Boulder Clearance Activities	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
36	Cable Route / Boulder Clearance Activities	Remote Exposure to a Relevant or Minor Particle	1	2	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	1	2	2
37	Trenching Activities	Ingestion of a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4

Item	Activity	Exposure Route / Hazard	Severity Factor	Frequency Factor	Risk Rating	Mitigation Measures	Revised Severity Factor	Revised Frequency Factor	Revised Risk Rating
38	Trenching Activities	Ingestion of a Relevant or Minor Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
39	Trenching Activities	Skin Contact with a 100 x Significant Particle	4	1	4	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	4	1	4
40	Trenching Activities	Skin Contact with a Relevant of Minor Particle	3	1	3	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	3	1	3
41	Trenching Activities	Remote Exposure to a 100 x Significant Particle	2	1	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	2	1	2
42	Trenching Activities	Remote Exposure to a Relevant or Minor Particle	1	2	2	Reassurance radiation monitoring of items retrieved from the seabed. PPE (coveralls, gloves, safety glasses).	1	2	2