

ENVIRONMENTAL STATEMENT (VOLUME II)

Chapter 7 – Climate Resilience

Padeswood Carbon Dioxide Spur Pipeline Proposed Development

Town and Country Planning Act 1990

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7. CLIMATE RESILIENCE

7.1. INTRODUCTION

- 7.1.1. This Chapter reports the assessment of the likely significant effects of climate change upon the Padeswood Spur Pipeline Proposed Development and describes:
- Relevant, legislation, policy and guidance;
 - Consultation undertaken;
 - Assessment methodology;
 - Baseline conditions;
 - Potential effects of the Construction, Operational and Decommissioning Stages of the Padeswood Spur Pipeline Proposed Development;
 - Potential design, mitigation and enhancement measures;
 - Residual effects; and
 - Next steps.
- 7.1.2. This chapter is intended to be read as part of the wider ES with particular reference to **Chapter 17 – Water Resources and Flood Risk** (Document Reference: PW.3.2.17) and **Chapter 18 – Combined and Cumulative Effects** (Document Reference: PW.3.2.18).

7.2. LEGISLATIVE AND POLICY FRAMEWORK

- 7.2.1. A summary of the international, national, and local legislation, planning policy and guidance relevant to the climate resilience assessment for the Padeswood Spur Pipeline Proposed Development is set out in this section.

LEGISLATIVE FRAMEWORK

National

Climate Change Act (HM Government, 2008)

- 7.2.2. The Climate Change Act 2008 sets targets for reducing the UK's impacts on climate change and the need to prepare for its impacts.

Climate Change Risk Assessment (UK Climate Risk, 2022)

- 7.2.3. The first UK Climate Change Risk Assessment (CCRA) was presented to Parliament in an Evidence Report in 2012, with the second presented in 2017 and the third (CCAR3) published in 2022. The overall aim of the Evidence Report is to assess the urgency of further action to tackle current and future risks, and realise opportunities, arising for the UK from climate change. The Act also requires the production of a National Adaptation Plan for the UK Government to be ready for the challenges of climate change.

The National Adaptation Programme (NAP) (2023)

- 7.2.4. The NAP sets the actions that government and others will take to adapt to the challenges of climate change in the UK. It sets out key actions for a five-year period.

POLICY

National

National Planning Policy Framework (Ministry of Housing, Communities & Local Government, 2024)

- 7.2.5. The NPPF sets out the Government's planning policies for England and how these should be applied. Guidance relating to ways to minimise vulnerability and improve resilience to climate change impacts is mainly set out in Section 14 "Meeting the Challenge of Climate Change, Flooding and Coastal Change".

Planning Practice Guidance (Department for Levelling Up, Housing and Communities, 2023)

- 7.2.6. The guidance explains the processes and tools that can be used through the planning system in England. The guidance advises how to identify suitable mitigation and adaptation measures in the planning process. The guidance particularly recommends the use of local risk assessments to identify climate-related risks and their implications for the built environment, biodiversity and vulnerable groups and communities.

Climate Change Adaptation: policy information (Department for Environment, Food and Rural Affairs, 2021)

- 7.2.7. The policy paper lays emphasis on the role of climate adaptation to reduce negative consequences of climate change in the UK and gives a description of the initiatives by the UK government for building preparedness and improving resilience to climate change impacts.

Local

Flintshire Local Development Plan (Flintshire County Council, 2023)

- 7.2.8. Flintshire's Local Development Plan highlights several policies which influence the climate resilience of new developments, notably STR13: Natural and Built Environment, Green Networks and Infrastructure; STR14: Climate Change and Environmental Protection; PC4: Sustainability and Resilience of New Development; and EN14: Flood Risk.

GUIDANCE

National

Institute of Environmental Management and Assessment (IEMA) EIA Guide to Climate Change Resilience and Adaptation (IEMA, 2020)

- 7.2.9. This guide sets out how to consider climate change resilience and adaptation in EIA reporting. The Guide identifies the need for the baseline to consider the current climate baseline (defined by historic climate conditions) to provide an indication of past vulnerability; and the future climate baseline (short-term extremes and long-term variation) to assess a project's future vulnerability to climate change.

Design Manual for Roads and Bridges (DMRB) LA 114 Climate (DMRB, 2021)

- 7.2.10. This document establishes the requirements for assessing and reporting the effects of climate on highways. While this project is not a highways scheme, the significance criteria assessment in Section 3 of LA114 provides a useful methodology which has been adapted for use within this assessment.

7.3. SCOPING OPINION AND CONSULTATION

RESPONSE TO THE SCOPING OPINION

- 7.3.1. An EIA Scoping Opinion was received by the Applicant from the Local Planning Authority (LPA) on 8 May 2024, including formal responses from Statutory Consultees. The responses from the LPA in relation to climate resilience and how these requirements are addressed by the Applicant are set out in **Appendix 1-3 Scoping Opinion Responses (Volume III)**(Document Reference: PW.3.3.1.3) .

