Salamander Offshore Wind Farm

Offshore EIA Report

Volume ER.A.3, Chapter 20: Climate Change and Carbon

SALAMANDER

Powered by Ørsted and Simply Blue Group

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Glossary

Term	Definition
Applicant	Salamander Wind Project Company Limited (SWPC) (formerly called Simply Blue Energy (Scotland) Limited), a joint venture between Ørsted, Simply Blue Group, and Subsea7.
Cumulative effects	The combined effect of the Salamander Project with the effects from a number of different projects, on the same single receptor/resource.
Design Envelope	A description of the range of possible elements that make up the Salamander Project design options under consideration, as set out in detail in the project description. This envelope is used to define the Salamander Project for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
EIA Regulations	The regulations that apply to this project are the Electricity Works (EIA) (Scotland) Regulations 2017, the Marine Works (EIA) (Scotland) Regulations 2017 and the Marine Works (EIA) Regulations 2007, and the Town and Country Planning (EIA) (Scotland) Regulations 2017.
Energy Balancing Infrastructure (EBI)	Energy Balancing Infrastructure which will provide services to the electrical grid, such as storing energy to meet periods of peak demand and improving overall reliability, as well as additional services such as system monitoring and computing. EBI will be housed within buildings and / or containers will be co-located with the Onshore Substation.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Regulations, including the publication of an Environmental Impact Assessment Report (EIAR).
Environmental Impact Assessment Report (EIAR)	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations.
Habitats Regulations Appraisal	A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European conservation sites and Ramsar sites (when these are also an SPA or SAC). The process consists of a multi stage assessment which incorporates screening, appropriate assessment,

Term	Definition
	assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI) and compensatory measures.
Kyoto Protocol	The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its parties to reducing greenhouse gas emissions by setting internationally binding emission reduction targets, implemented primarily through national measures but also via wider market based mechanisms.
Landfall	The generic term applied to the entire landfall corridor between Mean Low Water Spring (MLWS) tide and the Transition Joint Bay (TJB) inclusive of all construction works, including the offshore and onshore Export Cable Corridor (ECC), and landfall compound, where the offshore cables come ashore north of Peterhead.
Offshore Development	The entire Offshore Development, including all offshore components of the Salamander Project (Wind Turbine Generators (WTGs), Inter-array and Offshore Export Cable(s), floating substructures, mooring lines and anchors, and all other associated offshore infrastructure) required across all Project phases from development to decommissioning, for which the Applicant is seeking consent.
Offshore Development Area	The total area comprising the Offshore Array Area and the Offshore Export Cable Corridor.
Onshore Development Area	The total area comprising the Onshore Infrastructure and Onshore Export Cable Corridor.
Salamander Project	The proposed Salamander Offshore Wind Farm. The term covers all elements of both the offshore and onshore aspects of the Salamander Project.
Scoping	An early part of the EIA process by which the key potential significant impacts of the Salamander Project are identified, and methodologies identified for how these should be assessed. This process gives the relevant authorities and key consultees opportunity to comment and define the scope and level of detail to be provided as part of the EIAR – which can also then be tailored through the consultation process.

Acronyms

Term	Definition
AWI	Ancient Woodland Inventory
CEA	Cumulative Effect Assessment
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
GHG	Greenhouse Gas
GWh	Gigawatt Hours
HFCs	Hydrofluorocarbons
HRA	Habitats Regulations Appraisal
IAQM	Institute of Air Quality Management
ICCI	In-combination Climate Impact
IEMA	Institute of Environmental Management and Assessment
IPCC	International Panel on Climate Change
JV	Joint Venture
Km	Kilometres
MCCIP	Marine Climate Change Impacts Partnership
MD-LOT	Marine Directorate – Licensing Operations Team
MHWS	Mean High Water Springs
mm	Millimetres

Term	Definition
MW	Megawatts
NF_3	Nitrogen Trifluoride
N_2O	Nitrous Oxide
NVC	National Vegetation Classification
OAA	Offshore Array Area
O&M	Operation and Maintenance
PAS	Publicly Available Specification
PFCs	Perfluorocarbons
PPG	Pollution Prevention Guidelines
RCP	Representative Concentration Pathway
SF_6	Sulphur Hexafluoride
SWPC	Salamander Wind Project Company Limited (formerly called SBES)
UK	United Kingdom
UKCS	UK Continental Shelf
UKCP	UK Climate Projections
UKHab	UK Habitat classification survey

20 Climate Change and Carbon

20.1 Introduction

20.1.1.1 The Applicant, Salamander Wind Project Company (SWPC), a Joint Venture (JV) partnership between Ørsted, Simply Blue Group and Subsea7, is proposing the development of the Salamander Offshore Wind Farm (hereafter the 'Salamander Project'). The Salamander Project will consist of the installation of a floating offshore wind farm (up to 100 megawatts (MW) capacity) approximately 35 kilometres (km) east of Peterhead. It will consist of both offshore and onshore infrastructure, including an offshore generating station (wind farm), export cables to landfall, and connection to the electricity transmission network (please see **Volume ER.A.2, Chapter 4: Project Description** for full details on the Project design).

20.1.1.2 This chapter of the Environmental Impact Assessment Report (EIAR) presents the results of the EIA of potential effects of the Salamander Project on Climate Change and Carbon. Specifically, this chapter considers the potential impact of the Salamander Project during the construction, operation and maintenance, and decommissioning phases of the Onshore and Offshore Developments.

20.1.1.3 The chapter provides an overview of the existing environment for the proposed Onshore and Offshore Development Areas, followed by an assessment of significance of effect on climate change and greenhouse gas (GHG) emissions (calculated in carbon dioxide equivalent (CO_2e)), as well as an assessment of potential effects arising from the effects of climate change.

20.1.1.4 This chapter has been authored by Environmental Resources Management (ERM) Ltd. Further competency details of the authors of this chapter are outlined in **Volume ER.A.4, Annex 1.1: Details of the Project Team.**

20.2 Purpose

20.2.1.1 The primary purpose of this EIAR is for the application for the Salamander Project satisfying the requirements of Section 36 of the Electricity Act 1989, associated Marine Licences, and relevant planning permissions. This EIAR chapter includes:

- A **Climate Resilience Review** – this describes and assesses the potential physical climate-related risks which could impact the Salamander Project throughout the Project lifecycle, under both present day and future projected climatic conditions.
- A **GHG Assessment** – this includes consideration of GHG emissions throughout the entire lifecycle of the Salamander Project, generated through embodied carbon within construction materials and vehicle use across the lifespan of the Salamander Project.
- A **Blue Carbon Assessment** – this reviews the potential loss of stored carbon within the marine environment as a result of disturbance and habitat loss from the Offshore Salamander Project.
- A **Terrestrial Carbon Assessment**- this assessment considers the potential loss of stored carbon within the Onshore Salamander Project as a result of habitat loss caused by the Salamander Project development.

20.2.1.2 The EIAR has been finalised following the completion of the pre-application consultation (**Volume RP.A.4, Report 1: Pre-Application Consultation (PAC) Report**) and the Salamander EIA Scoping Report (SBES, 2023) (and takes account of the relevant advice set out within the Scoping Opinion from Marine Directorate - Licensing Operations Team (MD-LOT) (MD-LOT, 2023). Comments relating to the Energy Balancing Infrastructure (EBI) will also be addressed within this EIAR. This EIAR will accompany the application to MD-LOT for Section 36 Consent under the Electricity Act 1989, and Marine Licences under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009.

20.2.1.3 This Climate Change and Carbon chapter assesses both the onshore and offshore aspects of the Salamander Project and will be included in both the Onshore and Offshore EIARs. The Offshore EIAR will accompany the application to MD-LOT for Section 36 Consent, as required under the Electricity Act 1989, Marine Licences under the Marine (Scotland) Act 2010 for the works within 12 nm of the coast and the Marine and Coastal Access Act 2009 for the offshore works (12 – 200 nm), while the Onshore EIAR will accompany the planning application to Aberdeenshire Council and the application to the Scottish Ministers for consent under Section 36 of the Electricity Act in relation to the EBI.

20.2.1.4 This EIAR chapter:

- Outlines the existing environmental baseline determined from assessment of publicly available data, project-specific survey data and stakeholder consultation;
- Presents the potential environmental impacts and resulting effects arising from the Salamander Project on climate change receptors;
- Identifies mitigation measures designed to prevent, reduce, or offset adverse effects and enhance beneficial effects on the environment;
- Identifies any uncertainties or limitations in the methods used and conclusions drawn from the compiled environmental information.

20.3 Planning and Policy Context

20.3.1.1 The preparation of the Climate Change and Carbon Chapter has been informed by the following policy, legislation, and guidance outlined in **Table 20-1**.

Table 20-1 Relevant policy, legislation and guidance for the Climate Change and Carbon Chapter assessment

Relevant policy, legislation, and guidance
Policy
Scotland's National Marine Plan (2015)
National Planning Framework 4 (2023)
Climate Change Scotland: Scottish Climate Change Adaptation Programme 2019-2024 (2019)
Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update (2020)
The Innovation and Targeted Oil and Gas Decarbonisation Sectoral Marine Plan (2022)
The Electricity Generation Policy Statement (2013)
Aberdeenshire Local Development Plan (2023): • Policy C2: Renewable Energy; • Policy C4: Flooding; and • Policy P4: Hazardous and Potentially Polluting Developments and Contaminated Land.
Offshore Wind Policy Statement (2020)

Relevant policy, legislation, and guidance
Draft Energy Strategy and Just Transition Plan (2023)
Legislation
Marine and Coastal Access Act (2009)
The UN Framework Convention on Climate Change
The Kyoto Protocol
The Paris Agreement
The Climate Change Act 2008
Climate Change (Scotland) Act 2009
The Town and Country Planning (Scotland) Act 1997
The Town and Country Planning (Environmental Impact Assessment) Regulations 2017
The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019
The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017
The Marine Works (Environmental Impact Assessment) Regulations 2007
The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017
Electricity Act 1989
EU Directive 2008/50/EC Ambient Air Quality and cleaner air for Europe (transposed into Scottish legislation through the Air Quality Standards (Scotland) regulations 2010)
Guidance
Climate Change Resilience and Adaptation (Institute of Environmental Management and Assessment (IEMA), 2020)
Assessing Greenhouse Gas Emissions and Evaluating their Significance (IEMA, 2022)
Guidance on land-use planning and development control: Planning for air quality (Institute of Air Quality Management (IAQM), 2017)
Air quality monitoring in the vicinity of Demolition and construction sites (IAQM, 2018)
A guide to the assessment of air quality impacts on designated nature conservation sites (IAQM, 2020)

Relevant policy, legislation, and guidance
Pollution Prevention Guidelines 6 (PPG6): working at construction and demolition sites (currently under review) (SEPA et al., 2012)

20.3.1.2 Further details on the requirements for EIA are presented in V**olume ER.A.2, Chapter 2: Legislative Context and Regulatory Requirements.**

20.4 Consultation

20.4.1.1 Consultation is a key part of the application process. It has played an important part in ensuring that the baseline characterisation and impact assessment is appropriate to the scale of development as well as meeting the requirements of the regulators and their advisors.

20.4.1.2 An overview of the Salamander Project consultation process is outlined in **Volume ER.A.2, Chapter 5: Stakeholder Consultation**. Consultation regarding climate change and carbon has been conducted through the EIA scoping process.

20.4.1.3 The issues raised during consultation specific to climate change and carbon are outlined in **Table 20-2**, including consideration of where the issues have been addressed within the EIAR.

Table 20-2 Consultation responses specific to the Climate Change and Carbon chapter

Consultee	Date and Forum	Topic and Agreements	Where it is addressed within this EIAR
MD-LOT	21 June 2023; Scoping Opinion	**Climate and Greenhouse Gases** The Scoping Report proposes that the impact of climate change effects will be considered within a standalone chapter within the EIA Report. The Scottish Ministers are mindful that Greenhouse Gas ("GHG") emissions from all projects contribute to climate change. In this regard, the Scottish Ministers highlight the IEMA Environmental Impact Assessment Guide "Assessing Greenhouse Gas Emissions and Evaluating Their Significance" ("IEMA GHG Guidance"), which states that "GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as a such any GHG emissions or reductions from a project might be considered significant." The Scottish Ministers have considered this together with the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 and the requirement of the EIA Regulations to assess significant effects from the Proposed Development on climate. The Scottish Ministers therefore advise that the EIA Report must include a GHG Assessment which should be based on a Life Cycle Assessment ("LCA") approach and note that the IEMA GHG Guidance provides further insight on this matter. The Scottish Ministers highlight however that this should include the pre-construction, construction, operation and decommissioning phases, including consideration of the supply chain as well as benefits beyond the life cycle of the Proposed Development.	GHG assessment is presented in **Section 20.8.**
MD-LOT	21 June 2023; Scoping Opinion	The Scottish Ministers broadly agree with the proposed methods of assessment and impacts identified within Section 9.9 of the Scoping Report and would defer the Developer further to the Scottish Ministers comments provided at Section 3.5 of this Scoping Opinion. In addition, the Scottish Ministers direct the Developer to the NatureScot response with regard to consideration of climate change effects in both futureproofing the Proposed Development project design and in considering both the benefits and carbon costs	Comments relating to Section 3.5 of the Scoping Opinion are addressed in **Section 20.8** of this chapter as detailed in the row above.

Consultee	Date and Forum	Topic and Agreements	Where it is addressed within this EIAR
		associated with the Proposed Development overall which must be fully addressed by the Developer within the EIA Report.	
NatureScot	21 June 2023; comments on EIA Scoping Report	**Climate Change and Carbon Costs** The impact of climate change effects should be considered, both in futureproofing the project design and in considering both the benefits (production of renewable energy) and carbon costs (manufacturing and disposal of components) i.e. the carbon cycle associated with the project overall. We recognise that some aspects of this topic are addressed in Section 9.9 (Climate Change and Carbon). **Blue Carbon** In addition to the climate change and carbon assessment mentioned in the Scoping Report, we recommend that consideration is given to impacts on blue carbon. Not just in respect of the wind farm itself, but also in terms of any wet storage areas. We note that blue carbon has been recognised within the Benthic section of the Scoping Report at 8.1.5, with key habitats identified that support blue carbon storage and sequestration.	Potential future climate changes are outlined in **Section 20.6** and subsequent impacts of climate change effects as well as future proofing the Salamander Project are considered within the assessment of significance in **Section 20.7**. The GHG assessment in **Section 20.8** considers the carbon costs. Blue carbon is considered in **Section 20.9**, and terrestrial carbon is considered in **Section 20.10.** Wet storage of the floating substructures (and integrated WTGs) prior to tow-out to the Offshore Array Area (OAA) is considered to be outside the scope of this EIA and the Marine Licence applications for the Offshore Development. This is due to the fact that at this stage of the Salamanader Project it is not known which port(s) will be used for wet storage and therefore it is challenging to undertake a meaningful assessment of impacts related to wet storage. See **Section 20.9.3** for detail.
NatureScot	21 June 2023; comments on EIA Scoping Report	**Wet storage** Section 4.6.2 (Floating Substructures) refers to the potential for wet storage of the substructures prior to their installation within the OAA, either at the initial assembly site, the wind turbine integration site or a separate dedicated storage location. Section 4.7.1 (Floating Assembly) also indicates that once operational the substructures and WTGs will form an integrated assembly piece – the replacement of any major component parts of which is expected to be achieved by towing the assembly to port. Wet storage could represent a significant impact. Consideration of the potential impacts on all receptors needs to be addressed with the EIAR and HRA. We would welcome further discussion on this as and when further details are confirmed, noting the intention to seek a separate marine licence application for any requirements for wet storage outwith the OAA.	Wet storage of the floating substructures (and integrated WTGs) prior to tow-out to the OAA is considered to be outside the scope of this EIA and the Marine Licence applications for the Offshore Development. This is due to the fact that at this stage of the Salamander Project it is not known which port(s) will be used for wet storage and therefore it is challenging to undertake a meaningful assessment of impacts related to wet storage. The intent is that the Salamander Project will utilise the services of a port(s) that offer wet storage sites, which will have appropriate consents (obtained by the port authority) for wet storage of floating substructures, fabrication and assembly with the WTGs. To enable the availability of this option for the Salamander Project within the required timeframe, an owner of SWPC is an official member of the TS-FLOW UK-North Joint Industry Project (JIP) exploring the challenges of wet storage and identifying the opportunities

Consultee	Date and Forum	Topic and Agreements	Where it is addressed within this EIAR
			and potentially suitable locations for these activities. This JIP is in collaboration with relevant ports and other floating offshore wind developers. Separate Marine Licences and associated impact assessments for wet storage areas outwith the Offshore Development Area will be applied for and undertaken as appropriate.
Aberdeenshire Council	26 April 2023; Scoping Opinion.	Climate Change and Carbon; and Socioeconomics are to be detailed within the offshore section of the EIA, which would be acceptable within a combined EIA approach. However, if you opt to submit separate EIA's for marine and terrestrial planning, you will need to address Climate Change and Carbon; and Socioeconomics within the Terrestrial EIA.	The Climate Change and Carbon chapter assesses both the onshore and offshore aspects of the Salamander Project and will be included in both the onshore and offshore EIA Reports.

