

## 1.0 Climate Change Risk Assessment

### Introduction

- 1.1 This climate change risk assessment (CCRA) appendix assesses the potential adverse effects on the proposed development from climate change, in line with the Institute of Environmental Management and Assessment (IEMA) Environmental Impact Assessment Guide to Climate Change Resilience & Adaptation<sup>1</sup>. The report will inform the assessment of climate change impacts reported in Chapter 18.0: Climate Change.

### Methodology

#### Introduction

- 1.2 This report considers the climate-related physical risks on the proposed development and identifies the current and anticipated risks throughout its lifetime. This technical report evaluates the processes utilised for managing the risks through four key stages:
- An assessment of the baseline climate to understand present-day vulnerability and assess current climate-related risks, opportunities and levels of adaptation.
  - An assessment of future climate projections to understand future vulnerability and adaptation for Stranraer.
  - Identify vulnerability of project components to climate change and undertake an assessment of their likelihood and severity.
  - Review potential adaption and mitigation options.
- 1.3 Risks associated with climate change were identified using the current and future climate baseline, in combination with information available for the proposed development. The risk assessment and determination of overall risk rating considers the resilience measures that will be adopted by the proposed development.

#### Physical Risk Assessment

- 1.4 Risk in the context of climate risk is defined as the risk that a weather or climate event occurs and results in an adverse impact. Impacts due to weather and climate typically take two forms: sudden-onset (acute) or slow-onset due to cumulative events over time (chronic). For example:
- Risk of sudden-onset damage to an asset following an extreme weather-related event such as surface water flooding.
  - Risk that asset condition deteriorates below acceptable standards following years of changing seasonal weather.

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<sup>1</sup> IEMA: Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation: 2020

- 1.5 Given the variability in the nature of the potential effects of climate change at the site, receptors have been identified on a risk-specific basis, whereby all receptors relate to the continued safe and effective operation at the site. To classify each risk, relevant climate hazards have been identified using the obtained climate projections with consideration for exposure and vulnerability of the site.
- 1.6 The relationship between exposure and vulnerability is the defining factor to overall risk. A location can be exposed to a certain hazard but may not be vulnerable. Vulnerability can also be considered alongside coping capacity, or lack thereof. The combination of the two, with the identified exposure will be used to assign a significance rating. **Table 1-1** outlines definitions for hazard, exposure and vulnerability and **Table 1-2** outlines the significance matrix that is used to define the overall risk of a climate hazard on specific receptors. This approach to determining significance is consistent with the IEMA guidance<sup>2</sup>.

**Table 1-1: Hazard, exposure and vulnerability factor definitions**

Factor	Score definitions
<b>Hazard:</b> refers to the possible, future occurrence of natural or human physical events that may have adverse effects on vulnerable and exposed elements. The presence of a hazard is identified and weighted based on the location's exposure to that hazard. For example, a hazard may occur within a particular scenario, however the relative exposure to that hazard is how it will be measured.	
<b>Exposure:</b> considers the nature of the impacts and the degree of certainty based on the obtained climate projections. Exposure is necessary, but not determinant of risk. A site can be exposed but not vulnerable.	<b>Major:</b> large change to climate condition and large increase in the frequency of the event.
	<b>Moderate:</b> a large, measurable change in climate conditions at a regular frequency.
	<b>Minor:</b> change in climate conditions that may have measurable effect on a receptor, but which are low likelihood of occurring or infrequent.
<b>Vulnerability:</b> the degree of vulnerability of each receptor to the hazard. Vulnerability can be seen as situation specific.	<b>High:</b> short term, acute impact to functionality or a large, measurable decrease in receptor lifespan following the occurrence of a climate impact. Major increase in the need for maintenance and repairs.
	<b>Medium:</b> measurable decrease in receptor performance or lifespan or increase in necessary maintenance and repairs following the occurrence of a climate impact.
	<b>Low:</b> small measurable impact to a receptor's performance following climate impact, or deterioration of a receptor's lifespan due to a chronic effect.