CONSULTATION UNDERTAKEN TO DATE

- 7.3.2. No consultation has been undertaken to inform the climate resilience assessment to date. The approach to the assessment methodology is based on industry standard guidance, and data to inform the baseline is obtained from publicly available sources.

7.4. SCOPE OF THE ASSESSMENT

- 7.4.1. The scope of this assessment has been established through an ongoing scoping process. Further information can be found in **Chapter 5: EIA Methodology (Volume II) (Document Reference: PW.3.2.5)** of this ES.
- 7.4.2. This section provides an update to the scope of the assessment and re-iterates the evidence base for scoping out elements following further iterative assessment.

ELEMENTS SCOPED OUT OF THE ASSESSMENT

- 7.4.3. The receptors and climate variables were subject to a vulnerability assessment completed as part of the Climate Resilience inputs to the Scoping Report (**Appendix 1.1, Document Reference: PW.3.3.1.1**). The vulnerability assessment considers the sensitivity and exposure of receptors to climate variables across the applicable time periods. Where the vulnerability assessment resulted in a rating of 'low vulnerability', it is considered that the receptors have a low degree of susceptibility to climate change and will be able to cope with projected changes to the climate variables. As such, this will not give rise to likely significant effects for the receptor. Therefore, they have not been considered within this assessment.
- 7.4.4. All receptors relevant to the Construction Stage have been scoped out of further assessment. Certain receptors for the Operation Stage and Decommissioning Stage have been scoped out as shown in **Table 7-1**. The receptors scoped in are discussed in **paragraph 7.4.5**.

Table 7.1 – Elements Scoped out of the Assessment

Receptor		Climate variable	Justification
<u>Construction Stage</u> Construction site Construction workers	Precipitation	Change in annual average	Low vulnerability
		Drought	Low vulnerability
		Extreme precipitation events	Low vulnerability
	Temperature	Change in annual average	Low vulnerability
		Extreme temperature events	Low vulnerability
	Wind	Gales and extreme wind events	Low vulnerability
		Storms (snow, lightning, hail)	Low vulnerability
	Relative humidity	Changes in annual average	Low vulnerability
		Evaporation	Low vulnerability
	Sea level	Sea level rise	Low vulnerability
<u>Operation Stage</u> Padeswood Carbon Dioxide Spur Pipeline	Precipitation	Change in annual average	Low vulnerability
		Extreme precipitation events	Low vulnerability
	Temperature	Change in annual average	Low vulnerability
		Extreme temperature events	Low vulnerability
	Wind	Gales and extreme wind events	Low vulnerability
		Storms (snow, lightning, hail)	Low vulnerability
	Relative humidity	Changes in annual average	Low vulnerability
		Evaporation	Low vulnerability
	Sea level	Sea level rise	Low vulnerability
<u>Operation Stage</u> Padeswood AGI	Precipitation	Change in annual average	Low vulnerability
	Temperature	Change in annual average	Low vulnerability
		Extreme temperature events	Low vulnerability
	Relative humidity	Changes in annual average	Low vulnerability
		Evaporation	Low vulnerability
	Sea level	Sea level rise	Low vulnerability
<u>Decommissioning Stage</u> Decommissioning site Decommissioning workers	Precipitation	Change in annual average	Low vulnerability
		Drought	Low vulnerability
	Temperature	Change in annual average	Low vulnerability
	Relative humidity	Changes in annual average	Low vulnerability
		Evaporation	Low vulnerability
	Sea level	Sea level rise	Low vulnerability

ELEMENTS SCOPED INTO THE ASSESSMENT

Operation Stage

- 7.4.5. The below receptors are considered to have likely significant effects from projected changes to the listed climate variables during operation:

- Padeswood Carbon Dioxide Spur Pipeline
 - Precipitation – Drought
- Padeswood AGI
 - Precipitation – Drought; Extreme precipitation events
 - Wind – Storms (snow, lightning, hail); Gales and high winds

Decommissioning Stage

- 7.4.6. The receptor below is considered to have likely significant effects from projected changes to the listed climate variables during decommissioning:

- Decommissioning site and workers
 - Precipitation – Extreme precipitation events
 - Temperature - Extreme temperature events
 - Wind – Storms (snow, lightning, hail); Gales and high winds

7.5. ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

STUDY AREA

- 7.5.1. The scope for the climate resilience assessment relates to the impact of climate change on the Padeswood Spur Pipeline Proposed Development (rather than the impact of the Padeswood Spur Pipeline Proposed Development on the climate). As such, the Study Area for the Padeswood Spur Pipeline Proposed Development is defined as the land within the Red Line Boundary, as shown in **ES Figure 3.1 (Document Reference: PW.3.4.3.1)**.
- 7.5.2. The in-combination climate impacts (ICCI) assessment identifies how the resilience of identified receptors in the surrounding receiving environment is affected by future climate change conditions. Therefore, the area immediately adjacent to the Site is also considered. The ICCI assessment is specific to the environmental topic and is reported in each chapter.