20.5 Methodology to Inform Baseline

20.5.1 Site Specific Surveys

20.5.1.1 No site-specific surveys were undertaken for climate change and carbon as it is a desk-based assessment.

20.5.2 Data Sources

20.5.2.1 The data sources that have been used to inform this Climate Change and Carbon chapter of the EIA Report are set out within **Table 20-3**.

Table 20-3 Summary of key publicly available datasets for Climate Change and Carbon chapter

Source	Year	Spatial Coverage	Summary
Publicly Available Specification (PAS) 2080: 2016 Carbon Management in Infrastructure	2022	UK	PAS 2080 - carbon management in infrastructure | The Carbon Trust
Reports prepared and published by Marine Climate Change Impacts Partnership (MCCIP)	2020	UK	WELCOME TO THE MCCIP | Marine Climate Change Impacts Partnership
UK Climate Projections (UKCP18)	2019	UK	UK Climate Projections (UKCP) - Met Office
Aberdeenshire Council Air Quality Progress Reports (last updated 2021)	2021	Aberdeenshire	Air quality reports | Aberdeen City Council
Air Quality in Scotland	2014	Scotland	Air Quality Management Areas (scottishairquality.scot)
Digest of UK Energy Statistics (DUKES): electricity. Estimated carbon dioxide emissions from electricity supplied (DUKES 5.14)	2023	UK	Digest of UK Energy Statistics (DUKES): electricity - GOV.UK (www.gov.uk)

Source	Year	Spatial Coverage	Summary
Life Cycle Costs and Carbon Emissions of Offshore Wind Power	2015	Scotland	https://www.climatexchange.org.uk/media/1461/main_report_-_life_cycle_costs_and_carbon_emissions_of_offshore_wind_power.pdf

20.6 Future Baseline Environment

20.6.1.1 This section describes historic climate trends and future projections for Scotland and the wider UK. Climate projections are framed around timescales available from modelled data. Where possible, a 30- or 35-year projection has been used to align with the 35-year proposed operation and maintenance phase of the Salamander Project. Where not available, other timeframes are used and detailed within the specific topics covered.

20.6.2 Physical Environment

Air Temperature

20.6.2.1 Natural variations in air temperature are anticipated over the coming century, leading to expected temporary intervals of both warmer and cooler weather. Despite this, average air temperatures are increasing globally due to climate change, with a strong level of confidence that a consistent pattern of long-term warming has been evident throughout the UK continental shelf (UKCS) (Tinker and Howes, 2020). Future changes in UK weather and climate depend on both the amount of future global GHG emissions and on how the climate responds to these emissions. In 2014, the International Panel on Climate Change (IPCC) introduced the 'Relative Concentration Pathway' (RCP) scenarios as a means of assessing potential future climate change pathways based on atmospheric GHG concentrations. These pathways outline various climate change scenarios, all of which are plausible depending on the quantity of greenhouse gases released in the future. The RCPs, originally named RCP2.6, RCP4.5, RCP6, and RCP8.5, correspond to a potential range of radiative forcing[1] values in the year 2100 (2.6, 4.5, 6, and 8.5 W/m^2, respectively). Higher values indicate greater greenhouse gas emissions, leading to elevated global temperatures and more pronounced impacts of climate change. According to the 'business as usual' projections, the RCP8.5 scenario, by the year 2070 annual temperatures in the UK are expected to rise by approximately 0.7°C to 4.2°C during winter and 0.9°C to 5.4°C during summer when compared to the mean temperature between 1981 and 2000 (Lowe *et al.*, 2018). There is a north-south warming gradient expected to occur across the UK, with greater warming in the south than in the north (which includes the eastern regions of Scotland where the Salamander Project is located) (Met Office, 2019).

20.6.2.2 UKCP18 suggest that hotter summers will likely become more frequent; Scotland's ten warmest years on record have all occurred since 1997 (Scottish Government, 2021). By the middle of the century, summers will experience warming events such as those observed in 2018 more frequently (where temperatures were, on average, 2°C warmer than the 1981-2000 baseline), with a projected probability of over 50% (Lowe *et al.*, 2018). There will likely be a greater occurrence of daytime temperatures surpassing 30°C for consecutive periods of two days or more; although this pattern of temperatures exceeding 30°C for two or more

[1] Radiative forcing is a measure of the perturbation to the Earth's energy balance caused by external factors, such as changes in atmospheric composition or solar radiation. It quantifies the influence these factors have on the planet's energy budget by assessing the net change in energy flux at the top of the atmosphere, where a positive radiative forcing contributes to warming the Earth's surface and negative forcing leads to cooling.

consecutive days primarily applies to the southeast of the UK (Met Office, 2022). Whilst the east of Scotland is also expected to experience a heightened occurrence of hot summers, this will likely be to a lesser degree.

Precipitation

20.6.2.3 In the 'business as usual' scenario RCP8.5, UK average precipitation changes are -1% to +35% for winter, and -47% to +2% for summer when compared to the 1981 to 2000 mean, where positive values indicate more precipitation and negative values indicate reduced precipitation. In general, the projections indicate a tendency toward more frequent occurrences of warmer and wetter winters across the UK. Although cold and drier winters will still manifest due to inherent fluctuations in the climate system, it is anticipated that their frequency will reduce. In the summer months, the trend points toward a heightened occurrence of hotter and drier summers, but with occasional instances of cooler summers and wetter summers also. Between 2008 and 2017, Scotland experienced a 4% increase in rainfall compared to the mean from 1981 to 2010 (Lowe *et al.*, 2018). The overall trend of reduced summer precipitation levels is anticipated to be less pronounced in northern Scotland than in the southern regions of the UK (Met Office, 2019b).

20.6.2.4 The west of Scotland will experience a more significant increase in rainfall compared to the east, much of which is sheltered from the rain bearing westerly winds. This shelter reaches its greatest potential around the Moray Firth, where rainfall received is less than 700 millimetres (mm) on average per year (Met Office, 2023). Nevertheless, extreme downpours are expected to become more frequent. Recent research suggests that by 2070, east Scotland could see extreme downpour events occur eight times more frequently than they do today, whereas in the south of England, they are expected to be three times more common (Kendon, Fischer and Short, 2023).

Wind, Storms, Waves

20.6.2.5 Eastern Scotland is a windier part of the UK, particularly between December and February where mean speeds and gusts are high due to the increased frequency and strength of Atlantic depressions (Met Office, 2023). The frequency and intensity of storms in the northern Atlantic Ocean have been on the rise, however ascribing such shifts in weather patterns to climate change is challenging due to the high variability and limited understanding of climate mechanisms (Wolf *et al.*, 2020). Nevertheless, it is predicted that variability in wind, storms and waves will continue to be dominated by natural variability due to the action of internal climate modes over climate change (Pryor *et al.*, 2020). Mean significant wave height has decreased in the north of the UK whilst increasing in the south. Time-series data on mean significant wave height generally indicates an increase in wave heights in the northeastern Atlantic Ocean, primarily attributed to Atlantic swell rather than heightened wind speeds (Wolf *et al.*, 2020).

20.6.2.6 Climate change may still exert an influence on storm paths, subsequently affecting winds and wave heights, though significant uncertainty surrounds these predictions. Model outputs vary, with some indicating an anticipated increase in near-surface wind speeds across the UK between 2050 and 2100, along with a heightened frequency of winter storms under a high emissions scenario, and others showing no trend in wind speed over the same period (Met Office, 2019c). Projections also suggest a probable reduction in mean significant wave height overall, while the annual maximum wave height may increase by 0.5 m, indicating a rise in the height of extreme waves due to receding Arctic Sea ice and increased fetch (Wolf *et al.*, 2020). A decrease in mean significant wave height is likely linked to the enhanced warming of the Arctic, which reduces the temperature gradient between the Arctic and extratropical regions (Seiler and Zweirs, 2015). Nevertheless, projections from UKCP18 present a mixed picture regarding a general decrease in wave heights during the 21st century, with varying predictions about changes in extreme/severe wave heights among different models (Palmer *et al.*, 2018).

Sea Surface and near-bottom temperatures

20.6.2.7 Over the last 40 years, sea surface temperatures around the UK have risen by approximately 0.3°C per decade (Cornes *et al.*, 2023). In their 2020 study, Tinker and Howes (2020) investigated the warming trends in sea-surface temperatures spanning roughly three decades, from 1988 to 2017. Their analysis points out that the most pronounced increases in sea surface temperatures were evident in the northern regions of Scotland and in the North Sea where the Salamander Project is located (Tinker and Howes, 2020). Future projections for sea surface temperature increases in the North Sea by the year 2100 vary, ranging from 1°C to 4°C, contingent on geographic location and the specific climate model employed (Cornes *et al.*, 2023).

20.6.2.8 **Table 20-4** outlines the anticipated sea surface and near-bottom temperature increases for the central North Sea and UK shelf sea regions (note, Cornes *et al.*, 2023 characterised the region in which the Salamander Project is located as the northern North Sea, meanwhile in this EIAR it is described as the central North Sea. It is referred to as the central North Sea within **Table 20-4** and **Table 20-5** to remain consistent with the wider EIAR). These values denote the anticipated temperature discrepancies between the periods of 2000 to 2019 and 2079 to 2098. Importantly, the predictions have a high degree of confidence, as emphasised by Cornes *et al.*, 2023.

Table 20-4 Regional mean changes in sea surface and near-bottom temperatures between 2000-2019 and 2079-2098 (Cornes *et al.*, 2023)

Region	Sea Surface Temperature	Near-Bottom Temperature
Central North Sea	+3.14°C	+2.28°C
Shelf Seas	+3.11°C	+2.49°C

Stratification, Dissolved Oxygen, and Salinity

20.6.2.9 There are indications that the timing of thermal stratification in the North Sea has shifted over time, with a tendency to commence earlier in the year. Currently, there is no concrete evidence suggesting that this trend will persist or that it exceeds what could be attributed to natural variability. Climate projections predict that the onset of stratification in spring across the UKCS will likely begin one week earlier by the end of the century. Moreover, the breakdown of stratification in autumn is projected to happen five to ten days later compared to present day, primarily due to rising air temperatures. Under the RCP8.5 emissions scenario, the UKCS is expected to experience stronger stratification, resulting from alterations in seasonal heating cycles. This could potentially reduce the upward mixing of nutrients, leading to decreased primary production (Sharples *et al.*, 2020).

20.6.2.10 In the central North Sea, where the Salamander Project is located, shifts in the dynamics of exchange with the North Atlantic Ocean are anticipated. These changes could potentially result in permanent stratification, due to both salinity differences during winter and temperature differences during summer (Holt *et al.*, 2018). Permanent stratification would have severe consequences for the levels of dissolved oxygen within the sea. Roughly one-third of the projected reduction in future dissolved oxygen levels is anticipated to arise directly from the warming of the ocean, which reduces the solubility of oxygen. The remaining declines are linked to increased biological oxygen consumption. Dissolved oxygen concentrations are projected to continue declining in the North Sea through the end of the century, potentially reaching up to an 11.5% reduction when comparing the period from 2090 to 2100 with the period from 2000 to 2010 under the Special Report on Emissions Scenarios (SRES) A1B emissions scenario (Mahaffey *et al.*, 2020). For context, SRES were the emission scenarios adopted by the IPCC prior to the creation of the RCP scenarios; A1B refers to a future of globalisation and rapid economic and technical growth, with a balanced emphasis on all energy sources (i.e., a balanced use of both fossil fuel and non-fossil fuel based energy types) (Nakićenović, et al., 2000).

20.6.2.11 Over the past five years, salinity of waters off the coast of Scotland, such as the eastern North Atlantic, has decreased dramatically. However, this trend is less pronounced in the North Sea, where no clear long-term trend has emerged (Dye *et al.*, 2020). When the SRES A1B emissions scenario is considered, it is predicted that the North Sea's waters will become less saline by 2100 due to ocean circulation changes driven by climate change. The anticipated change in sea surface and near-bottom salinity is detailed in **Table 20-5**.

Table 20-5 Ensemble mean changes in annual sea surface and near-bottom salinity (psu) between 1960-1989 and 2069-2098 (Tinker, et al., 2016)

Region	Sea Surface Salinity	Near-Bottom Salinity
Central North Sea	-0.62 psu	-0.52 psu
Shelf Seas	-0.41 psu	-0.33 psu

20.6.2.12 The level of confidence in these predictions varies, with moderate confidence in the case of dissolved oxygen and salinity and lower confidence when it comes to stratification (Sharples *et al.*, 2020; Mahaffey *et al.*, 2020; Dye *et al.*, 2020).

Ocean Acidification

20.6.2.13 Ocean acidification is another consequence of climate change that brings about alterations in the ocean's physical characteristics, leading to impacts on marine life. It occurs when the ocean absorbs increased levels of anthropogenic carbon dioxide (CO_2), resulting in a decrease in pH.

20.6.2.14 The concentration of atmospheric CO_2 has now surpassed 420 parts per million, marking an increase of 50% since the start of the industrial revolution. Annually, approximately a quarter of anthropogenic CO_2 emissions are absorbed by the Earth's global oceans. Data collected through monitoring efforts in the North Sea have revealed evident shifts in pH levels at various sites along the shelf and coastal regions. Measurements taken at Stonehaven, located 90 km southwest of the Salamander Project, during the period from 2009 to 2013, revealed a pH decrease of 0.1 in this timeframe, with the most pronounced reduction occurring during the summer months, specifically from March to August (Humphreys *et al.*, 2020). The trends in pH variability remain uncertain, and further research is necessary to unravel and better understand the observed fluctuations.

20.6.2.15 Projections from models indicate that the pH levels of seawater on continental shelves will continue to decrease at rates comparable to those observed today until the year 2050. Following this, the rate of decline is expected to accelerate in the latter half of the century, contingent upon the emissions scenario (Findlay *et al.*, 2022). Under a high emission, business as usual scenario (RCP8.5), it is projected that the pH in the UKCS could decrease at a mean rate of 0.0036 per year, resulting in a drop of pH of approximately 0.366 between 1990 and 2100 (Humphreys *et al.*, 2020).

Sea Level Rise and Coastal Erosion

20.6.2.16 Climate change brings with it the potential consequences of sea-level rise and coastal erosion. Sea-level rise occurs due to a reduction of glacial ice on land and the expansion of seawater as it warms. Between 1993 and 2010, the average global sea-level rise was measured at 3.2 mm per year, and there is well-documented evidence of a long-term escalation in the rate of sea-level rise throughout the 20th century (Horsburgh *et al.*, 2020).

20.6.2.17 Over the past 20,000 years, the central regions of Scotland have experienced land rebound as the remnants of the Scottish ice sheet melted away, relieving pressure on the land. Initially, this rebound outpaced the global sea-level rise. However, the rate of uplift has since significantly decreased, with no more than a 0.6 mm increase per year. In contrast, coastal waters around the UK are seeing sea levels rise by as much as 2 mm per year. Consequently, Scotland, as a whole, is now encountering rising sea levels (NatureScot, 2022).

20.6.2.18 Aberdeen, located 72.2 km southwest of the OAA, has seen trend analysis indicating an annual sea level rise of 9.7 mm per decade up to 2014. These findings correspond with results observed throughout Scotland, which broadly agree with long-term projections of sea level rise, estimated at 14 mm per decade in the UK and 18 mm per decade globally (Scottish Government, 2020).

20.6.2.19 The rate of sea-level rise is not consistent and varies based on regional and local factors. Presently, due to climate change, it is expected that the UK will witness an annual sea-level increase ranging from 1 to 2 mm. For the south of England, when accounting for vertical land movement, this rate is projected to rise by an additional 1 mm each year, whereas some parts of Scotland may experience a decline in sea level. This upward trend in sea levels is anticipated to continue beyond the year 2100 (Horsburgh et al., 2020).

20.6.2.20 **Table 20-6** presents the projected sea-level rise for London and Edinburgh in both 2060 and 2100 under the scenario RCP8.5. Notably, sea-level rise in England is expected to surpass that in Scotland, and overall, the UK's sea level increase is predicted to be slightly lower than the global average (Horsburgh *et al.*, 2020).

Table 20-6 Projected sea-level rise (m) ranges (from the 5th to the 95th percentile), compared to the reference period of 1981-2000, for London and Edinburgh under RCP8.5 scenario (Horsburgh *et al*., 2020).