**Table 1-2: Risk assessment scoring matrix**

Vulnerability	Exposure		
	Major	Moderate	Minor
High	Significant	Significant	Significant
Medium	Significant	Significant	Not Significant
Low	Significant	Not Significant	Not Significant

<sup>2</sup> IEMA: Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation: 2020

## Project Elements

- 1.7 The main elements of the project have been identified through a review of **Volume 1, Chapter 1: Introduction & Background** and are presented in **Table 1-3**. The risk assessment presented in **Table 1-5** uses these asset classes to categorise the susceptibility to specific risks.

**Table 1-3: Project elements**

Asset class	Asset class ID	Project element
Land based	LB	<ul style="list-style-type: none"> <li>• New Workshops.</li> <li>• New floating harbour/marina facilities for users of the new berth pontoons.</li> <li>• Retrofitting of the existing harbour reception building to enhance energy efficiency.</li> <li>• New Fishermen’s Compound.</li> <li>• New quay wall to replace the existing wall at Breastworks car park.</li> <li>• New coastguard and marine research facility (Solway Coast and Marine Pilot Project).</li> <li>• Redeveloped public slipway, linking into and enhancing the existing coastal walk, connecting to the new reclaimed land area.</li> <li>• Upgrading and installation of new lighting through the project area.</li> <li>• New car parking and community space on reclaimed land area, with a new linked revetment between the land and water providing a seating area and a view point.</li> <li>• Upgrades to both Breastworks and Marine Lake car parks, including motorhome stances.</li> </ul>
Marine based	MB	<ul style="list-style-type: none"> <li>• Revised Marina layout - inclusion of an additional 185 new berths and approximately 14 commercial berths.</li> <li>• Increased dredging and breakwaters to accommodate new marina layout;</li> <li>• Fuel Berth.</li> <li>• New linkspans to berth pontoons.</li> </ul>

## Baseline conditions

- 1.8 The baseline climate data has been sourced from the Met Office climate station located in West Freugh (Dumfries & Galloway)<sup>3</sup> as it is the closest located climate station to the proposed development and provides records of observed climate averages covering the climate period 1981-2010.

## Climate Change Projections

- 1.9 The Met Office Hadley Centre (MOHC) publishes both probabilistic climate change projections and downscaled global circulation model outputs for the UK at various spatial scales. This is called the UK Climate Projections (‘UKCP18’) dataset<sup>4</sup>, first published in November 2018 and at v2.11.0 at the time of writing. The projections are based on Representative Concentration

<sup>3</sup> Met Office: UK Climate Averages – West Freugh: 2024

<sup>4</sup> MOHC: UK Climate Projections User Interface v2.11.0: 2024

Pathway (RCP) scenarios used by the Intergovernmental Panel on Climate Change (IPCC). The RCP scenarios (four scenarios presented in the IPCC fifth Assessment report which are included within the UKCP18 database) describe different climatic futures, all of which are considered possible depending on the volume of GHG emitted. The data presented here is for the emissions pathway RCP8.5, which is a high-emissions scenario assuming 'business as usual' growth globally with minimal mitigation. As required by IEMA guidance<sup>5</sup>, this risk assessment uses the emissions pathway RCP8.5 as a conservative and precautionary approach.

- 1.10 The probabilistic projections published at 25 km<sup>2</sup> grid cell scale are considered the most useful for this assessment, being designed to show a range of projection values that reflect uncertainty in modelled outcomes.
- 1.11 The construction of the proposed development is anticipated to begin in 2026, with the year of opening forecast to be 2028. Given the use of the proposed development, no set operational timeframe has been given, therefore climate projections have been used for the period 2070-2099, to cover the end of the century. This period represents the greatest change in climate from the 1981-2010 baseline and as such, reflects the greatest risk to the proposed development.