METHOD OF BASELINE DATA COLLECTION

Desk Study

- 7.5.3. Baseline data has been provided through desk-based study. The assessment has been informed by information on existing and projected change in climate variables derived from the following sources:
- State of the UK Climate (2023) (existing baseline) (Met Office, 2023);
 - Met Office Regional Climate Profile for Wales (existing baseline) (Met Office, N.D.);
 - Met Office Local Weather Station Data for Hawarden (existing baseline) (Met Office, N.D.);
 - Met Office Regional Weather data for England North West and Wales North (Met Office, N.D.);
 - UK Climate Projections 2018 (UKCP18) (future baseline) (Met Office, 2018); and
 - The Climate Risk Indicators (CRI) (future baseline) (Arnell, 2021).

Site Visits and Surveys

- 7.5.4. No site visits or surveys were required for this assessment.

IMPACT ASSESSMENT METHODOLOGY

- 7.5.5. The EIA Scoping Report (**Document Reference: PW.3.3.1.1**) identified the receptors (relevant components of the Padeswood Spur Pipeline Proposed Development) that are vulnerable to climate change. The significance of effects of changes in the (scoped in) climate variables on receptors has been considered in this assessment for the Operation and Decommissioning Stages.
- 7.5.6. The assessment at the ES stage has been undertaken using an approach based on the DMRB LA 114 (DMRB, 2021) and IEMA guidance (IEMA, 2020) and professional judgement.

7.5.7. The consequence and likelihood of potential impacts (that will result from changes in climate variables), determines the significance of effects on the Padeswood Spur Pipeline Proposed Development's receptors. The determination of consequence is based on the Padeswood Spur Pipeline Proposed Development design, including any embedded mitigation. The determination of likelihood is based on the future climate projections, as identified in the baseline. Consequence and likelihood are qualitatively assessed using the descriptions in **Table 7-2** and **Table 7-3**. These descriptions have been developed using professional judgement, informed by relevant guidance. Committed design measures and embedded mitigation are identified through engagement with the Applicant and the Padeswood Spur Pipeline Proposed Development design.

Table 7.2 – Consequence Definitions

Measure of consequence	Description
Negligible	No damage to receptors, minimal adverse effects on health, safety and the environment or financial loss. Little change to service and disruption lasting less than 1 day.
Minor adverse	Localised receptor disruption or loss of service. No permanent damage, minor restoration work required: disruption lasting less than 1 day. Small financial losses and/or slight adverse health or environmental effects.
Moderate adverse	Limited receptor damage and loss of service with damage recoverable by maintenance or minor repair. Disruption lasting more than 1 day but less than 1 week. Moderate financial losses. Adverse effects on health and/or the environment.
Large adverse	Extensive receptor damage and severe loss of service. Disruption lasting more than 1 week. Early renewal of infrastructure 50-90%. Permanent physical injuries and/or fatalities. Major financial loss. Significant effect on the environment, requiring remediation.

Table 7.3 – Likelihood Definitions

Measure of likelihood	Description
Very high	The event (potential effect) occurs multiple times during the lifetime of the project. e.g., approximately annually.
High	The event (potential effect) occurs several times during the lifetime of the project. e.g., approximately twelve events, once every 10 years.
Medium	The event (potential effect) occurs limited times during the lifetime of the project. e.g., approximately four events, once every 30 years.
Low	The event (potential effect) occurs occasionally during the lifetime of the project. e.g., approximately one event, once in 120 years.

SIGNIFICANCE CRITERIA

- 7.5.8. Significance assessment for climate resilience differs from the standard EIA significance criteria. The standard significance criteria use a magnitude and sensitivity matrix to assess the impact of the Padeswood Spur Pipeline Proposed Development on a particular receptor. However, in the case of the climate resilience assessment, the receptor is the Padeswood Spur Pipeline Proposed Development, and the impact is caused by the changes in future climate. Therefore, for the Climate Resilience assessment, the likelihood and consequence are combined to assess the significance of effects on the affected receptors, as shown in **Table 7.4**. The assessment is qualitative and determined through professional judgement, utilising knowledge of similar developments, engagement with the wider Project Team and a review of relevant literature.

Table 7.4 – Significance Rating Matrix

Likelihood	Consequence of Hazard Occurring				
	Negligible	Minor adverse	Moderate adverse	Large adverse	Very large adverse
Very High	Not significant	Significant	Significant	Significant	Significant
High	Not significant	Significant	Significant	Significant	Significant
Medium	Not significant	Not significant	Significant	Significant	Significant
Low	Not significant	Not significant	Not significant	Significant	Significant
Very Low	Not significant	Not significant	Not significant	Not significant	Not significant

ASSUMPTIONS AND LIMITATIONS

7.5.9.