Region	2060	2100
London	+0.26 – 0.52 m	+0.53 – 1.15 m
Edinburgh	+0.13 – 0.38 m	+0.3 – 0.9 m

20.6.2.21 Anticipated sea-level rise is set to exacerbate coastal erosion, affecting roughly 17% of the current UK coastline. Scotland's coastlines exhibit greater resistance to erosion, primarily because a larger portion is geologically classified as 'hard or mixed'. In fact, only 12% of the soft and easily erodible coastline in Scotland has retreated inland since the 1970s. It is imperative to recognise that coastal erosion is shaped by a myriad of factors, encompassing reduced sediment availability, intense storms, and human-induced disturbances (Masselink *et al.*, 2020). When examining coastal erosion specifically along Scotland's east coast since 1970, between Lamberton and John o' Groats, approximately 55% of the coast has experienced no change, 16% has retreated and 29% has, in fact, advanced (Hansom, Fitton and Rennie, 2017). Whilst the majority of the coastline is hard substrate, a significant proportion is classified as soft (particularly around the Moray Firth) which is susceptible to erosion. Predicting significant coastal erosion along Scotland's east coast by 2100 remains challenging due to uncertainties in future climate projections and the interplay between land rebound and sea level rise. However, projections under a high emissions scenario (RCP8.5) indicate that sea levels between Aberdeen and Spey (encompassing the region where the Salamander Project would make landfall) could increase by 0.2m by 2050 and 0.45m by 2100, potentially leading to substantial impacts on coastal areas and erosion rates in the region (Hansom, Fitton and Rennie, 2017). When taking account of both sea level rise and coastal erosion combined, it is estimated that the MHWS may retreat inland by up to approximately 15 m by 2065 (Rennie et al., 2021) (see **Volume ER.A.3, Chapter 7: Marine Physical Processes**).

20.6.2.22 Both current and projected coastal erosion carry implications for Scotland's societal assets. In the event of scenario RCP8.5, if there is a halt in maintaining artificial and natural defences (i.e., taking no action), it is estimated that approximately £1.2 billion worth of assets could be vulnerable to erosion, heightened flood risk, and the loss of essential services by the year 2050 (Rennie *et al*., 2021).

20.6.3 Biological Environment

20.6.3.1 Changes in the physical environment due to climate change can subsequently impact the biological environment via alterations in habitats and predator-prey relationships. Climate change is expected to bring about vast transformations in habitats globally, yet uncertainty persists regarding the specific nature of these changes. Certain habitats will encounter direct impacts. For instance, coastal machair habitats may face submersion and potential loss due to rising sea levels. More frequently, climate change will disrupt the delicate ecological equilibriums that support the growth and flourishing of plants and animals. Other examples include the shifting of sand dune habitats toward more inland locations, the potential desiccation and erosion of peat soils and bogs due to increasing temperatures, and the far-reaching and intricate consequences of ocean acidification on marine ecosystems (NatureScot, 2023).

20.6.3.2 There have already been documented changes to biology within the marine environment, likely because of rising temperatures. For example, cold-water zooplankton species like *Calanus finmarchicus* have seen a significant decline of over 70% in the North Sea since the 1960s, while warm-water species like *Calanus helgolandicus* are moving northwards. Furthermore, there have been documented increases in warm-water fish species, such as the bluefin tuna (*Thunnus thynnus*), and alterations in the timing of fish spawning, hatching, and migration. These changes in the biological environment are intricate and interconnected with shifts in the physical environment due to climate change (Edwards *et al.*, 2020).

20.6.3.3 Conducting a comprehensive assessment of potential climate-related biological impacts is challenging due to the uncertainty surrounding how the physical environment will react to climate change. Therefore, conducting a more extensive assessment of potential climate-related biological impacts has proven unfeasible.

20.6.4 Socio-Economics, Tourism and Recreation Environment

20.6.4.1 Changes to the physical and biological environment can also have an impact on human activities. For example, the warming of the ocean is causing shifts in the distribution of commercially harvested fish species and is influencing the productivity of fish stocks and the ecosystems that support them. Furthermore, certain research indicates that ocean acidification could potentially have significant effects on fisheries resources, particularly shell-forming invertebrates (Cheung *et al.*, 2012). The tourism sector could also experience the effects of climate change. With the rise in the frequency of warmer months, northwestern Europe is becoming increasingly attractive to tourists in comparison to the Mediterranean region. Consequently, the UK is anticipated to witness growth in its tourism industry, especially along its coastlines (Simpson, 2013).

20.6.4.2 Conducting a more comprehensive assessment of potential socio-economic, tourism and recreation impacts related to climate change is difficult due to uncertainties surrounding how the physical and biological environment will respond to climate change. Additionally, the complexity of distinguishing the effects of climate change from various other factors that affect the physical and biological environment, and associated socio-economic, tourism and recreation factors is complex and has not been possible.

20.6.5 Summary of Future Baseline Environment

20.6.5.1 A summary of the climate projections anticipated for the Salamander Project are provided below.

20.6.5.2 Anticipated weather event changes in Scotland under the RCP8.5 scenario include:

- Increased frequency of hotter and drier summers (Met Office, 2022) (Lowe et al., 2018);
- Potentially an eight-fold increase in the frequency of heavy rainfall events by 2070 in East Scotland (Kendon, Fischer and Short, 2023);
- Greater occurrence of winter storms expected from 2050 to 2100 (Met Office, 2019c);
- Reduced mean significant wave height (comparing 2070 to 2099 with 1970 to 1999) (Wolf et al., 2020); and
- Increased mean annual maximum wave height by 0.5 m (comparing 2070 to 2099 with 1970 to 1999) (Wolf et al., 2020).

20.6.5.3 Anticipated changes in sea conditions around Scotland under the RCP8.5 scenario include:

- Anticipated increases in sea surface temperature of 3.14°C and near-bottom temperature of 2.28°C in the Central North Sea (Tinker et al., 2016);
- The start of spring stratification in the UKCS is expected to commence approximately one week earlier by the century's end, and the seasonal stratification breakdown is anticipated to be delayed by 5 to 10 days compared to current conditions (Sharples et al., 2020);
- Dissolved oxygen levels have the potential to decrease by 11.5% by the century's end (Mahaffey et al., 2020);
- By 2100, the North Sea is expected to experience decreased salinity levels, with a surface salinity decrease of 0.62 psu and a near-bottom salinity decrease of 0.52 psu (Tinker et al., 2016);
- Projected annual pH reduction in the UKCS at a mean rate of 0.0036 per year, leading to an approximate drop in pH level of 0.366 by 2100 (Humphreys et al., 2020); and
- Increased sea level between Aberdeen and Spey by up to 0.2 m by 2050 (Hansom, Fitton and Rennie, 2017).

20.7 Climate Resilience Review

20.7.1 Introduction

20.7.1.1 This section considers the potential impacts that climate change may have on the Salamander Project, as well as the ability of the Salamander Project to withstand and/or recover from those impacts. Potential climate change impacts are based on the considerations detailed in **Section 20.6**.

20.7.2 Study Area

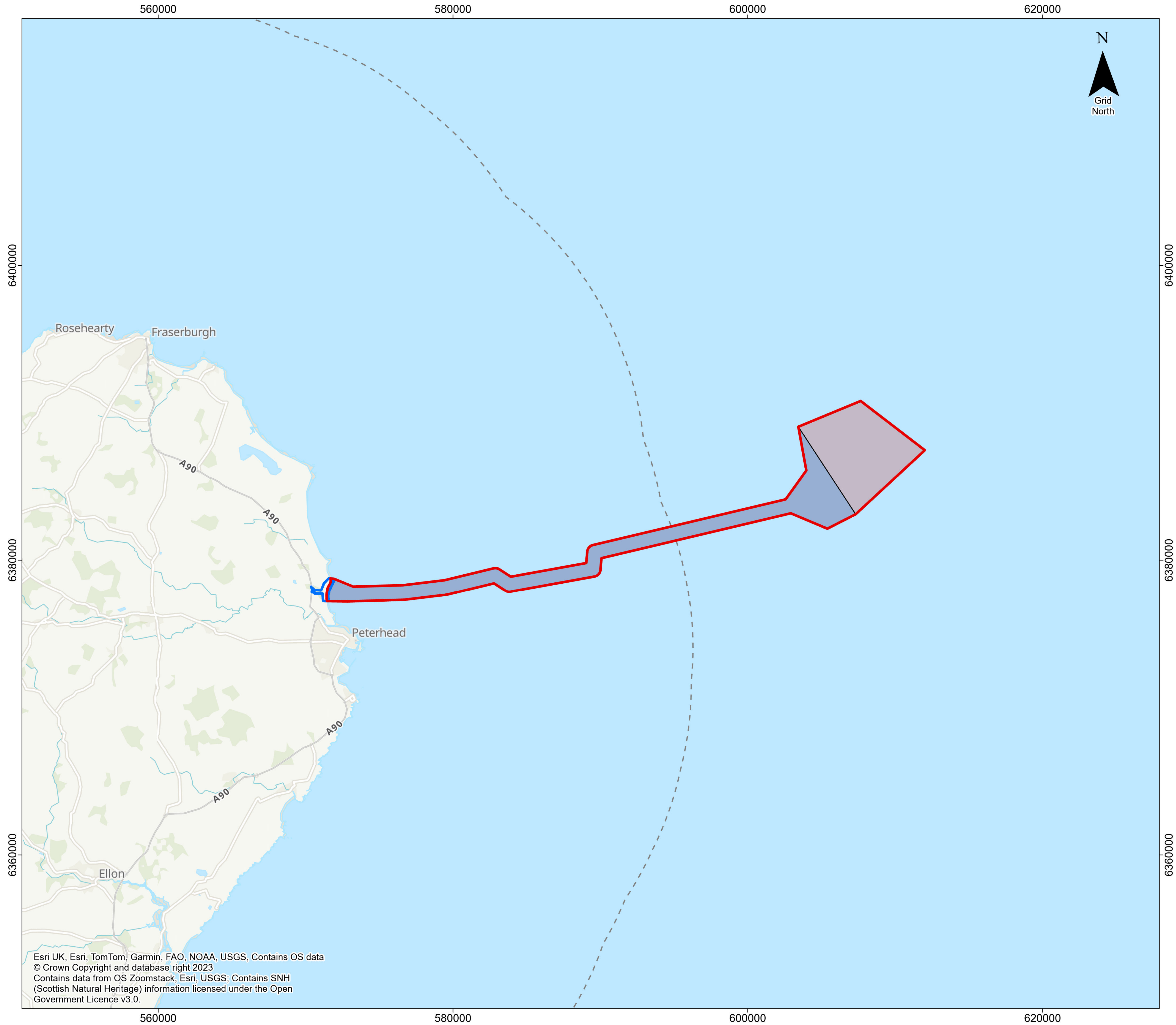
20.7.2.1 This review will focus on the assessment of physical climate-related risks across both onshore and offshore aspects of the Salamander Project during all phases of the Salamander Project lifecycle. The Salamander Project Study Area is shown in **Figure 20-1**.

20.7.2.2 The OAA is approximately 35 km due east of Peterhead, at its closest. Water depths vary from around 86 m below Lowest Astronomical Tide (LAT) in the centre to around 102 m below LAT in the south-western corner.

The Offshore ECC depths are smilar to the OAA until closer to the coastline, with a maximum depth of 105m below LAT.

20.7.2.3 The Intertidal ECC is located where the cable will cross from MLWS to MHWS. The export cable(s) will be installed through this area using trenchless methods. The Onshore Cable Corridor will cross a mix of dunes, arable farmland and forestry.

20.7.2.4 The Onshore Substation (OnSS) and Energy Balancing Infrastructure (EBI) including battery storage will be located close to Landfall and will include all necessary electrical equipment to meet the requirements of the UK onshore transmission network.



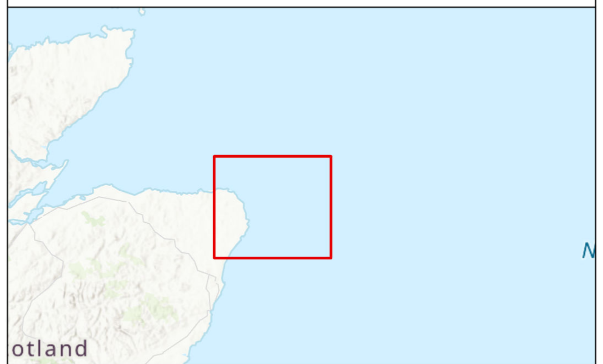
Salamander

Figure 20-1

Project Study Area

Legend

- Offshore Development Area
- Offshore Array Area
- Offshore Export Cable Corridor
- Indicative Onshore Development Area
- 12 nm limit



Coordinate System: WGS 1984 UTM Zone 30N

Scale @ A3 : 1:250,000

0 7.5 15 Kilometers

0 1.75 3.5 7 Nautical Miles

Rev	Description	Date
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Doc. Title : Project Study Area
Doc. No : SWF01ER0215
Created by : IW
Checked by : AN
Approved by : RM

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20.7.3 Assessment Methodology

20.7.3.1 The assessment of potential impacts from climate change has been carried out in line with the IEMA (2020) Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation guidelines.

20.7.4 Assumptions and Variables

20.7.4.1 Climate change assessments rely on projections of potential future scenarios. While research and confidence in these projections is growing, there are still assumptions and data gaps within the predictions. This assessment has been completed with the current best guidance and up-to-date data.

20.7.5 Receptors and Sensitivity

20.7.5.1 Following IEMA guidance, both human health and project infrastructure were considered as receptors to potential weather events as a result of climate change. Receptors were assessed for their sensitivity to impact from climate change, alongside the potential impact on those receptors as a result of any such climate event.

20.7.5.2 The following receptors were considered as part of this assessment:

- Assets of the Salamander Project – the materials and infrastructure in place to deliver energy generation.
- Energy generation – the ability for the Salamander Project to supply energy to the grid.
- Human health and safety – the health, safety and wellbeing of the Salamander Project workforce.

20.7.5.3 Sensitivity of receptors was determined through consideration of the following:

- Susceptibility – the probability that a receptor will be impacted by climate change.
- Vulnerability – how sensitive the receptor will be to the effects of climate change.
- Value – the overall importance of the receptor, either by economic or social value.

20.7.5.4 Score weighting for each of these criteria is set out in **Table 20-7**.

Table 20-7 Score weighting for determining sensitivity of receptors

Score	Susceptibility	Vulnerability	Value
High (Score: 4)	Receptor will be substantially impacted by the climatic event considered as a result of climate change.	Receptor is highly likely to be affected by climate event as a result of climate change.	High economic value or importance over an international scale.
Medium (Score: 3)	Receptor has a small amount of resilience to potential impacts from a climatic event.	Receptor is likely to be affected by climate event as a result of climate change.	Medium economic value or importance over a national scale.
Low (Score: 2)	Receptor can withstand significant impact from potential climatic events.	Receptor is unlikely to be affected by climate event as a result of climate change.	Low economic value or importance over a local or regional scale.
Negligible (Score: 1)	No significant impacts identified to the receptor that would impact their functional ability.	Receptor is very unlikely or not expected to be affected by climate event as a result of climate change.	Very low or no economic value or importance not of a noticeable impact at the local scale.

20.7.5.5 By combining the scores across the three criteria, the overall value produced determined the sensitivity of a receptor to the effects of climate change. The score ratings for sensitivity are:

- Score 0 – 3 Negligible
- Score 4 – 6 Low
- Score 7 – 9 Medium
- Score 10 – 12 High

20.7.5.6 Ratings for each of the receptors considered for the Salamander Project are set out in **Table 20-8**.

Table 20-8 Receptor assessment for sensitivity to impacts of climate change

Receptor	Susceptibility	Vulnerability	Value	Overall Score
Assets of the Salamander Project	Low: Salamander Project design (including inbuilt mitigation) reflects expected environmental conditions throughout the Salamander Project lifecycle.	Medium: Salamander Project infrastructure is expected to be exposed to any climate change events.	Medium: Assets are designed so that they can be repaired or maintained as required but do have high costs associated with this.	Medium – 8
Energy Generation	Low: Wind turbines cannot operate in certain extreme	Low: Salamander Project infrastructure is	Medium: Energy generation is the key	Medium – 7

Receptor	Susceptibility	Vulnerability	Value	Overall Score
	conditions, such as high wind levels, but are designed to withstand expected environmental conditions throughout the Salamander Project lifecycle, allowing return of energy generation when conditions are more favourable.	expected to be exposed to any climate change events. Wind projections are uncertain for future climate change but are unlikely to change significantly within the Salamander Project lifecycle to prevent energy generation.	output of the Salamander Project. The Salamander Project scale for energy generation is important as part of a wider energy portfolio on a national level.	
Human health and safety	Low: Within the lifecycle of the Salamander Project, humans are resilient to the expected climate predictions.	Medium: Staff for the Salamander Project are expected to be exposed to any climate change events.	High: Human health and safety are key and essential.	Medium – 9

20.7.6 Potential Climate Events and Potential Impact Magnitude

20.7.6.1 Consideration of the scale of impact is challenging due to the uncertainty of any possible climate change scenarios. An assessment of the magnitude of a climate change event has been made by considering the likelihood of a climate event occurrence and the potential consequence of such an event. **Table 20-9** sets out the ratings criteria for probability and consequence.