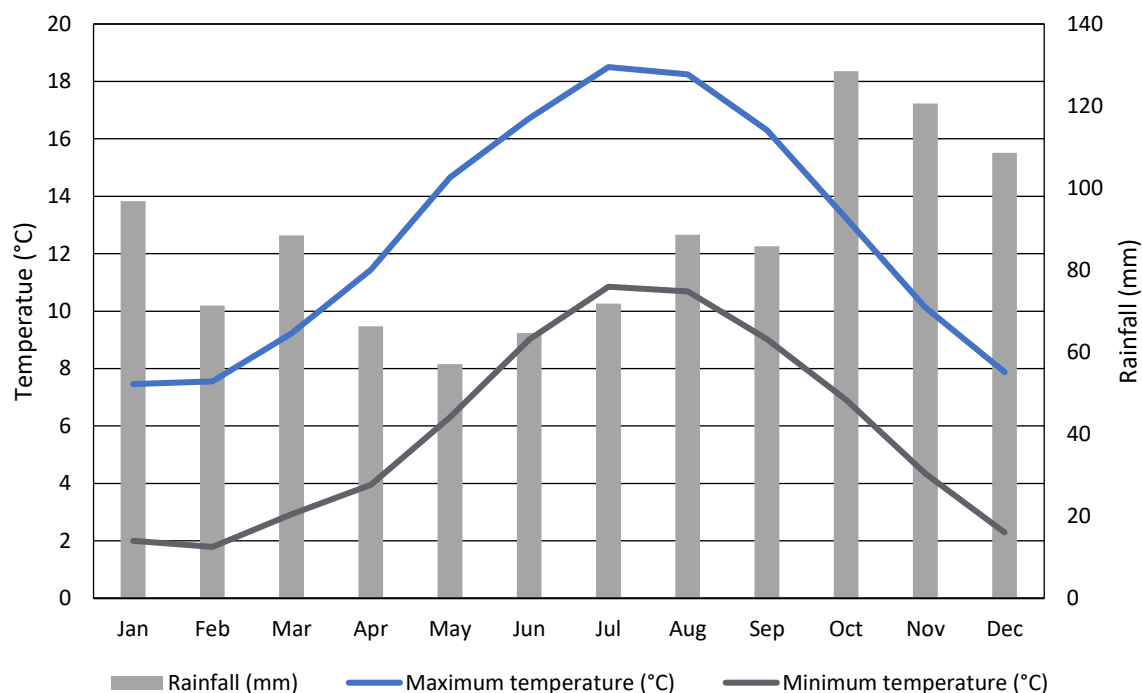
### Baseline Conditions

- 1.12 The key observed data points from West Freugh climate station and regional and UK averages are presented in **Figure 1.1** and show the following:
- Highest monthly average maximum temperature is in July at 18.5°C. This is higher compared to regional figures in July (17.65°C for West Scotland) and lower than national figures (19.45°C for the UK).
  - Lowest monthly average minimum temperature is in February at 1.79°C. This is higher compared to regional and national figures in February (0.59°C for West Scotland, and 0.72°C for the UK).
  - Wettest month is October, with average rainfall of 128.47 mm. This is lower than the regional figure in October (200.38 mm for West Scotland) and slightly higher than the national figure (125.61 mm for the UK).
  - Annual average precipitation is 1048.55 mm, lower than the regional figure of 1773.82 mm for West Scotland and higher than the UK annual average precipitation of 1141.95 mm.
  - 159 days of rain (>1 mm falling in a day) are experienced on average every year, lower than regional (192) and slightly higher than the UK (156) averages.

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<sup>5</sup> IEMA (2020) Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation. [online] <https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020> [Accessed July 2024].