The following assumptions and limitations are relevant to the climate resilience assessment:

- There is currently no agreed industry methodology that should be applied for assessing the vulnerability of major schemes under the Environmental Impact Assessment (EIA) Regulations. Therefore, an approach has been developed and applied in this assessment based on existing best practice and extensive project experience;
- The UKCP18 projections have been used to infer future changes in a range of climate variables that may affect the vulnerability of the Padeswood Spur Pipeline Proposed Development to climate change. At the time of writing, these represent the most up-to-date representation of future climate in the UK;
- The Climate Risk Indicators, developed as part of the UK Climate Resilience Programme, has been used to inform this assessment. As such there are inherited limitations and uncertainties within the data;
- There are inherent uncertainties associated with climate projections and they are not predictions of the future. It is possible that future climate will differ from the future baseline climate against which the resilience of the Padeswood Spur Pipeline Proposed Development has been assessed, depending on global emissions over the next century;
- A 'high' emissions scenario (RCP 8.5) using the 2080s time slice (2070–2099, the longest temporal scale available through UKCP18) has been used to develop the baseline against which resilience has been assessed. This is consistent with the precautionary principle and makes allowances for the anticipated design life to be exceeded;
- Any further research, analysis or decision-making should take account of the accuracies and uncertainties associated with climate projections. It is also important to note that the analysis is based on selected observational data, the results of climate model ensembles and a selected range of existing climate change research and literature available at the time of assessment. Any future decision-making based on this analysis should consider the range of literature, evidence and research available at that time and any changes to this; and

- The embedded mitigation provided by the design engineers is based on the preliminary design of the Padeswood Spur Pipeline Proposed Development and may alter as the design progresses. Where embedded mitigation measures note that adaptation aspects will be addressed at detailed design stage, it is assumed that this will be sufficiently addressed based on the climate projections detailed in this chapter (or as subsequent climate data is published) as the detailed design is progressed.

BASELINE CONDITIONS

- 7.5.10. The IEMA Guidance identifies the need for the baseline to consider:
- The current climate baseline (defined by historic climate conditions) to provide an indication of past vulnerability; and
 - The future climate baseline (short term extremes and long-term variation) to assess a project's vulnerability to climate change.
- 7.5.11. This section provides an overview of the current baseline conditions for the Site using weather station data, and the projected future changes in the climate for the Study Area.

DATA SOURCES

- 7.5.12. The key data sources referred for current and future baseline include:
- *Hawarden Weather Station data* (Met Office, N.D.)
 - *Wales Regional Climate report* (Met Office, N.D.)
 - *UK Climate Projections 2018 (UKCP18)* (Met Office, 2018)
 - *UK Climate Risk Indicators* (Arnell, 2021).

EXISTING BASELINE

- 7.5.13. This section is a summary of the climate trends over the past three decades (1991–2020) for temperature, precipitation (rain and snow), wind, humidity, and solar radiation. This provides an understanding of how recent climate trends have impacted the Study Area. This is presented for both the UK context as well as the local climate, as represented by Hawarden weather station.

UK Context

- 7.5.14. According to the latest State of the UK Climate Report (Met Office, 2023), the UK's climate is changing, with recent decades warmer, wetter, and sunnier than the 20th century on a national and local scale. This report highlights that the UK has warmed at a broadly consistent (though slightly higher) rate than the observed change in global mean temperature. The key findings from the report are:

- 2023 was the second warmest year on record for the UK in the series from 1884, with only 2022 warmer. Six years in the most recent decade (2014-2023) have been within the top-ten warmest in the series.
- Observations show that extremes of temperature in the UK have been affected much more than average temperature. The number of 'hot' days (28C) has more than doubled and 'very hot' days (30C) more than trebled for the most recent decade (2014-2023) compared to 1961-1990.
- The UK's second warmest year (2023), the warmest June and the September heatwave were all made more likely by climate change.
- 2023 was the seventh wettest year on record for the UK in the series from 1836, with 113% of the 1991-2020 average. March, July, October and December 2023 were all top-ten wettest months.
- Five of the ten wettest years for the UK in the series from 1836 have occurred in the 21st Century.
- For the second successive year, 2023 was the warmest year for UK near-coast sea surface temperature (SST) in a series from 1870.

Local Context

- 7.5.15. The current baseline describes the climate trends over the past three decades (1991-2020) for temperature, precipitation (rain and snow), wind, humidity and solar radiation. This provides an understanding of how recent climate trends have impacted the Study Area. Climate trend data is presented for both the UK context as well as the local climate, as represented by Hawarden weather station (approximately 5km east of the Padeswood Spur Pipeline Proposed Development) (Met Office, N.D.).

Precipitation – Rainfall, and Temperature

- 7.5.16. **Table 7-5** presents the long-term average seasonal rainfall (mm), long term average seasonal temperature (°C), and the long-term average seasonal sunshine (hours) for the local climate station, the region, and the UK. It shows that the weather station is drier, warmer, and sunnier than both the region and the UK average year-round.