Table 20-9 Probability and consequence rating of potential climate events

Rating	Probability	Consequence
High	High likelihood of occurrence	Very significant or significant consequence of a climate event occurring, including to: • Economic assets or infrastructure • Health and safety implications • Environmental implications, increased risk of pollution events or compliance with environmental regulations • Recovery times
Medium	Reasonably likely chance of occurrence	Reasonably significant consequence of climate event occurring, including to: • Economic assets or infrastructure • Health and safety implications • Environmental implications, increased risk of pollution events or compliance with environmental regulations • Recovery times

Rating	Probability	Consequence
Low	Low to unlikely chance of climate event occurring	Consequence of low significance from climate event occurring, including to: • Economic assets or infrastructure • Health and safety implications • Environmental implications, increased risk of pollution events or compliance with environmental regulations • Recovery times
Negligible	Very unlikely chance of climate event occurring	Consequence of climate event occurring is of very low significance to no effect, including to: • Economic assets or infrastructure • Health and safety implications • Environmental implications, increased risk of pollution events or compliance with environmental regulations • Recovery times

20.7.6.2 Climate change variables that have the potential to impact the Salamander Project have been considered in **Table 20-11** and a magnitude rating provided in **Table 20-10** which demonstrates the weighting given to probability and consequence in order to determine a level of magnitude.

Table 20-10 Magnitude rating

Magnitude Rating		Probability			
		Negligible	*Low*	*Medium*	*High*
Consequence	*Negligible*	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Low	Low
	Medium	Negligible	Low	Medium	Medium
	High	Negligible	Low	Medium	High

Table 20-11 Climate variables considered for impact magnitude assessment within climate resilience review

Climate Event Variable		Probability	Consequence	Overall Magnitude Rating
Extreme weather event	Storms	**Low**: Storms are predicted to become a more regular event around the UK as the effects of climate change continue. The rate at which this change might occur or potential scale is difficult to predict, but storm events of a significant scale relevant to the Salamander Project remain unlikely based on predicted climate baselines.	**Medium**: Storm events occur within present climate conditions and have the potential to impact the Salamander Project. Project design parameters take into account predicted environmental conditions that occur within storm events.	Low
	Extreme temperature events	**Low**: Extreme temperature events, including heatwaves and freezing conditions, can occur within existing climatic conditions. Climate predictions suggest the regularity of these events is set to increase under future baseline scenarios, but extreme temperature events of a scale that have the potential to impact the Salamander Project remain unlikely.	**Medium**: Depending on the degree and length of time that an extreme temperature event occurs for, there is potential for significant effects. These events occur within present climate conditions but have the potential to impact the Salamander Project. Project design parameters take into account predicted environmental conditions that occur within extreme temperature events.	Low
Sea level changes	Sea level rise/flooding/wave changes	**Medium**: Sea level rises are expected to occur due to changing climate conditions. The degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Changes to sea level may not be significant over the lifecycle of the Salamander Project but they do present an increased risk of flooding and changes to average wave conditions.	**Low**: Sea level rises are most likely to impact the Salamander Project at landfall areas or at terrestrial locations. Project design parameters take into account predicted environmental conditions that may occur as a result of potential sea level changes. Salamander Project turbines are designed to tolerate any changes to the wave conditions predicted across the Salamander Project timeline.	Low

Climate Event Variable		Probability	Consequence	Overall Magnitude Rating
Changing rates of coastal erosion	Landslides/unstable ground in coastal areas	**Medium**: Climate predictions, including rates of sea level rise, are likely to result in areas of increased coastal erosion and changes to coastal processes. The rates to which these might occur are variable depending on the wide range of climate predictions and local environmental conditions. The landfall location is predicted to receive modest coastal erosion over the lifetime of the Salamander Project, with retreat of the MHWS inland by up to approximately 15 m by 2065, in response to sea level rise and coastal erosion (Rennie et al., 2021).	**Low**: Key areas of impact for the Salamander Project will occur at the export cable landfall site. Project design for geology and soil conditions will account for the risk of impact due to coastal erosion, but landslides could result in significant impacts if they interact directly with project infrastructure areas. The Salamander Project landfall location is characterised by a sandy beach and dune complex and therefore potential impacts of coastal erosion on these landscape features are reduced due to their substrate type.	Low
Changing weather	Changes to temperature (averages)	**Low**: Temperature changes are expected through all climate change predictions, but the degree to which this occurs is more variable the further ahead predictions are made.	**Negligible**: The Salamander Project design is suitable for predicted temperature averages across the Salamander Project lifecycle. Expected temperature changes as an average are not expected to be of a level outside of reasonably manageable conditions.	Negligible
	Increased rainfall	**Low**: Rainfall changes are expected through all climate change predictions, but the degree to which this occurs is more variable the further ahead predictions are made.	**Negligible**: The Salamander Project design is suitable for predicted rainfall averages across the Salamander Project lifecycle. Expected rainfall changes as an average are not expected to be of a level outside of reasonably manageable conditions.	Negligible

20.7.7 Significance Assessment

20.7.7.1 The overall significance of an effect is determined by a review of the relationship between the sensitivity of the receptor and the magnitude of the potential impact.

20.7.7.2 For the purposes of this assessment, a significance assessment score of ‘major’ or ‘moderate’ are considered to be 'significant' in EIA terms, while significance scores of 'minor’ or below are considered ‘not significant’.

20.7.7.3 **Table 20-12** is the significance of effect matrix.

Table 20-12 Significance of effect matrix

Significance of effect		**Receptor Sensitivity**			
		Negligible	*Low*	*Medium*	*High*
Magnitude of impact	*Negligible*	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate
	High	Negligible	Minor	Moderate	Major

Construction

20.7.7.4 The onshore construction period for the Salamander Project is expected to commence by Q1 2027 at the earliest and be closed by the end of 2028. The offshore construction period is expected to start in Q3 2027 and has a window of 2.5 years, however, construction will only take place over a period of 18 months (excluding pre-construction surveys). Pre-construction surveys will occur prior to the 18 month construction period. This means the timeframe for construction activities are such that the identified changes in climate, which will occur over a gradual process, are not expected to be significantly different to existing climate conditions. Potential impacts to the Salamander Project are therefore in line with consequences consistent with projects currently within the construction process.

20.7.7.5 Given the near-term nature of planned construction, such that climate parameters will be similar to existing environmental conditions, it is considered that the parameters assessed across the EIA are sufficient to appropriately address the potential impacts of climate change on construction activities for the Salamander Project.

20.7.7.6 The majority of current climate related events result in delays to the construction schedule. For example, extreme weather events may prevent activities taking place within a safe environment, while also increasing the potential that assets could be damaged through the construction schedule. Extreme weather events present health and safety risks to personnel working on the construction of the Salamander Project.

20.7.7.7 Potential impacts from climate events that could occur within the construction phase of the Salamander Project are addressed within the relevant chapters of this EIAR and captured within mitigation and monitoring measures.

Operations and Maintenance

20.7.7.8 Consideration of potential impacts due to climate events as a result of climate change across the operations and maintenance phase of the Salamander Project are considered within **Table 20-13**.

Table 20-13 Summary of impacts and effects for Climate Change and Carbon for the Operation and Maintenance phase of the Salamander Project

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
Assets	Storms	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29	Medium	Low	**Minor:** Assets will likely be exposed to storm events but are designed to withstand storm conditions.	No additional mitigation measures required	Minor	Not significant
	Extreme temperature events	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor:** Assets will likely be exposed to extreme temperature events if/when they occur. Extreme weather could damage assets and require maintenance activities. Maintenance activities are	No additional mitigation measures required	Minor	Not significant

[2] Relevant embedded mitigations are listed and defined in **Table 20-20**

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						expected to occur across the lifecycle of the Salamander Project.			
	Sea level rise/flooding	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor:** Changes to sea conditions may result in increased wave height, or risk of flooding to assets. Scale of events are expected to be similar to existing climate events to which the Salamander Project design will appropriately addresses.	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
	Landslides/unstable ground in coastal areas	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor:** Unstable land may impact the viability of asset infrastructure, particularly in areas such as the export cable landfall. However, Salamander Project design will consider extensively the suitability of ground conditions.	No additional mitigation measures required	Minor	Not significant
	Changes to temperature (averages)	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Negligible	**Negligible:** Changing temperatures over an average during the Salamander Project lifecycle will not change to a level that will present a risk to assets, which will	No additional mitigation measures required	Negligible	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						be designed to operate within predicted temperature averages.			
	Increased rainfall	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Negligible	**Negligible:** Changing rainfall averages will not change to a level within the Salamander Project lifecycle that will present a risk to assets, which will be designed to operate within predicted rainfall averages.	No additional mitigation measures required	Negligible	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
Energy generation (Note, this is not an evaluation of the project's energy generating capacity over its lifecycle in response to anticipated climate changes, but rather an analysis of how energy generation might respond, i.e. its sensitivity as a receptor, to potential extreme future climatic conditions.)	Storms	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29	Medium	Low	**Minor:** Changes in wind speeds and storm likelihood are challenging to predict in future baselines. However, generation of energy through wind power is limited by the automatic cut-out of the WTGs when excessive wind speeds are reached.	No additional mitigation measures required	Minor	Not significant
	Extreme temperature events	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor**: Assets will likely be exposed to extreme weather events if/when they occur. Extreme weather could damage assets and require maintenance activities, that will	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						hinder energy generation. Maintenance activities are expected to occur across the lifecycle of the Salamander Project.			
	Sea level rise/flooding	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor:** Overall changes in sea level, including changes to wave height or occurrence, are not expected to occur on a scale (across an average) that will inhibit energy generation.	No additional mitigation measures required	Minor	Not significant
	Landslides/unstable ground in coastal areas	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Low	**Minor:** Unstable land may impact the viability of asset	No additional mitigation	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						infrastructure, particularly in areas such as the export cable landfall. However, Salamander Project design will consider extensively the suitability of ground conditions.	measures required		
	Changes to temperate (averages)	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Negligible	**Negligible:** Changing temperatures over an average will not change to a level within the Salamander Project lifecycle that will present a risk to energy generation, as turbines for the Salamander Project will be designed to operate within	No additional mitigation measures required	Negligible	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						predicted temperature averages.			
	Increased rainfall	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	Co29		Negligible	**Negligible:** Changing rainfall averages will not change to a level within the Salamander Project lifecycle that will present a risk to energy generation, as turbines for the Salamander Project will be designed to operate within predicted rainfall averages.	No additional mitigation measures required	Negligible	Not significant
Human health and safety	Storms	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation	Medium	Low	**Minor:** Exposure of workforce to storm events has the potential to impact health and safety of individuals and a workforce. The risk	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						of storms is currently present and adherence to relevant health and safety legislations will manage a safe working environment, which includes not working in unsuitable conditions.			
	Extreme temperature events	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation		Low	**Minor:** Exposure of workforce to extreme temperatures, either summer heatwaves or freezing conditions, has potential to impact health and safety, including an increased risk of	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						accidents. The risk of extreme temperature events is currently present and adherence to relevant health and safety legislations will manage a safe working environment, which includes not working in unsuitable conditions.			
	Sea level rise/flooding	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation		Low	**Minor:** Sea condition changes over the lifecycle of the Salamander Project are not expected to be at a level where significant changes will occur that will	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						impact the workforce. The risk of floods is currently present and adherence to relevant health and safety legislations will manage a safe working environment, which includes not working in unsuitable conditions.			
	Landslides/unstable ground in coastal areas	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation		Low	**Minor:** The risk of landslides/unstable ground is currently present and adherence to relevant health and safety legislations will manage a safe working environment, which includes not	No additional mitigation measures required	Minor	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
						working in unsuitable conditions. If future baselines change, working practices will be consistently reviewed to address changing conditions.			
	Changes to temperate (averages)	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation		Negligible	**Negligible:** Changing temperature averages will not change to a level within the Salamander Project lifecycle that will present a risk to health and safety conditions outside of what is currently expected for project activities.	No additional mitigation measures required	Negligible	Not significant

Receptor	Climate Event Variable	Project Aspect	Embedded Mitigation[2]	Sensitivity	Magnitude	Significance of Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effect in EIA terms
	Increased rainfall	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation and EBI	No relevant embedded mitigation		Negligible	**Negligible:** Changing rainfall averages will not change to a level within the Salamander Project lifecycle that will present a risk to health and safety conditions outside of what is currently expected for Salamander Project activities.	No additional mitigation measures required	Negligible	Not significant

Decommissioning

20.7.7.9 Predictions of climate change demonstrate that there will likely be changes to conditions relevant to the decommissioning process of the Salamander Project. The level of certainty as to the predictions made is more variable and challenging the further forward the predictions are made. The Salamander Project's resilience to the effects of climate change during decommissioning is expected to be consistent with that during the operational phase, as detailed in **Table 20-13**.

20.8 Greenhouse Gas Assessment

20.8.1.1 The emission of greenhouse gases occurs across all industries. Renewable energy projects, while producing emissions largely during construction, also reduce the overall levels of GHG emissions in operation by replacing other energy generation sources that produce higher levels of emissions.

20.8.1.2 A GHG assessment has been carried out in order to predict the effects of GHG emissions that are expected to be produced as a result of the Salamander Project. The GHG assessment provides the following:

- An evaluation of the overall GHG emissions produced as a result of the Salamander Project.
- The GHG emissions that will be avoided as a result of the Salamander Project being deployed. This is calculated through a comparative assessment of total GHG emissions occurring from the Salamander Project against those of carbon intensive methods of energy generation to deliver equivalent energy resources.
- The “payback” assessment, which considers the timeframe through which the Salamander Project must operate before it has returned an overall reduction in GHG emissions that result from the overall Salamander Project, Construction, Operation and Maintenance and Decommissioning phases, noting that the Construction phase encompasses: pre-construction surveys, enabling works and installation itself also.

20.8.2 Study Area

20.8.2.1 Climate change issues associated with the release of greenhouse gases occur on a global scale. Therefore, there is no specific Study Area defined for this GHG assessment. As the assessment of climate change and carbon is carried out in support of national and international targets for the reduction of greenhouse gas emissions, this GHG assessment is conducted within the context of UK carbon budgets.

20.8.3 Energy Generation Baseline

20.8.3.1 In order to assess the potential GHG emissions scenario as a result of the Salamander Project, a baseline of a non-renewable energy source (natural gas using a combined cycle gas turbine) to produce the equivalent energy of the Salamander Project has been used. It is not deemed appropriate to use the future emission factors of the UK grid for this purpose, as these values factor in the implementation of renewable energy sources such as the Salamander Project into the emission factor calculations, therefore not providing a fair representation of the removal of emissions. For this reason, Carbon Capture Storage (CCS) or other methods of removing emissions are also not included as a baseline of a non-renewable energy source.

20.8.4 Project Design Envelope Parameters

20.8.4.1 Given that the realistic worst-case scenario is based on the design option (or combination of options) that represents the greatest potential for change, as set out in **Volume ER.A.2, Chapter 4: Project Description**, a confidence can be taken that development of any alternative options within the Salamander Project design envelope parameters will give rise to no effects greater or worse than those assessed in this impact assessment.

20.8.4.2 The GHG assessment is considered using the realistic worst-case scenario, defined as the high emissions scenario, for the development of the Salamander Project, which aligns with relevant guidance (IEMA, 2022). In addition, further supporting information is provided through a comparison scenario of a reduced number of turbines, referred to as the low emissions scenario.

20.8.4.3 The high emissions scenario for this assessment is aligned to the predicted worst-case emissions scenario for production and installation of the major components of the Salamander Project, both within the marine and terrestrial environments, and the expected activities required to operate and maintain the assets. It also considers necessary vehicle use, either for transport or use in the various project phases.

20.8.4.4 The low emissions scenario has also been assessed which estimates a Salamander Project design including a smaller number of wind turbines at six, less carbon intensive materials, and a best-case scenario for vehicle usage. The low emissions scenario also includes a reduced cable length as only one export cable of 35km is considered compared to the worst-case scenario of two 35km export cable routes.

20.8.4.5 The Salamander Project Design Envelope parameters relevant to the GHG assessment scenarios are outlined in **Appendix 1: Greenhouse Gas Assessment- CO2e Emissions.**

Embodied carbon

20.8.4.6 The manufacturing process of materials, including activities such as mining raw materials, refining, and forming, generates CO_2e emissions, commonly referred to as "embodied carbon." In the context of the Salamander Project, embodied carbon refers to the CO_2e emissions linked to the production of the infrastructure, encompassing components such as wind turbine generators (WTGs), floating substructures along with their moorings and anchors, cables, protective measures for remediation, and onshore components.

Wind Turbine Generators

20.8.4.7 Each wind turbine generator has been considered as a single unit comprising the tower, nacelle and blades. The worst-case scenario considers the use of seven turbines, while the low emissions scenario accounts for six turbines. The total mass of the turbines has been calculated based on primary materials for the components and figures provided by the Applicant.

Floating Foundation

20.8.4.8 Each wind turbine generator requires a floating foundation, which is supported by a mooring and anchor system. The worst-case scenario considers the use of seven floating foundations made from steel, which were determined to have a higher CO_2e emissions profile than concreted based foundations, which are used for the six-turbine low emissions scenario. Mooring and anchor systems are considered for the worst-case scenario based on the needs for securing seven floating foundations using the highest mass scenarios. The low emissions alternative considers the lowest mass options required to secure six floating foundations.