**Figure 1.1: Observed climatic conditions at West Freugh (Dumfries and Galloway) for the period 1981-2010.**



### Climate Projections

1.13 **Table 1-4** show potential climatic changes from the UKCP18 probabilistic dataset for the 2070-2099 time period relative to the 1981-2010 baseline for the 25 km<sup>2</sup> grid square in which the proposed development is located (206033, 560995).

1.14 In summary, the data within **Table 1-4** shows increased intensity in seasonal precipitation trends and increased temperatures across the year by the end of the century. The key observed data points from the climate projections show the following:

- Precipitation is projected to decrease by up to 43.6% during the summer and increase by up to 74.3% in winter.
- In the driest month (May), precipitation is projected to decrease by up to 27.6%, whilst in the wettest month (October), precipitation is projected to increase by up to 74.3%.
- The annual average temperature is projected to increase by 4.6°C, with the maximum temperature in the hottest month (July) projected to increase by up to 7.4°C. The minimum temperature in the coldest month (February) could also increase by up to 5.5°C.

**Table 1-4: Climate Projections 2070-2099**

Climate variables	Units	10th percentile	Median value	90th percentile
Precipitation - annual	%	-4.7	+8.3	+22.9
Precipitation - winter	%	+3.3	+30.2	+61.9
Precipitation - summer	%	-43.6	-23.1	-0.8
Precipitation - driest month	%	-27.6	+0.4	+28.0

Climate variables	Units	10th percentile	Median value	90th percentile
Precipitation - wettest month	%	-17.2	+24.6	+74.3
Average Temperature - annual	°C	+1.7	+3.1	+4.6
Average Temperature - summer	°C	+1.8	+3.9	+6.0
Average Temperature - winter	°C	+0.9	+2.6	+4.5
Average Temperature - hottest month	°C	+1.4	+3.9	+6.6
Average Temperature - coldest month	°C	+0.5	+2.6	+4.6
Maximum Temperature - summer	°C	+1.6	+4.1	+6.6
Maximum Temperature - hottest month	°C	+1.2	+4.1	+7.4
Minimum Temperature - Winter	°C	+0.8	+3.0	+5.4
Minimum Temperature - coldest month	°C	+0.5	+2.9	+5.5

### *Sea level rise and storm surge*

- 1.15 The UKCP18 marine report<sup>6</sup> indicates that sea level is projected to increase across the UK through the 21st century. This report uses Portpatrick in South West Scotland, located approximately 9km from the proposed development as an example location to illustrate sea level projections. The total range of projected sea level rise at 2100 across all RCP scenarios at 2100 is approximately 0.1 - 0.9m for Portpatrick.
- 1.16 The UKCP18 Factsheet: Sea level rise and storm surge<sup>7</sup> highlights that sea level rise is expected to be the primary mechanism by which coastal flood risk will change in the UK in the future.
- 1.17 The flood risk assessment undertaken for the proposed development (see **Volume 1, Chapter 10: Flood Risk**) has accounted for changes to flood risk arising from climate change within its assessment. The Environment Agency in collaboration with the Scottish Environmental Protection Agency (SEPA) and Natural Resources Wales have produced a dataset of extreme sea levels (ESLs) around the coastline of the UK, based on the likelihood of the co-occurrence of tidal high water and extreme storm surges. This coastal boundary dataset defines a 1 in 200 year ESL of 3.86 m AOD at the head of Loch Ryan in the current climate.
- 1.18 As detailed within **Volume 1, Chapter 10: Flood Risk**, SEPA guidance on applying climate change allowances in the assessment of flood risk provides predictions of anticipated sea level rise around Scotland, based on UKCP18 projections. This guidance recommends a sea level rise allowance of 0.88 m up to the year 2100 in Loch Ryan. This uplift has been applied to identified ESLs to provide a 1 in 200 year plus climate change ESL of 4.47 m AOD.