Table 7.5 - Long term average seasonal rainfall (mm), seasonal temperature (oC), and seasonal sunshine (hours) (1991–2020) for Hawarden Climate Station, England North West and Wales North, and the rest of the UK

Variable	Season	Location		
		Hawarden Climate Station	England North West and Wales North	UK
Precipitation - Long term average seasonal rainfall	Summer (June, July, August)	183 mm	297 mm	253 mm
	Winter (January, February, December)	185 mm	399 mm	345 mm
Temperature - Long term average mean seasonal temperature	Summer (June, July, August)	15.9 oC	14.6 oC	14.6 oC
	Winter (January, February, December)	5.2 oC	4.2 oC	4.1 oC
Solar Radiation - Long term average seasonal sunshine	Summer (June, July, August)	561 hours	501 hours	506 hours
	Winter (January, February, December)	202 hours	154 hours	162 hours

Wind

- 7.5.17. Wales is one of the windier parts of the UK, with the windiest areas being over the highest ground and along the coasts, particularly those facing directions between north-west and south. Mean speeds and gusts (short duration peak values) are strongest during the winter months (Met Office, N.D.).

Humidity

- 7.5.18. The annual average relative humidity in the vicinity of the Padeswood Spur Pipeline Proposed Development is 80-82%.

- 7.5.19. The Padeswood Spur Pipeline Proposed Development is partly located adjacent to the River Alyn, which flows into the River Dee and out to the Irish Sea. There is a fluvial flood risk around the River Alyn, however is not in the vicinity of the proposed Above Ground Installation (Padeswood AGI) for the Padeswood Spur Pipeline Proposed Development. The Padeswood AGI is located within surface water Flood Zones 2 and 3 (medium and high risk). The Padeswood Spur Pipeline Proposed Development is considered to be at less than a 0.1% chance of flooding from the sea in a given year, including the impacts of climate change. (Natural Resources Wales , 2024) Further details on flood risk are provide in the Flood Consequence Assessment (**Appendix 17.1 Document Reference: PW.3.3.17.1**)).

FUTURE BASELINE

- 7.5.20. The future baseline scenario has considered the Padeswood Carbon Capture and Storage Plant as developed prior to the Padeswood Spur Pipeline Proposed Development commencing.
- 7.5.21. The UKCP18 (Met Office, 2018) probabilistic projections for RCP8.5^{1,2} (high emission scenarios) have been used to inform future changes in a range of climate variables that may affect the vulnerability of the Padeswood Spur Pipeline Proposed Development to climate change. The Climate Risk Indicators (CRI) (Arnell, 2021), developed as part of the UK Climate Resilience Programme have been used to inform this assessment³. The CRI utilises the UKCP18 projections to establish a range of climate related indicators (including but not limited to Met Office Heatwaves and heat stress). The CRI data for Flintshire County Council has been used to inform this assessment.
- 7.5.22. The future climate has been presented for the 2030s (2020-2049), the 2050s (2040-2069) and 2080s (2070-2099) to identify the anticipated climate conditions. These projections are provided against the baseline period of 1981-2010 (based on model data), and 1991-2020 (current climate) as an indication of change from the baseline period.

There are inherited limitations and uncertainties within the data. Further information on the methodology used to produce this data can be found in Arnell, et al., (2021) Changing climate risk in the UK: a multi-sectoral analysis using policy-relevant indicators. Climate Risk Management 31, 100265 10.1016/j.crm.2020.100265

- 7.5.23. Climate change is projected to lead to warmer wetter winters and hotter drier summers, with an increase in the intensity and frequency of extreme events such as heatwaves, drought, extreme rainfall leading to flash flooding, storms and wind events. The information presented below illustrates how the climate may evolve at the Padeswood Spur Pipeline Proposed Development by the end of the century.
- 7.5.24. **Table 7-6** provides an overview of current and projected summer and winter temperature and rainfall for the location of the Project, as well as soil moisture.

Table 7.6 - Table Temperature and Rainfall Data for the Model Reference (1981-2010), Current (1991-2020) and Future Climate (2030s, 2050s and 2080s) for RCP8.5 (anomalies), The Table shows the 50th Percentile (10th Percentile to 90th percentile) Values.

Climate Variable	Model Reference (1981-2010)	Current Baseline (1991-2020)	RCP 8.5		
			2030s	2050s	2080s
Average summer temperature	15.7 oC	15.9 oC	+1.2oC (+0.5 oC to +1.9 oC)	+2.2 oC (+0.9oC to +3.4 oC)	+4.4 oC (+2.2oC to +6.7 oC)
Average winter temperature	4.8 oC	5.2 oC	+0.9 oC (+0.2oC to +1.6 oC)	+1.6 oC (+0.6oC to +2.7 oC)	+2.9 oC (+1.2oC to +4.7 oC)
Min winter temperature	1.5 oC	1.9 oC	+0.9 oC (+0.2oC to +1.7 oC)	+1.6 oC (+0.5oC to +2.9 oC)	+2.9 oC (+1.1oC to +5.1 oC)
Max summer temperature	20.2 oC	20.4 oC	+1.3 oC (+0.4oC to +2.3 oC)	+2.4 oC (+0.9oC to +3.9 oC)	+4.9 oC (+2.2oC to +7.6 oC)
Average summer Rainfall	173mm	183mm	-6.0% (-20.7% to +8.1%)	-14.9% (-33.8% to +2.7%)	-30.5% (-53.9% to -7.0%)
Average winter rainfall	179mm	185mm	+0.3% (-5.7% to +6.9%)	+3.5% (-4.8% to +13.0%)	+9.5% (-3.3% to +24.0%)
Soil moisture – winter*	0	N/A	-0.2% (-0.9% to +0.7%)	-0.2% (-0.8% to +0.6%)	-0.1% (-1.0% to +0.8%)
Soil moisture – summer*	0	N/A	-12.7% (-25.7% to -9.6%)	-21.6% (-34.6% to -18.1%)	-33.0% (-46.7% to -27.0%)