Offshore Cables

20.8.4.9 Up to two export cables will be required to deliver electricity to shore for the Salamander Project. An export cable would have an estimated maximum length of 43 km. Two cables are included for the worst-case scenario (85 km total) compared to one for the low emissions comparison. The cables are assumed to be 3-core, cross-linked polyethylene (XPLE) submarine cables, primarily composed of copper, steel, and polyethylene (plastic). The assumed mass of these materials is 0.0187 t/m for steel, 0.00968 t/m for corrosion-resistant alloy (CRA), 0.0312 t/m for plastics, and 0.000337 t/m for copper.

20.8.4.10 Inter-array cabling is needed to transmit the electricity generated by each wind turbine generator. In the realistic worst-case scenario with high emissions, it is assumed that 35 km of interconnector cable is needed, while in the low-emission scenario, the requirement is estimated to be 30 km, accounting for the reduced number of turbines. The materials are assumed to be the same as those used for the export cable(s).

Onshore Construction Activities

20.8.4.11 Onshore construction activities to deliver the supporting infrastructure of the Salamander Project are combined into total mass requirements of the major construction components, including steel, concrete and aggregates. The infrastructure considered under the Onshore Salamander Project requirements include high and low emissions scenarios for substation and temporary construction compounds; access tracks; energy balancing infrastructure (180MW battery storage worst case, 100MW low emissions); as well as other variable infrastructure including various minor buildings.

Operation and Maintenance

20.8.4.12 The exact requirements for the operation and maintenance of the Salamander Project are unknown at this stage. Thomson & Harrison (2015) calculated the life cycle costs and carbon emissions of offshore wind farms, and estimated that replacement parts accounted for 3.7% of the total GHG emissions of a project. This figure has been used to estimate the expected CO_2 emissions from the realistic worst-case and low emissions scenarios.

Decommissioning

20.8.4.13 Beyond predictable vehicle/vessel movements associated with the decommissioning activities and the return of materials to shore, the requirements for decommissioning are unknown at this stage and therefore beyond the scope of this assessment.

Vessel and Vehicle Activity

20.8.4.14 Estimated emissions for the use of vessels across the Construction, Operation and Maintenance and Decommissioning phases have been provided by the Applicant.

Construction (inclusive of Pre-construction activities)

20.8.4.15 All vessels used in order to carry out the required pre-construction surveys have been assumed to be multi-support vessels. There is assumed to be no difference in activities required for the two emissions scenarios.

20.8.4.16 Vessel and vehicle use was broken down to various key activities. Each activity was assigned a vessel or vehicle type based on the most likely type required for the activity. For this assessment, it is assumed that all activities occur before the operational period commencing in 2030 and no improvements in efficiency have been considered for this assessment.

20.8.4.17 For transportation vessels and vehicles, the number of trips and best and realistic worst-case scenarios for the distances to deliver materials have been calculated.

20.8.4.18 Other vehicles assessed have been considered based on estimates of days of activities required.

Operation and Maintenance

20.8.4.19 Emissions resulting from offshore operation and maintenance activities have been assessed for the Salamander Project. The operational and maintenance vessel/vehicle requirements were determined by factors for the high and low emissions scenarios such as the quantity of WTGs and the nature of the activities needed, such as inspections or component maintenance or replacement. This calculation adopts a conservative stance as it does not account for assumed vessel efficiency that is likely to improve over the Salamander Project lifespan. Onshore maintenance activities including vehicle transit and inspections of equipment were also evaluated.

Decommissioning

20.8.4.20 Vehicle and vessel activity associated with decommissioning is assumed to be based on existing emissions factors, and therefore does not take into account efficiency improvements or the development of different fuel types such as electric motors. This is therefore a conservative estimate as government policies will require a move towards more efficient vehicles and vessels.

20.8.5 Assessment Methodology

20.8.5.1 IEMA guidance (2022) identifies that the key assessment to be completed as part of a GHG assessment is whether a project, regardless of emissions produced, contributes to reducing GHG emissions relative to a comparable baseline in order to enable a continued trajectory towards the UK targets of net zero by 2050.

20.8.5.2 In order to complete this assessment, and in the absence of local emissions budgets, the UK Carbon Budgets as outlined in **Table 20-14** are beneficial to frame the potential significance level of any impact as a result of the Salamander Project. The UK Carbon Budgets are legally binding restrictions that limit the amount of greenhouse gases the UK can emit within a 5-year period. There are currently six UK Carbon Budgets, with the sixth budget in place detailing emissions limits up to 2037.

20.8.5.3 Carbon budgets are calculated as tonnes of carbon dioxide equivalent (CO_2e) which recognises that the seven gases referenced under the Kyoto agreement (CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)) have different potential impacts to global warming. Emissions from GHGs are converted into the same amount of carbon dioxide with the equivalent global warming potential (over a 100 year period) by multiplying the overall amount of a gas by its associated global warming potential. For example, one tonne of methane gas is equivalent to 25 tonnes of carbon dioxide.

20.8.5.4 This assessment considers the impacts of GHG emissions using CO_2e.

Table 20-14 UK Carbon Budgets

Year	Annual Carbon Budget (million tonnes CO_2e)	% Reduction Below Base Year (1990)
2023-2027	1,950	50% by 2025
2028-2032	1,735	57% by 2030
2033-2037	965	78% by 2035

20.8.5.5 All GHG emissions have the potential to be detrimental as all emissions will contribute to the overall effects of climate change. This report focuses on reasonably foreseeable and consequentially realistic sources of emissions that will occur as a result of the Salamander Project. Minor and unpredictable sources of emissions, such as one-off or unplanned travel requirements, would be difficult and disproportionate to evaluate within this GHG assessment, and therefore have been excluded on the basis of not being material in the context of the overall Salamander Project.

20.8.5.6 GHG emissions resulting from the Salamander Project were divided into three main source areas (see **Appendix 1: Greenhouse Gas Assessment- CO2e Emissions** for further details):

- Emissions from materials – GHG emissions generated through the production of materials and throughout the supply chain, including the extraction, transport, manufacturing/assembly and end of life profile of those materials.
- Marine vessel emissions – GHG emissions generated through the use of vessels/vehicles required to undertake the installation, operation and maintenance, and decommissioning activities of the marine components of the Salamander Project. Typical release of GHG is a result of exhaust discharge from fossil fuel combustion engines. Vessel emissions were calculated on a realistic worst-case scenario (ORE Catapult, 2021) and a precautionary assumption that the ratio of transit to idle time for vessel use will be 50:50.
- Terrestrial vehicle and plant emissions – GHG emissions generated by vehicles required to undertake the construction, operation and maintenance, and decommissioning activities of the terrestrial components of the Salamander Project. Typical release of GHG is a result of exhaust discharge from fossil fuel combustion engines. Also includes the fuel use of relevant plant equipment and generators required for construction activities.

20.8.5.7 GHG emissions have been calculated for the Salamander Project under the following structure:

- GHG emission factor x activity data = GHG emission

20.8.5.8 Calculations have been carried out at the most relevant scales, but therefore differ depending on the activity type involved. Overall calculations have been summed to represent the GHG emissions expected from the Salamander Project as a whole.

20.8.5.9 Emissions of the lifecycle of materials used for the Salamander Project have been calculated using the predicted quantities or volumes of materials.

20.8.6 Limitations and Assumptions

20.8.6.1 The following limitations and assumptions have been identified for the GHG assessment in order to deliver an evaluation of the realistic worst-case and comparison scenario:

- To assess potential embodied carbon of components of the Salamander Project, the mass of major materials has been estimated and the CO_2 equivalent emissions for the production has been taken as an average where specific material components are not precisely known at the time of assessment.
- It is assumed that there will be no reduction in the volume of emissions produced from the creation of materials from the point of assessment to the commencement of the development.
- Asset design and construction, including the production and transport of relevant materials, will not change from the time of assessment to the commencement of the development. Realistic worst-case scenarios for transport distances were calculated as the furthest country from which supply of such materials will be feasible for the Salamander Project. Vehicle and HGV movements were assumed to commence from the nearest city.
- All vessel/vehicle movements are considered to operate under diesel engine power and no consideration is given to an increase in engine efficiency or a move to other forms of engine energy supply such as petrol, green fuels or electric power.
- Energy generated is assumed to replace electricity from natural gas, rather than other less carbon- intensive sources such as other renewable energy sources or nuclear power. It is assumed that there will be no efficiency changes in the amount of CO_2e produced by energy generation for natural gas over the Salamander Project lifetime.

- The Salamander Project is estimated to generate an energy yield of 461.8 GWh/annum for a seven wind turbine scenario. The energy yield assessment is based on seven wind turbines, as this reflects the realistic worst-case emissions scenario for Salamander Project design which is relevant for the EIA assessment. The comparative low-emissions scenario may result in lower energy generation due to a reduced number of turbines installed.
- While CO_2 equivalent emissions for the production of EBI has been included within calculations for the GHG assessment emissions, any benefits provided for by EBI have not been included within the calculations. It is not possible to predict how energy stored in the EBI would be produced, and therefore there is a risk of double-counting benefits from other renewable sources.

20.8.7 Expected Greenhouse Gas Emissions

20.8.7.1 The predicted emissions of onshore and offshore activities, based on the scenarios outlined and according to the detailed assumptions, are included in **Table 20-15** and presented in **Figure 20-2**.

Table 20-15 Total emissions from the Salamander Project for a high and low emissions scenario comparison

Emissions Source Type	Salamander Project Phase	High Emissions Scenario (tonnes CO_2e)	Low Emissions Scenario (tonnes CO_2e)
Construction Materials	Construction Materials	379,214	105,685
	Operation and Maintenance-Replacement Parts	27,323	15,428
Vessel/Vehicle Use	Pre-Construction	2,479	2,479
	Construction	63,068	34,497
	Operation and Maintenance (O&M)	265,936	250,862
	Decommissioning	27,815	23,437
Overall Total		*765,835*	*432,388*

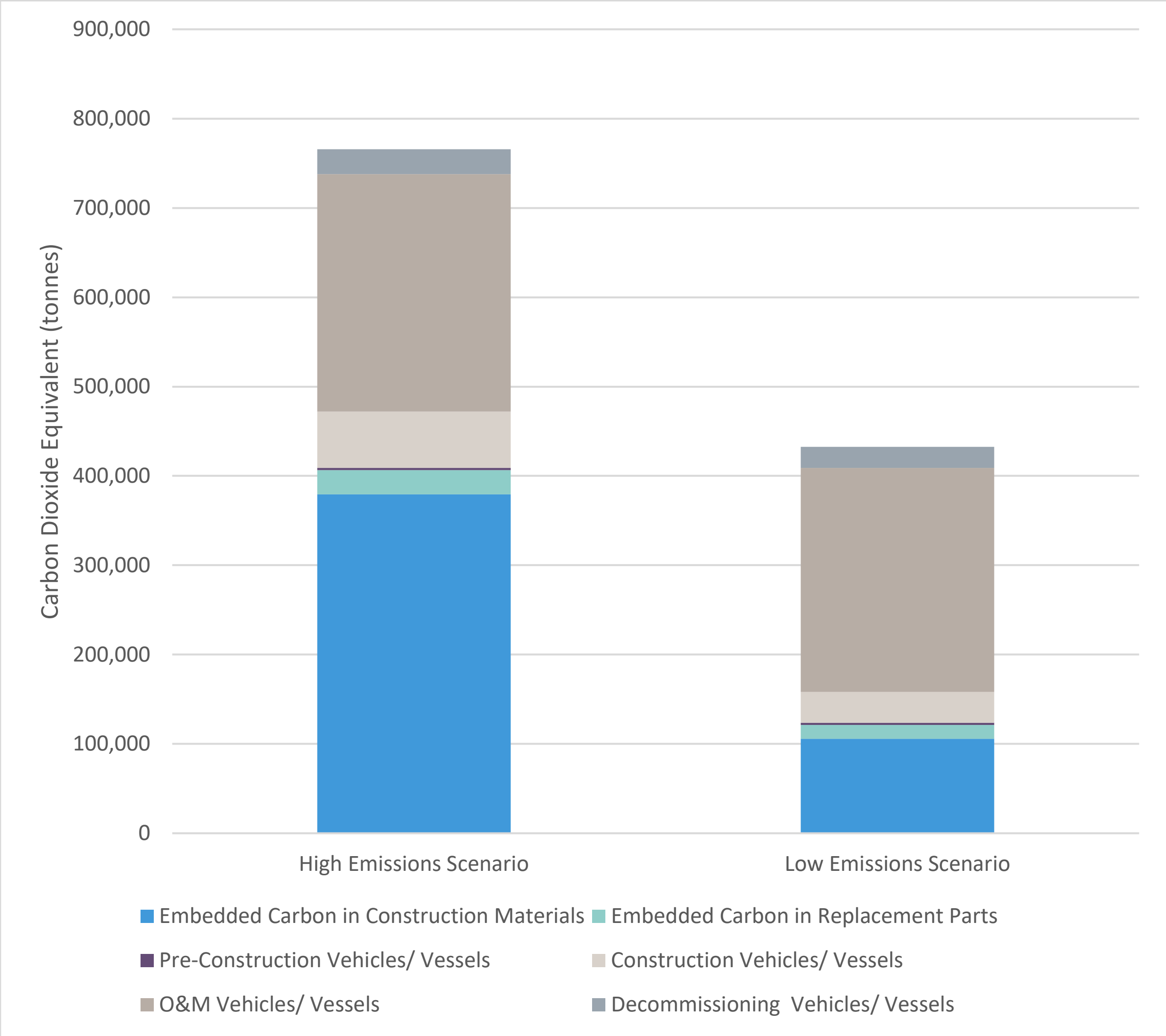


Figure 20-2 Total emissions from the Salamander Project for a high and low emissions scenario comparison

20.8.8 Significance of Greenhouse Gas Emissions

Greenhouse Gas Intensity

20.8.8.1 To meet global climate change targets, GHG emission reductions are required from all sectors. Energy generation is a major contributor to GHG emissions, as shown in the UK where it accounts for 17% of the country's overall emissions (Office of National Statistics, 2023). Different methods of energy generation contribute different levels of GHG emissions for equivalent levels of electricity produced. The predicted GHG emissions from the Salamander Project are an important comparison point against energy generation from a non-renewable resource in the context of a GHG assessment, as it provides a distinction between energy generated from fossil fuels and a form of renewable energy that can contribute to reductions in emissions and benefit the UK in its climate change objectives. **Table 20-16** demonstrates a comparison between the GHG intensity of the Salamander Project against a combined cycle gas turbine, which is a typical form of energy generation using fossil fuels (Committee on Climate Change, 2013). GHG intensity is the ratio of GHG emissions created in order to generate electricity. It is represented by the number of tonnes of CO_2

equivalent considered for the generation of a gigawatt hour (GWh) of energy (t CO_2e/GWh). The GHG intensity for the entire Salamander Project is calculated by averaging the total predicted CO_2 equivalent emissions (including all pre-construction, construction, operations and maintenance, and decommissioning activities) over the operational lifespan of the Salamander Project (35 years), and then dividing by the estimated energy generation of the Salamander Project of 461.8 GWh per annum using the seven wind turbine scenario. It is appropriate to use this figure as the basis for the assessment as the seven wind turbine option represents the worst-case emissions scenario for the Salamander Project. The figure for the combustion of natural gas, 371tCO_2e/GWh, is provided by the latest estimate by the UK Government for 2022 (DESNZ, 2023a); note, the figure for the combustion of natural gas does not account for whole life cycle carbon as it relates only to generator emissions in the operational phase (it does not include emissions related to the fuel supply chain or maintenance activities).

Table 20-16 Greenhouse gas intensity for the production of energy

Energy Generation Method	GHG Intensity (tCO_2e/GWh)
Combined cycle gas turbine	371
Salamander Project (high emissions scenario)	47.4
Salamander Project (low emissions scenario)	26.8

20.8.8.2 The expected GHG emissions savings as a result of energy generation from the Salamander Project comparative to the combustion of gas results in major reductions in emissions, even when considering realistic worst-case scenarios for emissions for the Salamander Project (323.6 tCO_2e/GWh less than natural gas combustion). **Table 20-17** demonstrates the emissions savings from the constructed Salamander Project over its operational lifespan from the replacement of the equivalent energy provided to the grid (461.8 GWh), from combined cycle gas generation (DESNZ, 2023a).

Table 20-17 Greenhouse gas emissions avoided for the energy produced by the Salamander Project

Year of Energy Generation	Total energy generation from Salamander Project (GWh)	GHG emissions avoided as a result of the Salamander Project when operational (tonnes CO_2e)
1	461.8	171,328
35	16,163	5,996,473

Carbon Budgets

20.8.8.3 The operational impact of the Salamander Project on the UK's carbon budgets (2023 – 2037) is outlined in **Table 20-18**. Emissions from the Salamander Project were aligned to the relevant carbon budget windows based on the expected development programme. Therefore, emissions generated in the pre-construction and construction phases of the Salamander Project are reflected in the 2023-2027 and 2028-2032 carbon budget windows. Energy generation from the Salamander Project is expected to begin at the end of 2029, therefore this assessment calculated the first full year of energy generation commencing in 2030.