<sup>6</sup> MOHC (2018) UKCP18 Marine report. [online] <https://nora.nerc.ac.uk/id/eprint/522257/1/UKCP18-Marine-report.pdf>

<sup>7</sup> Fung F, Palmer M, Howard T, Lowe J, Maisey P and Mitchell JFB (2018). UKCP18 Factsheet: Sea Level Rise and Storm Surge, Met Office Hadley Centre, Exeter

- 1.19 ESLs also have the potential to be exacerbated by wind-generated waves. A wave study and coastal flood modelling study has been carried out to estimate potential combinations of ESLs and significant wave heights that could coincide to result in a 1 in 200 year plus climate change joint ESL, with allowance for waves. Based on this study, a conservative estimate of maximum 1 in 200 year plus climate change ESL, with allowance for waves, of 5.27 m AOD has been identified.
- 1.20 See **Volume 1, Chapter 10: Flood Risk** for further detailed information.

### Physical Risk Assessment

- 1.21 The risks associated with rising temperatures, more frequent extreme weather patterns and rising sea levels in the UK are presented in the third Climate Change Risk Assessment (CCRA3), Chapter 4: Infrastructure<sup>8</sup> and Chapter 5: Health, Communities and the Built Environment<sup>9</sup> and detailed in the Independent Assessment of UK Climate Risk<sup>10</sup>. These risks are further investigated within this section.
- 1.22 **Table 1-5** shows the climate change risks to the proposed development that have been identified and the relevant risk scores assigned, following the approach set out in **Table 1-1** and **Table 1-2**. Embedded design measures have been identified as necessary to accordingly reduce the risk to an acceptable level and mitigate a potential significant effect.
- 1.23 The most significant risk from climate change on the proposed development arises from flooding, largely as a result of coastal flooding from rising sea levels and storm surges. This is assessed in detail as part of the planning application within **Volume 1, Chapter 10: Flood Risk**.
- 1.24 Considering the proposed mitigation within **Table 1-5** below, the potential risk posed to the proposed development would be reduced to an acceptable and non-significant level in EIA terms.

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<sup>8</sup> Jaroszowski, D., Wood, R., and Chapman, L. (2021) Infrastructure. In: The Third UK Climate Change Risk Assessment Technical Report. [Betts, R.A., Haward, A.B., Pearson, K.V. (eds)] Prepared for the Climate Change Committee, London

<sup>9</sup> Kovats, S. and Brisley, R. (2021) Health, communities and the built environment. In: The Third UK Climate Change Risk Assessment Technical Report Prepared for the Climate Change Committee, London [Online] <https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Chapter-5-FINAL.pdf> [Accessed October 2024]

<sup>10</sup> Climate Change Committee (2021): Independent Assessment of UK Climate Risk, Advice to the Government for the UK's third Climate Change Risk Assessment (CCRA3). [Online] <https://www.theccc.org.uk/publication/independent-assessment-of-uk-climate-risk/> [Accessed October 2024].