*Wales regional data only

7.5.25. Indicators of climate risk are shown in **Table 7-7**. These provide an indication of sector specific thresholds which are projected to change in the future. The indicators presented in **Table 7-7** are provided against the model reference period of 1981-2010. These indicators are unavailable for the current baseline period (1991-2020), however the modelled baseline (1981-2010) has been provided.

Table 7.7 - Future Projections (absolute) of Climate Risk Indicators for the 2030s, 2050s and 2080s for RCP8.5, The Table shows the 50th Percentile (10th Percentile to 90th Percentile) Values.

Climate Variable	Model Reference (1981-2010)	RCP 8.5		
		2030s	2050s	2080s
Met office heatwave ¹ (events per year)	0.6	1.2 (0.7 to 1.9)	2.1 (1.0 to 3.7)	4.1 (2.1 to 5.4)
Road accident risk ¹ (days per year)	40.8	30.2 (23.4 to 37.5)	23.8 (15.6 to 33.7)	14.8 (6.6 to 27.4)
Road melt risk (days per year) ¹	6.9	12.9 (8.6 to 18.6)	20.5 (11.3 to 36.7)	47.9 (20.5 to 78.6)
Heat stress ¹ (days per year)	0.03	0.19 (0.10 to 0.48)	0.69 (0.18 to 2.00)	4.50 (0.95 to 13.50)
Wildfire events ¹ (days per year)	9.4	14.1 (8.4 to 24.9)	21.6 (10.0 to 44.2)	45.9 (16.3 to 83.6)

Snow

- 7.5.26. Rising future winter temperatures are likely to reduce the amount of precipitation that falls as snow in winter. Snowfall data is unavailable for the probabilistic projections (25 km), however both the regional (12 km) and the local (2.2 km) show a decrease in both falling and lying snow across the UK for the period of 2061-2080 relative to the 1981-2000 baseline.

Humidity

- 7.5.27. Projections for humidity anticipate an average decrease of approximately 0.8 % in the 2030s (-1.9 % to -0.6 %), and a decrease of 1.5 % in the 2050s (-2.9 % to -0.9 %).

Wind

- 7.5.28. UKCP18 depicts a wide spread of future changes in mean surface wind speed, however, there is large uncertainty in projected changes in circulation over the UK and natural climate variability contributes to much of this uncertainty. It is therefore difficult to represent regional extreme winds and gusts within regional climate models.
- 7.5.29. Central estimates of change in mean wind speed for the 2050s are small in all ensemble runs ($<0.2 \text{ ms}^{-1}$). A wind speed of 0.2 ms^{-1} (approximately 0.4 knots) is small compared with the typical magnitude of summer mean wind speed of about $3.6\text{--}5.1 \text{ ms}^{-1}$ (7 – 10 knots) over much of the UK. Seasonal changes at individual locations across the UK lie within the range of -15 % to +10 %.
- 7.5.30. Studies (Belcher, 2014) relating to future projections of storms suggest that climate driven storm changes are less distinct in the northern than southern hemisphere. However, such is the wide range of inter-model variation, robust projections of changes in storm track are not yet possible and there is low confidence in the direction of future changes in the frequency, duration or intensity of storms affecting the UK.

Sea Level Rise and Flood Risk

7.5.31. The Padeswood Spur Pipeline Proposed Development is partly located along the River Alyn, which flows into the River Dee and out to the Irish Sea. Sea level projections at the closest marine projections data point, approximately 20 km north west of the closest section of the Red Line Boundary, range from 0.10 m in the 2030 s to 0.67 m in the 2080s. **Table 7-8** below depicts the projected sea level rise for the 2030s, 2050s and 2080s using UKCP18 marine projections data. The Padeswood Spur Pipeline Proposed Development is not likely to be impacted by sea level rise due to its location and the proposed Padeswood Carbon Dioxide Spur Pipeline will be located at least 75 m above sea level; due to the local topography where ground level is on average at least 100 m above sea level.

Table 7.8 - Projected Sea Level Rise data (m) at the Nearest Data Point to the Padeswood Spur Pipeline Proposed Development

2030s	2050s	2080s
0.13 m (0.10 m to 0.18 m)	0.25 m (0.18 m to 0.33 m)	0.50 m (0.36 m to 0.67 m)

7.6. SENSITIVE RECEPTORS

7.6.1. The following sensitive Receptors have been assessed in relation to noted climate variables and are displayed in **Table 7-9** below.