20.8.8.4 Pre-construction and construction activity emissions were totalled and averaged across seven years, to predict emissions from the Salamander Project from 2023 to 2029, which is the expected pre-construction and construction window.

20.8.8.5 For the second carbon budget window (2028-2032), years 2028 and 2029 were considered to be within the construction phase of the Salamander Project, while the remaining three years were assessed as part of the operational phase. Emissions from the operation phase were calculated based on the expected removal of GHG emissions due to the replacement of natural gas energy (-171,328 tonnes CO_2e per year), as demonstrated in **Table 20-17**, combined with the expected emissions produced by the Salamander Project during the operation phase. The total for the impact on the annual carbon budget of 2028-2032 is presented as an average from the five years of expected activity.

20.8.8.6 **Table 20-18** demonstrates the potential emissions avoided as a result of the Salamander Project through the direct replacement of the equivalent energy produced via a combined cycle gas turbine. The greater the negative number, the greater the emissions avoided.

Table 20-18 The effects of the Salamander Project on the UK Carbon Budget

Carbon Budget Timeframe	Annual Carbon Budget (tonnes CO_2e)	Impact from Salamander Project on Carbon Budget (tonnes CO_2e)		Percentage change in Carbon Budget as a result of Salamander Project (%)	
		High Emissions Scenario	Low Emissions Scenario	High Emissions Scenario	Low Emissions Scenario
2023-2027	1,950,000,000	63,537	20,380	0.003	0.001
2028-2032	1,735,000,000	-72,355	-90,079	-0.004	-0.005
2033-2037	965,000,000	-162,949	-163,719	-0.017	-0.017

20.8.8.7 The Salamander Project will provide benefit to the UK's net zero strategy and can be seen as having a beneficial effect on the risk of climate change by avoiding GHG release, when compared to a baseline where non-renewable energy sources are used for energy generation in the UK. Carbon budgets are currently not set beyond 2037, and as such it is not possible to quantify the Salamander Project's continued contribution to a reduction in the UK carbon budgets from 2038 until the end of Salamander Project's lifecycle (the operational period is expected to end after circa 35 years).

20.8.8.8 Based on the assessment carried out, the Salamander Project will provide a net reduction in GHG emissions comparative to non-renewable energy resources. Consequences for GHG emissions as a result of the Salamander Project are therefore beneficial compared to a baseline of combined cycle gas energy generation, thus the overall impact of the Salamander Project is considered to be **Beneficial** and **Significant** based on the evaluation criteria set out by the IEMA 2022 guidance.

20.8.9 'Greenhouse Gas (GHG) Payback'

20.8.9.1 The 'GHG payback' period serves as a crucial metric for evaluating a proposed project. A shorter payback period indicates a more significant benefit for the development in mitigating emissions linked to electricity produced from burning fossil fuels. The payback period is determined by dividing the total carbon cost (carbon losses) associated with the development by the annual carbon gains achieved through displaced fossil fuel power generation. This metric provides insight into the efficiency of the Salamander Project in offsetting its carbon footprint and highlights the positive environmental impact it can achieve.

20.8.9.2 To estimate the 'GHG payback' period of the Salamander Project, it was assumed that electricity generated through natural gas combustion is replaced based on the GHG intensity figures (371 tonnes CO_2e/GWh) (DESNZ 2023a).

20.8.9.3 An alternative method for gauging the 'GHG payback' could involve utilizing the future electricity emission factors of the UK grid, with projections accessible from BEIS (BEIS 2021d). However, these projections incorporate the impact of upcoming renewable energy initiatives which would contribute to the decarbonisation of the UK electricity grid. Consequently, relying on the future projection of the UK grid is deemed an impractical approach for determining the 'GHG payback' of a renewable energy project. Government projects to 2040 (DESNZ 2023b) demonstrate that natural gas combustion will still be a significant contributor to energy generation through to 2040 such that it is considered an appropriate comparison of energy generation for the Salamander Project.

20.8.9.4 In accordance with our assumptions, the 'GHG payback' period for the Salamander Project based on the displacement of electricity produced by natural gas combustion for the UK grid is anticipated to be less than 4.5 years (**Table 20-19**).

Table 20-19 Greenhouse Gas payback for the Salamander Project

GHG emissions avoided by the Salamander Project per year against baseline (tonnes CO_2e)	Total emissions generated by the Salamander Project (tonnes CO_2e)		Years to payback	
	High Emissions Scenario	Low Emissions Scenario	High emissions scenario	Low Emissions Scenario
171,328	765,835	432,388	4.5	2.5

20.8.9.5 The difference between the realistic worst-case, high emissions scenario and the low emissions scenario shows a difference of approximately 2 years for payback of GHG emissions. It is expected that the Salamander Project, when complete, will payback GHG emissions at some point between these two emission scenario timeframes.

20.8.9.6 Based on a Salamander Project lifespan for energy generation of 35 years, there is a minimum of 30.5 years for the Salamander Project that will actively be contributing to UK targets for net zero emissions.

20.8.10 Additional Benefits to the Reduction of Greenhouse Gas Emissions

20.8.10.1 In addition to the net zero contributions, the Salamander Project will also deliver Energy Balancing Infrastructure (EBI) of up to 180 MW to provide support for the stability and reliability of renewable energy generation. There is a national requirement to balance the peaks and troughs associated with electricity supply and demands, to avoid strains on transmission and distribution networks, and to try to keep the electricity system stable. This is particularly relevant for renewable energy sources such as offshore wind, which are inherently inconsistent in their levels of energy generation due to natural variation in wind conditions.

20.8.10.2 The EBI reduces the need for extra capacity within the electricity generation sector to back-up wind farm generation and reduces the need to have further electricity generation elsewhere as storage allows the complete utilisation of wind energy by minimising losses associated with supply and demand.

20.8.10.3 It is challenging to account for the benefits of EBI within GHG assessment calculations. IEMA states in the 'EIA Guide to Greenhouse Emissions Assessment', that high level, qualitative assessment is acceptable particularly where data is unavailable, or mitigation measures are agreed.

20.8.10.4 The manufacturing of stationary batteries drives the majority of their environmental effects (Vandepaera et al 2017). This effect is significantly influenced by the percentage of fossil fuels used for energy generation in the country of battery production. A literature review on lithium-ion batteries' life-cycle assessments concluded that the lifecycle greenhouse gas emissions for batteries range from 150-200 kg CO_2e/kWh installed (Romare & Dahllof 2017). Despite the focus on battery production for light-duty vehicles, the available (albeit limited) data suggests a nearly linear increase in greenhouse gas emissions with larger battery sizes.

20.8.10.5 Using the higher emissions factor of 200 kg CO_2e/kWh and considering the Salamander Project's higher proposed storage capacity of 180 MWh, the resulting emissions cost is approximately 36,000 tonnes CO_2e. This cost is expected to be recouped in less than half a year of the wind turbine generators' operation compared to natural gas electricity generation. This figure does not account for potential CO_2 savings brought about through the implementation of EBI, making it a conservative estimate. Wider benefits of decarbonisation and supply security would also be delivered by the implementation of EBI, including a reduction in the need to use fossil fuel use at times of low renewable energy generation.

20.8.10.6 The battery storage component of the development has the potential to utilise electricity generated by the wind turbine generators during peak times or when fossil fuel sources would otherwise be used. While it's likely that the integration benefits of battery storage would contribute to the further decarbonisation of the UK electrical grid, this assessment refrains from assigning direct emissions savings to the energy storage facility, as such benefits could be claimed by other renewable energy applications, potentially leading to double-counting.

20.8.10.7 Given that the inclusion of a 180 MWh EBI within the realistic worst-case scenario for embedded carbon only extends the Salamander Projects payback period by less than a further half year, the EBI is deemed to have **Negligible** environmental effects, while delivering wider material benefits to a de-carbonised UK grid.

20.9 Blue Carbon Assessment

20.9.1 Introduction

20.9.1.1 Blue carbon is defined as "carbon stored in coastal and marine ecosystems" (IUCN, 2017).

20.9.1.2 Carbon is stored within the natural marine environment through biological processes, for example via photosynthesising phytoplankton. When phytoplankton and other marine animals die, they sink to the ocean floor, accumulating as sediment and eventually becoming sedimentary rock. Depending on the local environmental conditions, the fate of the carbon within dead fauna may differ. Carbon can be stored as either organic or inorganic carbon in marine sediments depending on various factors, including water chemistry and oxygen levels, and the presence of microbial activity. Within marine sediments, the predominant source of carbon is stored as inorganic carbon. Marine habitats around Scotland act as a reserve of stored carbon, and potential disturbance and resuspension of inorganic material can return this carbon to the carbon cycle, where organisms absorb and ultimately release CO_2.

20.9.1.3 There are several habitats in UK waters which are deemed blue carbon habitats, including kelp forests, salt marshes, mudflats and sandflats (JNCC, 2021), although at present there is no existing UK legislation or policies that protect blue carbon habitats (Luisetti *et al* 2013).

20.9.1.4 These habitats are also present within the marine waters of Scotland, where the majority of blue carbon is stored within sediments on the seabed. In Scotland, it is estimated that 7.64 mega tonnes of carbon is sequestered (or absorbed) by sediments annually and that benthic sediments currently store approximately 2,622 mega tonnes of carbon (Scottish Blue Carbon Forum, 2022).

20.9.1.5 This Blue Carbon Assessment expands on the information provided within **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology** in order to assess the potential for the Salamander Project to have an effect on blue carbon.

20.9.2 Study Area

20.9.2.1 The overall blue carbon assessment area is defined by the Offshore Development Area, as demonstrated in **Figure 20-1**. This is an appropriate and conservative scale, considering the actual potential habitat loss as a result of the Salamander Project, and thereby a loss of carbon, will be much smaller than the defined boundaries. This is due to the actual physical footprint of the Salamander Project being significantly smaller than the overall boundary.

20.9.3 Assessment Methodology

20.9.3.1 Considerations of potential impacts to benthic habitats, including habitat loss and disturbance of sediments, follow the assessment methodology presented in **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology**.

20.9.3.2 An environmental survey was undertaken to characterise the benthic environment (**Volume ER.A.4, Annex 9.1: Environmental Baseline Report**). The surveys included faunal grab sampling, drop down video recording and particle size and contaminants grab sampling, for which samples were later analysed in a laboratory. These sampling methods allowed the species abundance, richness and diversity, as well as sediment composition to be quantified across the benthos within the Offshore Development Area. This enabled habitats to be classified throughout the Study Area, supporting the Blue Carbon Assessment.

20.9.3.3 It is possible that some infrastructure components will be assembled outside of the Offshore Development Area, such as at an operational port or harbour, and stored for a period of time prior to being towed to the OAA. Infrastructure may include, but is not necessarily limited to, the floating substructures and WTGs.

20.9.3.4 Wet storage of the floating substructures (and integrated WTGs) prior to tow-out to the OAA is considered to be outside the scope of this EIA and the Marine Licence applications for the Offshore Development. This is due to the fact that at this stage of the Salamander Project it is not known which port(s) will be used for wet storage and therefore it is challenging to undertake a meaningful assessment of impacts related to wet storage. The intent is that the Salamander Project will utilise the services of a port(s) that offer wet storage sites, which will have appropriate consents (obtained by the port authority) for wet storage of floating substructures, fabrication and assembly with the WTGs. To enable the availability of this option for the Salamander Project within the required timeframe, an owner of SWPC is an official member of the TS-FLOW UK-North Joint Industry Project (JIP) exploring the challenges of wet storage and identifying the opportunities and potentially suitable locations for these activities. This JIP is in collaboration with relevant ports and other floating offshore wind developers.

20.9.3.5 Therefore, wet storage has been scoped out of this EIAR for all receptors; separate Marine Licences and associated impact assessments for wet storage areas outwith the Offshore Development Area will be applied for and undertaken as appropriate.

20.9.4 Significance Assessment

20.9.4.1 As set out within **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology**, the total area of potential temporary habitat loss or seabed disturbance equates to 5.3 km^2. This constitutes a very small proportion (0.001%) of the marine area covered by the Scottish marine environment, estimated to be 462,315 km^2, from which marine carbon could be released (Marine Scotland, 2023).

20.9.4.2 The near-field Study Area, as defined in **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology**, contains intertidal sand, subtidal sand, mud and mixed sediments that are all considered key habitats that support blue carbon storage and sequestration and are also likely to be subject to temporary habitat disturbance and / or long-term habitat loss. However, these habitats are widely distributed in the wider area, and only a small area overlaps the Offshore Development Area (see **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology** for further details).

20.9.4.3 Subtidal sand is found across much of the OAA and has a low average carbon storage (1,700 ± 100 g m^2) compared to subtidal mud (5,500 ± 500 g m^2), and intertidal sand which has the highest average carbon storage of 6,500 ± 4,000 g m^2 (Parker et al., 2021; Swaile et al., 2022).

20.9.4.4 Average sequestration for mixed sediments (sand/mud/gravel), which is found across most of the Offshore ECC, is low with a rate of 7 g m^2 yr-1 (Burrows et al., 2014), while subtidal sand also demonstrates sequestration rates (10 g m^{-2} yr-1) compared to subtidal mud (29.5 ± 29.3 g m^{-2} yr-1) (Painting, 2010; Alonso *et al*., 2012; Parker *et al*., 2021; Swaile *et al*., 2022).

20.9.4.5 Within the near-field Study Area, other likely blue carbon habitats include kelp forests. However, their potential for carbon storage and sequestration is lower than subtidal sand or mud (665 g m^2 and 0.3 ± 0.017 g m^{-2} yr-1, respectively) (Jupp and Drew, 1974; Kain, 1977; Smale *et al*., 2016; Parker *et al*., 2021; Swaile *et al*., 2022).

20.9.4.6 Generally, the sediments and habitats identified within the Offshore Development Area support minimal blue carbon storage or sequestration, where the overall percentage of carbonate in the top 10 cm of superficial sediments ranges from <10-20%, which is low in relative terms. The small scale of the footprint compared to the broader marine environment and the local nature of the impacts indicates there is limited potential for release of carbon from disturbed sediments.

20.9.4.7 Within the near-field Study Area it is estimated that a total of 5.3 km^2 will be subject to temporary habitat disturbance during the construction phase. When considering both the near-field and far-field Study Areas, this equates to temporary disturbance of 6.2% of habitats across the Study Area.

20.9.4.8 Based on the realistic worst-case scenario, total long term habitat loss is estimated to total 0.75 km^2 due to the placement of infrastructure on the seabed during the operation and maintenance phase. This represents 0.93% of benthic habitats when considering both the near-field and far-field Study Areas.

20.9.4.9 If all permanent habitat loss had the equivalent of the habitat with the highest carbon storage value (intertidal mud at 6,500g m^2) the potential CO_2 emissions impact from the development of the Salamander Project would be 4798 tonnes CO_2e.

20.9.4.10 Based on the above, the potential release of carbon from marine sediments as a result of the Salamander Project are considered to be so small scale and lacking in certainty as to be regarded as **Negligible,** which is **Not Significant** in EIA terms, and as such are not considered further within this chapter.