**Table 1-5: Climate Risk Assessment Matrix for the Proposed Development**

Hazard	Asset Class ID	Impact	Embedded Mitigation	Exposure	Vulnerability	Significant Effect
Increased frequency of coastal flood events	LB	Due to its harbourside location, the proposed development is located within an area identified as being at risk of coastal flooding. Electrical system failure due to inundation.	<b>Volume 1, Chapter 10: Flood Risk</b> provides detail regarding the measures implemented to account for flood events within the design of the proposed development. As part of the proposed development, the existing breakwater will be extended which will act as coastal flood protection for the development. The design of the breakwater/revetment protection includes a climate change consideration of a 1 in 200 year + climate change event. The reclaimed land area is raised to provide additional flood protection. Implementation of a flood evacuation plan within the suite of operational management plans.	Moderate	Low	Not significant
	LB	Flooding causing damage to building fabric and on-site infrastructure.		Moderate	Low	Not significant
	LB	Disruption to marina access and subsequent operational activity through flooding of access routes.		Moderate	Low	Not significant
	LB	Risk to the safety of users of the proposed development.		Moderate	Low	Not significant
Increased frequency and intensity of extreme weather i.e. storms	MB	Due to the harbourside location, the proposed development is at risk of storm surges, which may result in increased risk of flooding causing damage to building fabric and on-site infrastructure.	The proposed development located is sheltered. <b>Volume 1, Chapter 10: Flood Risk</b> provides detail regarding the measures implemented to account for flood events within the design of the proposed development. As part of the proposed development, the existing breakwater will be extended which will act as coastal flood protection for the development. The design of the breakwater/revetment protection includes a climate change consideration of a 1 in 200 year + climate change event. The reclaimed land area is raised to provide additional flood protection. Implementation of resilience management plans to monitor damage to structures and implement maintenance and repair work as appropriate.	Moderate	Low	Not significant
	LB	Disruption to marina access and subsequent operational activity through flooding of access routes.		Moderate	Low	Not significant
	MB	Wave slam, which will increase as sea level rises, may cause damage to structures in the marina, which could limit operations and incur high repair costs.		Minor	Medium	Not significant
	LB	Storms, heavy snow, high winds, and other extreme weather events may cause structural damage to the proposed development.		Minor	Low	Not significant
	LB	Lightning strikes may cause temporary dips in power causing failure of the marina's operations and services.		Minor	Low	Not significant
	LB MB	Risk to the safety of users of the proposed development.		Moderate	Low	Not significant
Increased intensity in seasonal precipitation, i.e. drier summers and wetter winters	LB	Increased in winter precipitation may result in increased standing surface water, particularly in areas that are covered by mostly impermeable surfaces, such as the car parks.	<b>Volume 1, Chapter 10: Flood Risk</b> provides detail regarding the measures implemented to account for flood events within the design of the proposed development. All buildings will be built in line with current building regulations for structural design with safety margin. Implementation of resilience management plans to monitor damage to structures and implement maintenance and repair work as appropriate.	Moderate	Low	Not significant
	LB	Disruption to marina access and subsequent operational activity through flooding of access routes.		Moderate	Low	Not significant
	LB MB	Excessive rainfall and drought cycles may cause subsistence and coastal erosion resulting in structural damage to the proposed development.		Minor	Medium	Not significant
	LB	Excessive rainfall and drought cycles may cause pavement layers to raise. This may cause disruption marina accesses and require more frequent repairs.		Moderate	Low	Not significant
Increased summer temperatures	LB	High temperatures may result in overheating within buildings leading to user health impacts.	Appropriate ventilation will be accounted for within the design of the buildings.	Moderate	Low	Not significant

Hazard	Asset Class ID	Impact	Embedded Mitigation	Exposure	Vulnerability	Significant Effect
Low winter temperatures resulting in freeze thaw events	LB	Winter temperatures are increasing, which will reduce the frequency of freeze thaw events, however it will still be a risk. Freeze thaw events can lead to cracking and damage of building structures.	Implementation of resilience management plans to monitor damage to structures and implement maintenance and repair work as appropriate.	Minor	Low	Not significant
Increased humidity as a result of increased annual precipitation.	LB	Damage to building fabric from water ingress causing damp.	Appropriate ventilation will be accounted for within the design of the buildings.	Moderate	Low	Not significant
Increased sea surface temperature	MB	Changes in sea water chemistry may lead to structure corrosion. This may increase need for maintenance and repair of affected structures.	Implementation of resilience management plans to monitor damage to structures and implement maintenance and repair work as appropriate.	Minor	Medium	Not significant

## Abbreviations

<b>Abbreviation</b>	<b>Definition</b>
CCRA	Climate Change Risk Assessment
LB	Land based
MB	Marine based
RCP	Representative Concentration Pathway
MOHC	Met Office Hadley Centre
IPCC	Intergovernmental Panel on Climate Change
IEMA	Institute of Environmental Management and Assessment
UKCP18	UK Climate Projections