Table 7.9 – Sensitive Receptors

Value / Sensitivity	Receptor	Climate variable
Significant	Carbon dioxide pipeline	Precipitation – Drought
Significant	Padeswood AGI	Precipitation – Drought; Extreme precipitation events Wind – Storms (snow, lightning, hail); Gales and high winds
Significant	Decommissioning site and workers	Precipitation – Extreme precipitation events Temperature - Extreme temperature events Wind – Storms (snow, lightning, hail); Gales and high winds

7.7. DESIGN DEVELOPMENT, IMPACT AVOIDANCE AND EMBEDDED MITIGATION

7.7.1. Measures to manage and reduce the impacts from climate change are outlined in **Table 7-10**.

Table 7.10 – Embedded Mitigation

Climate variable	Embedded mitigation	Evidence of commitment
Drought conditions	Regular inspections will be conducted to monitor impacts (damage or degradation) from drought conditions to the Padeswood Spur Pipeline Proposed Development.	Included in the OEMP (Document Reference: PW.4.1). See OEMP reference PW-CR-001.
	Pipeline is of welded steel construction which is able to withstand some ground movement	Included in the OEMP (Document Reference: PW.4.1). See OEMP reference PW-CR-002.
Lightning strike	A Lightning Protection Study will be performed for the Padeswood AGI during detailed design, and all necessary protective measures implemented. The study will consider the Padeswood CCS Project which is expected to have much taller structures than the AGI and will likely reduce the risk of lightning strike on the AGI.	Included in the OEMP (Document Reference: PW.4.1). See OEMP reference PW-CR-003.
Wind and storm activity	There are no permanent structures foreseen over 5 meters' height within the AGIs. Permanent above ground features in the AGIs will be attached to concrete foundations and designed and installed per recognised international standards considering wind loading (i.e. EN 1991-1-4 "Eurocode 1: Actions on structures").	Included in the OEMP (Document Reference: PW.4.1). See OEMP references PW-CR-004 and PW-CR-005.
	The E&I kiosks will be weather-sealed, and the outdoor electrical and instrumentation equipment will be IP-rated. Structures within the AGIs will be designed according to "Eurocode 1: Actions on structures - Part 1-3: General actions — Snow loads" and the UK National Annex. Characteristic ground snow load = 0.5 kN/m ² Zone 2 from Figure NA.1 from the Eurocode.	
Precipitation	Drainage from the Padeswood AGI will be linked to the wider Padeswood CCS Plant drainage system, which has been subject to a Flood Consequence Assessment. The Flood Consequences Assessment for the Padeswood CCS Project – (Planning Reference: DNS CAS-02009-W1R1Z7) stated that the additional surface water generated within the Padeswood CCS Project will be accommodated and managed through current on-site drainage systems. The design of the proposed Padeswood AGI and platform will be required to take into account the presence and risk level from the small watercourse known as Black Brook Tributary 1. It is expected that this flood risk to the Padeswood AGI will be mitigated by a combination of the planned road drainage and plant area drainage network. Further details of this drainage network are available within the HMUK application (Planning Reference: DNS CAS-02009-W1R1Z7). Above ground equipment will be specified with a high-quality external coating to protect from all credible external corrosive mechanisms, regardless of rainfall volume. The E&I Kiosk will be weather-sealed, and outdoor electrical equipment will be rated to a suitable ingress protection rating.	Included in the OEMP (Document Reference: PW. 4.1). See OEMP reference PW-CR-008. Appendix 17.1 - Flood Consequence Assessment (Document Reference: PW.3.3.17.1).
Managing risks to the site and workers during decommissioning	Prior to decommissioning, a Decommissioning Environmental Management Plan will be developed and agreed with relevant stakeholders.	Included in the OEMP (Document Reference: PW. 4.1). See OEMP reference PW-CR-010.

7.8. PRELIMINARY ASSESSMENT OF LIKELY IMPACTS AND EFFECTS

7.8.1. This section details the preliminary assessment of predicted impacts and effects for the Padeswood Spur Pipeline Proposed Development during the Operational and Decommissioning Stages.

7.8.2. The potential likely significant effects as a result of the predicted impacts during the Operation and Decommissioning Stage of the Padeswood Spur Pipeline Proposed Development are assessed.

OPERATIONAL AND DECOMMISSIONING STAGES

7.8.3. The likely significant effects for Climate Resilience associated with the Operational Stage are set out below.

7.8.4. The full assessment of potential effects from climate change during Operation and Decommissioning Stages following the identification of embedded mitigation in the design stage (**Table 7-10**) are listed in **Tables 7-11** and **7-12**, respectively.