20.10 Terrestrial Carbon Assessment

20.10.1 Introduction

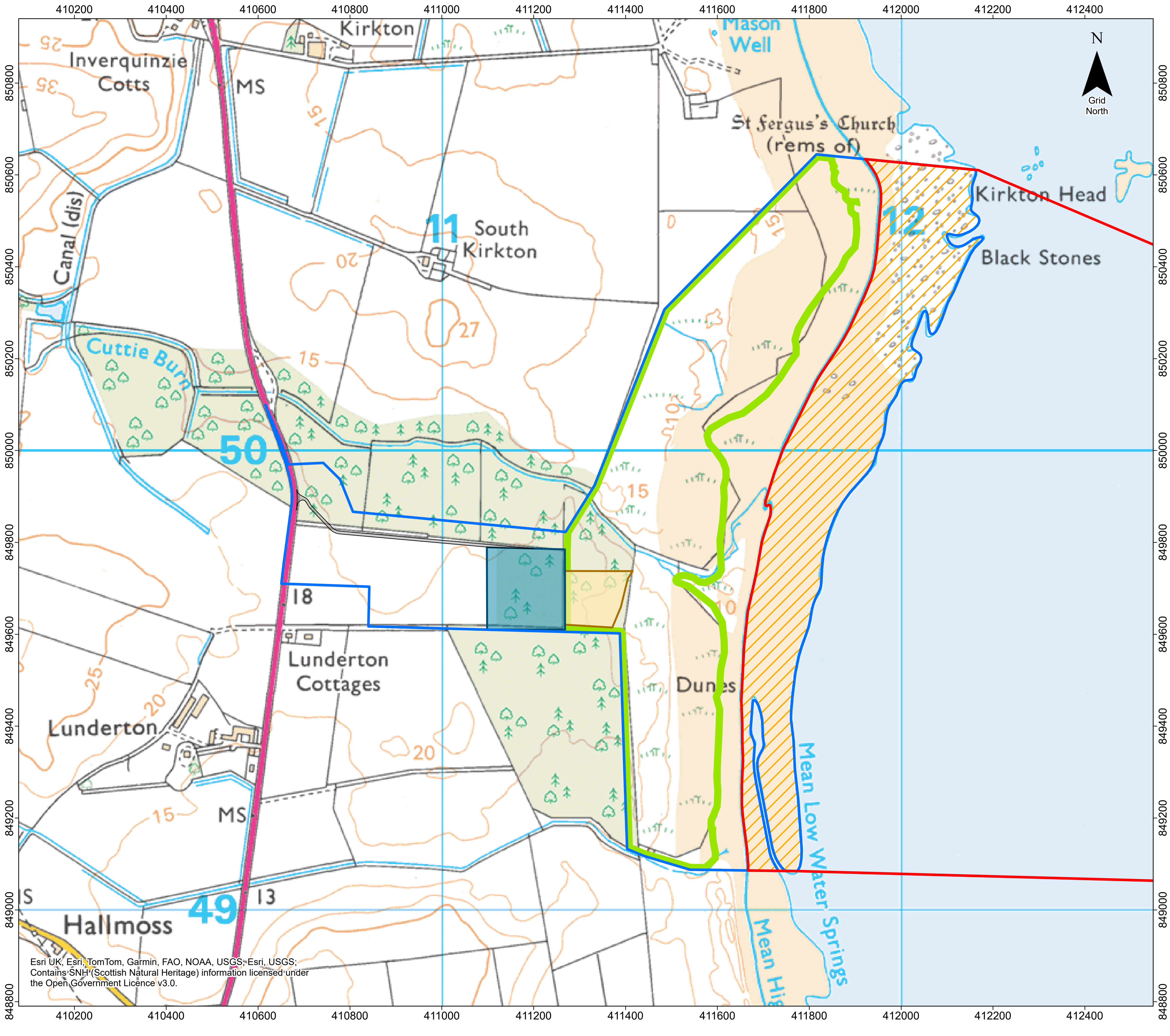
20.10.1.1 As detailed within the Scottish Government's Technical Note Version 2.10.0 on calculating potential carbon losses and savings from wind farms on Scottish peatlands, the manufacturing, construction and installation of energy infrastructure within terrestrial locations has an associated carbon cost. While impacts from offshore developments are expected to be less significant than an onshore windfarm, relevant infrastructure on land should still be assessed. Carbon losses as a result of onshore developments are associated with reduced carbon fixation potential, the loss of organic matter, including within soil through drainage effects or the felling of trees, and excavation of peat to allow for construction activities.

20.10.1.2 In terrestrial environments, soils are the most significant carbon store in Scotland, where they store more than 3,000 mega tonnes of carbon. Of this, peatlands store 53% of the total carbon contained in soils across Scotland, making peat soils a key carbon sink (NatureScot, 2020). To do this, peatlands absorb carbon dioxide and store it as carbon. This carbon can be released as carbon dioxide due to land use change. Windfarm developments on peatlands may result in a negative impact on these habitats if not appropriately considered during scheme design and development. Changes to the peatland habitat through development could result in a significant effect on its ability to store carbon, potentially resulting in reduced net carbon benefits of the Development.

20.10.1.3 Other important terrestrial carbon stores include vegetated areas such as woodland and forest. Like peatlands, these habitats absorb carbon dioxide, which is absorbed during the plant's growth and the carbon is used to form the structural parts of the plant, thus becoming 'locked-up' within the roots, stems, and leaves. Around 16% of the total land area of Scotland is covered by woodlands and forests, which are estimated to store 50 mega tonnes of carbon (NatureScot, 2020).

20.10.2 Study Area

20.10.2.1 The Study Area for the calculation of carbon losses is defined by the boundaries of the Onshore Development Area, shown in **Figure 20-3**. This is an appropriate and conservative scale, considering the actual potential habitat loss as a result of the Salamander Project, and thereby a loss of carbon, will be much smaller than the defined boundaries. This is due to the actual physical footprint of the Salamander Project being significantly smaller than the overall boundary.



Salamander

Figure 20-3

Indicative Onshore Development Layout

- Indicative Onshore Development Area
- Offshore Development Area
- Access Road
- Preferred Landfall Compound Location
- OnSS and EBI Compounds
- Landfall Compound Area Of Search
- Intertidal Area

Coordinate System: British National Grid

Vertical Datum : MLLW Scale @ A3 : 1:8,000

0 0.2 0.4 Kilometers

0 0.07 0.15 0.3 Miles

Rev	Description	Date
00	FINAL	22/04/2024
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Doc. Title : Indicative Onshore Development Layout
Doc. No : SWF01ER0000
Created by : MTC
Checked by : RM
Approved by : AH

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20.10.3 Assessment Methodology

20.10.3.1 Considerations of potential impacts to terrestrial habitats, including habitat loss, follow the assessment methodology presented in the onshore EIAR.

20.10.3.2 A number of terrestrial surveys were also undertaken to identify habitat types within and around the Onshore Development Area to support the assessment of terrestrial ecology. These included a UK Habitat (UKHab) classification survey and National Vegetation Classification (NVC) survey, as well as a desk based assessment of the Ancient Woodland Inventory (AWI) (NatureScot, 2000) and the Carbon and Peatland Map (Scottish Government, 2016), which will also be used to further inform the Terrestrial Carbon Assessment by identifying key habitats for carbon storage potential.

20.10.4 Significance Assessment

20.10.4.1 The UKHab and NVC surveys identified various habitats throughout the Onshore Development Area which primarily included a number of grasslands, dunes, hedgerows and woodlands. A full list of habitats is detailed in the onshore EIAR**.** Of these habitats, woodlands have the greatest carbon storage potential. The woodlands identified within the Study Area included:

- 'Other broadleaved woodland';
- 'Other mixed woodland'; and
- 'Other coniferous woodland'.

20.10.4.2 However, these woodland habitats were not observed to be the primary habitat type of the Onshore Development Area and only comprised of a small proportion of the overall Study Area. An area of woodland habitat will be permanently lost due to the construction of access roads, battery storage facilities and an onshore substation.

20.10.4.3 The Onshore Development Area was identified as being largely agricultural on the landward (west) side with an extensive dune system along the eastern extent of the Study Area. Sand dune habitat will be impacted by onshore construction works at the landfall and during cable installation, assuming trenchless installation of the cable into the landfall compound. However, the loss of dune habitat will predominantly be temporary as habitats will be returned to their previous conditions post cable lay operations. Permanent loss is predicted for dune habitats, cereal crops habitats and neutral grassland.

20.10.4.4 Additionally, there are no identified areas of ancient woodland on the AWI or nationally important peatlands within 500 m of the Site, therefore, there is no pathway for impacts to occur to these habitats.

20.10.4.5 In general, the habitats identified within the Onshore Development Area exhibit minimal carbon storage potential. The relatively small-scale footprint of the onshore works in comparison to the broader regional area, coupled with the local habitat types identified, suggests a limited potential for the release of carbon from habitat loss, or a loss of carbon sequestration potential.

20.10.4.6 Given the above, the anticipated carbon release from the Onshore Development of the Salamander Project is deemed to be small scale and is considered **Negligible,** which is **Not Significant** in EIA terms. Consequently, this aspect is not explored further within this chapter.

20.11 Mitigation and Monitoring

20.11.1.1 There is no additional mitigation and monitoring required as a result of the climate change resilience and GHG assessments carried out beyond those specific measures considered within the relevant EIAR chapters. The embedded mitigations relevant to the Climate Change and Carbon assessment are presented in **Table 20-20**. These have been committed to by the Salamander Project within **Volume ER.A.4, Annex 6.1: Commitments and Mitigations Register.**

Table 20-20 Embedded Mitigation for the Climate Change and Carbon assessment

Potential Impact and Effect	Mitigation ID	Mitigation	Project Aspect	Project Phase
Primary				
Impacts upon Assets and Energy generation from: • Storms • Extreme temperature events • Sea level rise/flooding • Landslides/unstable ground in coastal areas • Changes to temperature (averages) • Increased rainfall	Co29	Project infrastructure will be designed to withstand changes to environmental conditions as a result of climate change by adhering to relevant industry best practices and codes.	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation	Construction, Operation and Maintenance, and Decommissioning
Tertiary				
Release of carbon from habitat loss	Co12	Reducing Localised Habitat Loss. Best practice will be followed to ensure that potential habitat loss is minimised throughout the proposed works (e.g. micrositing and minimising the benthic footprint of the Offshore Development).	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation	Construction and Operation and Maintenance
Emissions from Vessels	Co28	A Decommissioning Programme will be developed and adhered to for the decommissioning phase of the Salamander Project, however the plan will be further developed and updated to reflect best practice at the time of decommissioning.	OAA, Offshore ECC, Intertidal ECC, Onshore ECC, Onshore Substation	Decommissioning

20.12 Cumulative Effect Assessment

20.12.1.1 GHG emissions result in impacts on a global scale, such as contributions to climate change, and therefore any potential impacts are by their nature cumulative. IEMA guidance (2022) supports the principle that a GHG assessment is cumulative in its approach, and there is no requirement for additional assessments of individual specific projects.

20.12.1.2 An in-combination climate impact assessment, in line with IEMA guidance (2020) is presented in **Appendix 3: In-combination Climate Impact Assessment**.

20.13 Transboundary Effects

20.13.1.1 Transboundary effects are defined as effects that extend into other European Economic Area (EEA) states. These may occur from the Salamander Project alone, or cumulatively with other plans or projects.

20.13.1.2 Impacts of climate change are considered to occur on a global scale, and in this context are assessed against the UK carbon budgets (see **Table 20-14**), which are reflective of international commitments for the reduction of carbon emissions, as detailed in **Table 20-1.** Due to the international nature of these considerations, transboundary effects from the Salamander Project on climate change do not require specific consideration. This aligns with the approach taken for the CEA and the 2022 IEMA guidance which states that "the GHG emissions from all projects will contribute to climate change; the largest inter-related cumulative environmental effect."

20.14 Inter-related Effects

20.14.1.1 Inter-related effects consider the potential for multiple project impacts to interact on one receptor, thereby creating a more significant impact on a receptor than when assessed in isolation. Inter-related effects may be temporal or spatial in nature and can occur across short or longer timeframes across the lifecycle of a project.

20.14.1.2 This chapter has assessed potential impacts relating to climate and carbon across the Salamander Project lifecycle and considering all potential impacts. Potential inter-related effects are also captured within the in-combination climate impact assessment presented in **Volume ER.A.3, Chapter 22: Inter-related Effects**. No inter-related effects beyond those presented in the assessments within this chapter and within **Appendix 3: In-combination Climate Impact Assessment** have been identified.

20.15 Conclusion and Summary

20.15.1.1 This Climate Change and GHG assessment has considered the potential impact of climate change on the Salamander Project and the overall impact of the Salamander Project's GHG emissions in relation to the UK's net zero targets.

20.15.1.2 The assessment on climate resilience has demonstrated that there are no identified risks from potential climate events to the Salamander Project based on the Salamander Project design. Sensitive receptors were identified and compared against the likelihood of interacting with a climate event and the potential magnitude of any impacts. None were identified as being of moderate or major significance.

20.15.1.3 The overall GHG emissions predicted to occur because of the Salamander Project were assessed, considering both embedded carbon from materials and construction of assets, as well as expected vessel use. Comparisons were made against the equivalent GHG emissions that would occur to generate the same level of energy using a non-renewable energy source, and the "payback" period for the Salamander Project to deliver a net benefit to emissions reductions was identified. Providing a net benefit to emissions reductions after four and a half years of the Salamander Project generating energy, clearly demonstrates an overall benefit of the Salamander Project when considering the implications of GHG emissions.

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20.17 Appendix 1: Greenhouse Gas Assessment- CO_2e Emissions

20.17.1 Embodied carbon

Table 20-21 Worst-Case Scenario Construction Components- 7 Wind Turbines

Component	Material	Value	Unit	CO_2e Emissions
Floating Foundation	Steel	25,401	Tonne	62,740
Wind Turbines (7 total)	Steel	13,939	Tonne	33,839
Inter Array Cables	Steel, Copper, Plastic	35	Km	5,259
Export Cables	Steel, Copper, Plastic	86	Km	12,922
Moorings	Steel	33,868	Tonne	83,654
Anchors	Steel	35,562	Tonne	87,838
Subsea Hub (2 total)	Steel	363	Tonne	897
Batteries	Various	180	MW	36,000
Onshore Construction Activities	Aggregates	67,543	Tonne	505
	Steel	22,221	Tonne	54,935
	Concrete	6,065	Tonne	625

Table 20-22 Low emissions Scenario Construction Components- 6 Wind Turbines

Component	Materials	Low emissions scenario, six wind turbines	Unit	CO_2e Emissions
Floating Foundation	Concrete	125,191	Tonne	12,894
Wind Turbines	Steel	11,948	Tonne	29,512
Interconnector Cables	Steel, Copper, Plastic	30	km	4,508
Export Cables	Steel, Copper, Plastic	43	Km	6,461
Moorings	Polyester	1,312	Tonne	3,332
Anchors	Steel	2,449	Tonne	6,049
Subsea Hub	Steel	181	Tonne	447
Batteries	Various	100	Number	20,000
Onshore Construction Activities	Aggregates	36,051	Tonne	269
	Steel	8,854	Tonne	21,869
	Concrete	3,343	Tonne	344

Vessel and Vehicle Activity

Table 20-23 Vessel activity parameters for Greenhouse Gas assessment scenarios

Salamander Project Phase		Vessel/Vehicle Type (assumed)	Total Activity (days, unless specified)		CO_2e emissions (tonnes)	
			High Emissions Scenario	*Low Emissions Scenario*	*High Emissions Scenario*	*Low Emissions Scenario*
Pre- construction	Technical Surveys	Multi-support vessels (CTV)	115	115	1938.9	1938.9
	Environmental Surveys- Vessel	Multi-support vessels (CTV)	32	32	539.52	539.52
	G.I. Visits	Personal vehicles	91 (litres fuel)	91 (litres fuel)	0.23	0.23
Construction	Construction vessels	*Multi-support vessels (SOV)*	595	532	22193.98	19,842.03
	Transport vessels	*Large cargo vessels*	558	66	20,813.85	2461.85
	Cable laying and armour	*Multi-support vessels (SOV)*	231	126	8616.48	4699.90
	Support vessels	Multi-support vessels (CTV)	651	420	10975.86	7081.2
	Construction plant	Various plant vehicles	23,389 (litres fuel)	23,389 (litres fuel)	58.71	58.71
	Transport vehicles	HGVs and Staff Vehicles	307195.2 (km travelled, HGV) 916,772 (km travelled, vans)	307195.2 (km travelled, HGV) 916,772 (km travelled, cars)	409.43	353.1
Operations and Maintenance	Offshore scheduled inspections	Multi-support vessels (CTV)	3,955	3,395	66681.3	57239.7

	Offshore Maintenance	Multi-support vessels (SOV)	5,341	5,190	199,223.57	193,591.15
	Terrestrial transit/inspections	Transit Vans	12,569 (litres fuel)	12,569 (litres fuel)	31.55	31.55
Decommissioning	Construction Plant	Various plant vehicles	27,390 (litres fuel)	12,008 (litres fuel)	68.75	30.14
	Construction vessels	Multi-support vessels (SOV)	323	259	12,048.16	9,660.91
	Transport vessels	Large cargo vessels	182	136	6788.75	5072.91
	Cable laying and armour	Multi-support vessels (SOV)	49	49	1827.74	1827.74
	Support vessels	Multi-support vessels (CTV)	420	406	7081.2	6845.16

20.18 Appendix 2: Emissions Factors

Table 20-24 Emissions factors for materials

Material	Emission Factor (kg CO_2e/kg, unless stated)	Source	Additional Information
Aggregate (general UK)	0.00747	ICE DC V3.0	Includes sand
Cement	0.832	ICE DC V3.0	Average of all steel values within database
Concrete (general)	0.103	ICE DC V3.0	UK average mix
Copper	2.71	ICE DC V3.0	EU Production Data
Diesel fuel	2.51 (kg CO2e/litre)	DESNZ 2023c	
Geotextiles	4.2	ICE DC V3.0	Damp Proof Course Membrane used.
Lubricants	2.75 (kg CO_2e/litre)	DESNZ 2023c	
Marine gas oil	2.77 (kg CO_2e/litre)	DESNZ 2023c	
Marine fuel oil	3.10 (kg CO_2e/litre)	DESNZ 2023c	
Polyethylene	2.54	ICE DC V3.0	Based on average use in EU construction, used as representative of plastics.
PVC Pipe	3.23000	ICE DC V3.0	
Stone/Quarried rock (scour protection)	0.079	ICE DC V3.0	Database average
SF6	9	Cambell & McCulloch 1998	
Steel	2.47	ICE DC V3.0	Average of all steel values within database
Stone (Quarried Rock for Scour Protection)	0.079	ICE DC V3.0	

Table 20-25 Emissions for vehicles and vessels

Vehicle or Vessel Category	CO2e Emissions	Unit	Source	Additional Information
Multi-support vessels SOV- Transit	2775.4	kg CO_2e / hr	ORE Catapult 2021	Day units calculated on 50:50 idle to transit expectation.
Multi-support vessels SOV- Idle	333	kg CO_2e / hr	ORE Catapult 2021	Day units calculated on 50:50 idle to transit expectation.
Multi-support vessels CTV- Transit	999.1	kg CO_2e / hr	ORE Catapult 2021	Day units calculated on 50:50 idle to transit expectation.
Multi-support vessels CTV- Idle	405.9	kg CO_2e / hr	ORE Catapult 2021	Day units calculated on 50:50 idle to transit expectation.
Personal Vehicle	0.16983	kg CO_2e / km	DESNZ 2023c	Average car size
Large cargo vessels	0.01321	kg CO_2e / km	DESNZ 2023c	Average of general cargo ship criteria.
Vans	0.23128	kg CO_2e / km	DESNZ 2023c	Average of various van classes (up to 3.5 tonnes)
HGV	0.64258	kg CO_2e / km	DESNZ 2023c	Average of HGV types

20.19 Appendix 3: In-combination Climate Impact Assessment

20.19.1 Introduction

20.19.1.1 The In-Combination Climate Impact (ICCI) assessment considers how the anticipated effects from the Salamander Project could be increased or reduced in any way by the predicted changes in the future baseline of the environment. This assessment has been conducted in alignment with the Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation by IEMA (2020).

20.19.2 Assessment methodology

20.19.2.1 The in-combination climate impact assessment takes into account all the potential receptors susceptible to influence from the Salamander Project as outlined within the Offshore and Onshore EIAR. It considers the potential impact of the Salamander Project on relevant EIA receptors within the context of future climate conditions.

20.19.3 Limitations and Assumptions

20.19.3.1 The following limitations and assumptions have been identified for the ICCI assessment:

- At the time of writing, onshore chapter development for the Onshore EIAR is still in draft form, and therefore, while this chapter has been written based on best available evidence, there is potential that chapter information may feature small scale adjustments. This chapter will be included within the Onshore EIAR and updates will be made if necessary.

20.19.4 Receptor and Impact Identification

20.19.4.1 The in-combination climate impact assessment focuses solely on impacts related to the operation and maintenance of the Salamander Project, given that the present climate conditions are deemed applicable during the near-term construction phase. A detailed decommissioning strategy will be developed as part of a final decommissioning programme, toward the time of decommissioning taking place. A comprehensive evaluation of the in-combination impact of climate change and the Salamander Project at the time of decommissioning will be considered as part of this decommissioning programme to appropriately address potential in-combination impacts from decommissioning when these impacts are more readily foreseeable.

20.19.4.2 **Section 20.6** provides a summary of future climate projections, which has been reviewed to identify potential impacts on the EIA topics covered in the EIAR. The impacts of the Salamander Project are assessed alongside the future climate projections to ascertain whether the impact from the Salamander Project is intensified or mitigated.

20.19.4.3 The following receptors shown in **Table 20-26**, based on EIAR chapters, have been excluded from the assessment.

Table 20-26 Receptors excluded from In-combination Climate Impact assessment

Receptor not taken forward to ICCI Assessment	Justification
Aviation and Radar	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.

Receptor not taken forward to ICCI Assessment	Justification
Commercial Fisheries	Key impacts will be directly to fish and shellfish, such as range shifts. This is addressed by the Fish and Shellfish Ecology ICCI.
Shipping and Navigation	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.
Archaeology and Cultural Heritage	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.
Other Users of the Land and Marine Environment	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.
Seascape, Landscape and Visual	Key impacts are expected to be as a result of impacts to coastal environment, therefore this is addressed under the marine physical processes ICCI.
Socio-economics, Tourism and Recreation	Climate change is expected to have both positive and negative effects on, socio-economics, tourism and recreation factors, particularly tourism and recreation. Key negative impacts are expected to occur due to sea level rise and changes in coastal morphology, as such the marine physical processes ICCI is appropriate to address this.
Traffic and Transport	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.
Noise and Vibration	Negligible sensitivity to changes to climate, therefore ICCI extremely unlikely.
Major Accidents and Disasters	The Climate Resilience assessment considers the risk to the Salamander Project of climate change related extreme events. The hazards scoped into the major accidents and hazards chapter are not expected to be impacted by changing climate variables, outside those already addressed within the Climate Resilience assessment. Therefore an ICCI is not required for this topic.

20.19.5 Potential Magnitude of In-combination Climate Impacts

20.19.5.1 The magnitude of an ICCI effect is determined by the probability of a potential impact occurring and scale of the consequence of the impact.

20.19.5.2 The rating criteria for probability and consequence are shown in **Table 20-27**. The probability of the ICCI occurring is based on expert judgement and takes into account the potential for the climate prediction to occur alongside how likely the receptor would interact with such an event. The consequence of the effect considers if the ICCI increases the potential effect on the receptor.

Table 20-27 Probability and consequence of potential In-combination Climate Impact

Rating	Probability	Consequence
High	High likelihood of occurrence	Impact to receptor is increased to very significant or significant as a result of ICCI.
Medium	Reasonably likely chance of occurrence	Impact to receptor is increased to reasonably significant as a result of ICCI.
Low	Low to unlikely chance of climate event occurring	Impact to receptor is of low significance as a result of ICCI.
Negligible	Very unlikely chance of climate event occurring	Consequence to receptor is of very low significance to no effect when ICCI is taken into account.

20.19.5.3 The potential magnitude of impact on key EIA topic areas and features due to climate change variables have been considered for the Salamander Project in **Table 20-29** based on a magnitude rating provided in **Table 20-28**.

Table 20-28 Magnitude Rating for In-combination Climate Impact Assessment

Magnitude Rating		Probability			
		Negligible	*Low*	*Medium*	*High*
Consequence	*Negligible*	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Low	Low
	Medium	Negligible	Low	Medium	Medium
	High	Negligible	Low	Medium	High

Table 20-29 Topic areas considered for impact magnitude assessment within In-combination Climate Impact Assessment

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
Marine Physical Processes	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	High: Predicted changes in baseline conditions due to climate events are expected to interact with marine physical processes, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events, which have a high probability of interacting with marine physical processes.	Low: Climate events are not predicted to interact with marine physical processes to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to marine physical processes.	Low
Water and Sediment Quality	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas	Medium: Predicted changes due to climate change events are likely to interact with water and sediment quality features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence a there is medium	Low: Climate change variables are not predicted to interact with water and sediment quality to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to water and sediment quality.	Low

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
	Changes to temperature (averages) Increased rainfall	probability for climate change events to interact with water and sediment quality.		
Benthic and Intertidal Ecology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium: Predicted changes due to climate change events are likely to interact with benthic and intertidal ecology features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence a there is medium probability for climate change events to interact with benthic and intertidal ecology.	Low: Climate change variables are not predicted to interact with benthic and intertidal ecology to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to benthic and intertidal ecology.	Low
Fish and Shellfish Ecology	Storms Extreme temperature events Sea level rise/flooding	Medium: Predicted changes due to climate change events are likely to interact with fish and shellfish features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is	Low: Climate change variables are not predicted to interact with fish and shellfish ecology to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to fish and shellfish ecology.	Low

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
	Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with fish and shellfish ecology.		
Marine Mammals	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with marine mammal features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with marine mammal features.	Low: Climate change variables are not predicted to interact with marine mammals to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to marine mammals.	Low
Offshore Ornithology	Storms Extreme temperature events	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with offshore ornithology features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a	Low: Climate change variables are not predicted to interact with offshore ornithology features to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the	Low

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
	Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with offshore ornithology features.	Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to offshore ornithology.	
Onshore-Geology, Hydrology and Hydrogeology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with onshore geology, hydrology and hydrogeology features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with onshore geology, hydrology and hydrogeology features.	Low: Climate change variables are not predicted to interact with onshore geology, hydrology and hydrogeology features to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to onshore geology, hydrology and hydrogeology.	Low
Terrestrial Ornithology	Storms	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with onshore ornithology features across the	Low: Climate change variables are not predicted to interact with terrestrial ornithology features to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project.	Low

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
	Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with terrestrial ornithology features.	Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to terrestrial ornithology.	
Terrestrial Ecology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with terrestrial ecology features across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with terrestrial ecology.	Low: Climate change variables are not predicted to interact with terrestrial ecology features to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to terrestrial ecology.	Low

Topic	Relevant Climate Event Variables	Probability	Consequence	Overall Magnitude Rating
Air Quality	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium: Predicted changes in environmental conditions due to climate change events are likely to interact with air quality across the Salamander Project lifespan, given the current, and highly likely, ongoing temperature rises, largely as a result of anthropogenic warming. Strong positive corelations have been found between increased temperatures and increased climatic events; however, the degree to which this will occur is uncertain and dependent on a variety of global warming scenarios. Hence there is medium probability for climate change events to interact with air quality.	Low: Climate change variables are not predicted to interact with air quality features to a scale where there is likely to be a significant consequence over the lifetime of the Salamander Project. Significant changes to climate events occur over large spatial and temporal scales, usually hundreds to thousands of years. Given the Operational Lifetime of the Salamander Project is 35 years, climate events are not expected to change significantly in a manner which will cause significant effects to air quality.	Low

20.19.6 Significance Assessment

20.19.6.1 The significance of an ICCI can be determined based on the following significance assessment matrix shown in **Table 20-30**. It considers the magnitude of the effect that could occur as a result of changing climate, against how sensitive each topic area is to the impacts of climate events.

20.19.6.2 The determination of receptor sensitivity is based on expert knowledge and consideration of topic areas, having regard to assessments carried out within the individual EIAR chapters. All topic areas are considered alongside embedded mitigation measures as set out within the relevant EIAR chapters.

Table 20-30 Significance of In-combination Climate Impact effect matrix

Significance of effect		Receptor Sensitivity			
		Negligible	*Low*	*Medium*	*High*
Magnitude of ICCI effect	*Negligible*	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate
	High	Negligible	Minor	Moderate	Major

20.19.6.3 The significance categories provide a scale through which the ICCI can be determined. '**Moderate**' and '**Major**' impacts are considered to be '**Significant**' within the EIA framework, while those that rate as **'Minor'** or '**Negligible**' are considered '**Not Significant**'.

20.19.6.4 Limitations to this assessment occur due to the reliance on future predictions, which contain assumptions and data gaps. This assessment has been completed with the current best guidance and up-to-date data.

20.19.6.5 The ICCI assessment is detailed in **Table 20-31.**

Table 20-31 Significance for In-combination Climate Impact assessment

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
Marine Physical Processes	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium	Low	**Minor:** Potential changes to sea conditions as a result of climate change events, such as sea level rise resulting in increased wave heights, has the potential to increase impacts from the Salamander Project on marine physical processes. However, impacts identified are small scale, infrequent and localised, and it is not expected that climate changes within the lifecycle of the Salamander Project could lead to a significant increase in the potential magnitude of the impacts from the Salamander Project, which are all identified as not significant.	No additional mitigation measures required	**Minor**	Not significant
Water and Sediment Quality	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas	Medium	Low	**Minor:** Changing climate events, such as increased storm activity, has the potential to interact with water and sediment quality, for example through increased turbidity. However, impacts identified are small scale, infrequent and localised. Impacts from the Salamander Project, are all considered not significant, coupled with the large scale and dispersive effects of the marine environment, would result in an ICCI that would not be significant.	No additional mitigation measures required	Minor	Not significant

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Changes to temperature (averages) Increased rainfall						
Benthic and Intertidal Ecology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium	Low	**Minor:** All benthic and intertidal ecology impacts were assessed as not significant within the EIAR chapter. While climate change effects are likely to interact with benthic and intertidal ecology, through factors such as increased wave height or storm events altering local conditions. These impacts identified are small scale, infrequent and localised and are not considered to interact on a scale that would result in an increase in the significance of the potential impacts from the Salamander Project.	No additional mitigation measures required	Minor	Not significant
Fish and Shellfish Ecology	Storms Extreme temperature events Sea level rise/flooding	Medium	Low	**Minor:** Climate change events are likely to impact fish and shellfish ecology. This may be particularly relevant where changing sea temperatures result in range shifts of various species. However, significant changes to temperature occur over large temporal scales and the Salamander Project assessment of impacts alone on this topic has identified only Minor or Negligible effects.	No additional mitigation measures required	Minor	Not significant

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall			Therefore, it is not considered that the effects of climate change events will result in a significant increase to any potential impacts to fish and shellfish ecology features.			
Marine Mammals	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Low	Low	**Negligible:** While marine mammals are likely to interact with changing climate events, through such factors as increased storm events or changing sea temperatures resulting in range changes (particularly for prey species), marine mammal physiology indicates an adaptive ability to predicted climate changes that are expected to occur within the Salamander Project lifecycle. Given the mobile nature of marine mammals and ability to adapt to potential range shift in prey species, the interaction between climate events and the impacts from the Salamander Project on marine mammals, which are identified as not significant, are not expected to increase through an ICCI.	No additional mitigation measures required	Negligible	Not significant
Offshore Ornithology	Storms	Medium	Low	**Minor:** Changing temperatures could impact prey availability and ranges, while temperature changes and	No additional mitigation	Minor	

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall			storm events could also impact the ability of bird species to successfully forage. However, significant changes to temperature occur over large temporal scales and additionally all effects from the Salamander Project alone were identified as not significant, and there are no identified climate impacts over the Salamander Project lifecycle that could interact at a level that would increase the significance of the impact. Therefore, it is not considered that the effects of climate change events will result in a significant increase to any potential impacts to offshore ornithology features.	measures required		
Onshore-Geology, Hydrology and Hydrogeology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages)	Low	Low	**Negligible:** Climate change effects may interact with onshore geology, hydrology and hydrogeology, largely through increasing temperature, increasing such factors as rainfall or storm events altering local conditions. However, significant changes to temperature occur over large temporal scales, as such these effects are not considered to interact on a scale that would result in an increase in the significance of the potential impacts during the lifetime of the Salamander Project. Therefore, it is not considered that the effects of climate change events will result in a significant increase to any	No additional mitigation measures required	Negligible	Not significant

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Increased rainfall			potential impacts to onshore geology, hydrology or hydrogeology features through an ICCI.			
Terrestrial Ornithology	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall	Medium	Low	**Minor:** Changing temperatures could impact prey availability and ranges, while temperature changes and storm events could also impact the ability of bird species to successfully forage. However, significant changes to temperature occur over large temporal scales and additionally all effects from the Salamander Project alone were identified as not significant, and there are no identified climate impacts over the Salamander Project lifecycle that could interact at a level that would increase the significance of the impact. Therefore, it is not considered that the effects of climate change events will result in a significant increase to any potential impacts to terrestrial ornithology features.	No additional mitigation measures required	Minor	Not significant
Terrestrial Ecology	Storms	Medium	Low	**Minor:** Climate change events are likely to impact terrestrial ecology. This may be particularly relevant where changing temperatures result in range shifts of	No additional mitigation	Minor	Not significant

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages) Increased rainfall			various species. However, significant changes to temperature occur over large temporal scales and additionally, the Salamander Project assessment of impacts alone on this topic has identified only Minor or Negligible effects. Therefore, it is not considered that the effects of climate change events will result in a significant increase to any potential impacts to terrestrial ecology features.	measures required		
Air Quality	Storms Extreme temperature events Sea level rise/flooding Landslides/unstable ground in coastal areas Changes to temperature (averages)	Low	Low	**Negligible:** While climate change effects may interact with air quality, through such factors as increased temperatures altering local conditions, significant changes to temperature occur over large temporal scales. Therefore, these effects are not considered to interact on a scale that would result in an increase in the significance of the potential impacts from the Salamander Project over the lifetime of the Salamander Project. As such, it is not considered that the effects of climate change events will result in a significant increase to any potential impacts to air quality through an ICCI.	No additional mitigation measures required	Negligible	Not significant

Topic	Relevant Climate Event Variable	Sensitivity of Receptor to Climate Change Effects	Magnitude	Significance of ICCI Effect	Additional Mitigation	Residual Significance of Effect	Significance of Effects in EIA Terms
	Increased rainfall						

20.19.7 Conclusion

20.19.7.1 The ICCI assessment reviewed potential impacts that could occur as a result of in-combination effects. The overall conclusions demonstrated that the residual significance of potential effects through an in-combination assessment was either **Negligible** or **Minor**, and therefore are considered **Not Significant** within the context of EIA. There are no identified risks from potential in-combination climate effects to the Salamander Project that are not addressed through embedded mitigation measures delivered through project design.