Table 7.11 – Effects on Receptors During Operation of the Padeswood Spur Pipeline Proposed Development

Receptor	Climate variable	Potential Impact	Likelihood	Consequence	Significance
Carbon Dioxide Pipeline	Drought	Shrinking and cracking of soils causing ground movement and damage to the pipeline.	High	<i>Minor adverse</i>	<i>Not Significant</i>
AGIs	Extreme precipitation events	Flooding causing damage to equipment.	High	<i>Minor adverse</i>	<i>Not Significant</i>
	Drought	Shrinking and cracking of soils causing ground movement and damage to the AGI.	Moderate	<i>Minor adverse</i>	<i>Not Significant</i>
	Gales and high winds Storms (including hail & snow)	Damage and potential operational delays from high winds and rain infiltration into components.	High	<i>Minor adverse</i>	<i>Not Significant</i>
	Storms (lightning)	Lightning strikes causing damage to equipment and fires.	Low	<i>Minor adverse</i>	<i>Not Significant</i>

DECOMMISSIONING STAGES

- 7.8.5. The likely significant effects for Climate Resilience associated with the Decommissioning Stage are set out in **Table 7-12**.

Table 7.22 - Effects on Receptors During Decommissioning of the Padeswood Spur Pipeline Proposed Development

Receptor	Climate variable	Potential Impact	Likelihood	Consequence	Significance
Decommissioning site	Extreme precipitation events	Flooding of sites and components causing damage to equipment.	Medium	<i>Minor Adverse</i>	<i>Not significant</i>
		Damage to sites and components from increased run off.	Medium	<i>Minor Adverse</i>	<i>Not significant</i>
	Extreme precipitation events	Existing drainage infrastructure overwhelmed leading to surface water flooding and siltation.	Medium	<i>Minor Adverse</i>	<i>Not significant</i>
	Extreme temperature events	Overheating of equipment leading to damage and fire	Low	<i>Minor Adverse</i>	<i>Not significant</i>
	Gales and high winds Storms (including hail & snow)	Damage from high winds and rain infiltration into components.	Medium	<i>Minor Adverse</i>	<i>Not significant</i>
	Gales and high winds Storms (including hail & snow)	Storm and high wind events delaying decommissioning work.	Medium	<i>Minor Adverse</i>	<i>Not significant</i>
	Gales and high winds Storms (including hail & snow)	Snow loading causing damage to equipment	Low	<i>Minor Adverse</i>	<i>Not significant</i>
	Storms (lightening)	Lightning strikes causing fires.	Low	<i>Minor Adverse</i>	<i>Not significant</i>

Receptor	Climate variable	Potential Impact	Likelihood	Consequence	Significance
Decommissioning workers	Extreme precipitation events	Flooding of site leading to dangerous working conditions	Low	Minor Adverse	Not significant
	Extreme precipitation events	Flooding causing access issues	Medium	Minor Adverse	Not significant
	Extreme temperature events	Overheating of equipment leading to damage and fire	Low	Minor Adverse	Not significant
	Extreme temperature events	Health and safety risks from heatstroke, heat stress and UV radiation	Medium	Minor Adverse	Not significant
	Gales and high winds Storms (including hail & snow)	Flying debris causing health and safety risks to workers.	Medium	Minor Adverse	Not significant

7.9. ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

7.9.1. This section details the assessment of significant effects taking account of the embedded mitigation measures detailed in Table 7-10 above.

CONSTRUCTION STAGES

7.9.2. This has been scoped out of this assessment.

OPERATIONAL STAGES

7.9.3. Given the embedded mitigation measures that will be carried forward in the OEMP this assessment has concluded that there are no likely significant residual effects for the Padeswood Spur Pipeline Proposed Development during the Operational Stage.

DECOMMISSIONING STAGES

7.9.4. Given the embedded mitigation measures that will be carried forward in the OEMP this assessment has concluded that there are no likely significant effects for the Padeswood Spur Pipeline Proposed Development during the Decommissioning Stage.

ASSESSMENT AGAINST FUTURE BASELINE

7.9.5. The assessment against a future baseline is inherent in the Climate Resilience assessment methodology.

7.10. MONITORING

7.10.1. As included in reference PW-CR-001 of the **OEMP (Document Reference: PW.4.1)**, the Applicant will undertake the following monitoring measures:

- A list of extreme weather-related incidents (for example, rainfall, heatwaves, snow and ice, etc.) will be maintained by the Applicant to assist in identifying thresholds which, when exceeded, require maintenance or alteration. Inspections will be carried out following an intense rainfall event or heatwave to monitor any damage and implement appropriate mitigation as necessary.
- A schedule of general inspections and principal inspections of each structure will be carried out to determine condition of the AGI and identify any potential maintenance requirements. Inspections will be undertaken following an intense rainfall event or heatwave to monitor any damage, maintain surface water drainage features and implement appropriate mitigation as necessary.

- The Padeswood Spur Pipeline Proposed Development will have an Operations and Maintenance Procedure for routine maintenance and inspection visits of the Carbon Dioxide Pipeline and the AGI to ensure their protection against potential climate impacts identified.

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