Heidelberg Materials

TYTHERINGTON QUARRY: 6 MILLION TONNES ADDITIONAL RESERVES

Environmental Statement: Chapter 13 Climate Change Resilience

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 62282762

OUR REF. NO. 6MT ES/CHAPTER 13 CLIMATE CHANGE RESILIENCE

DATE: MAY 2024

WSP

Canon Court West
Abbey Lawn
Shrewsbury
SY2 5DE

Phone: +44 1743 342 000

WSP.com

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TABLES

13 CLIMATE CHANGE - CLIMATE RESILIENCE

13.1 INTRODUCTION

13.1.1 This ES chapter reports the outcome of the assessment of likely significant effects arising from climate change impacts upon the Proposed Scheme. This chapter is intended to be read as part of the wider ES with particular reference to **Chapter 3: Description of Proposed Scheme.**

13.2 LIMITATIONS AND ASSUMPTIONS

13.2.1 To ensure transparency within the EIA process, the following limitations and assumptions have been identified:

- There is currently no agreed industry methodology that should be applied for assessing the vulnerability of major projects under the EIA Regulations. Therefore, an approach has been developed and applied in this assessment based on existing best practice and our 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 Project to climate change[1]. At the time of writing, these represent the most up-to-date representation of future climate in the UK. However, the UKCP18 data currently available does not provide data for extreme precipitation, drought, snow and ice or wind.
- 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 Project 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.
- 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.

13.3 POLICY AND LEGISLATIVE CONTEXT

13.3.1 This section identifies the legislation, planning policy and technical guidance that has informed the assessment of effects with respect to Climate Resilience. Further information on policies relevant to the Proposed Scheme is provided in **Chapter 5: Planning policy overview** as well as the accompanying Planning Statement.

[1] UKCP18 UK Climate Projections Data (Online). Accessed from: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/download-data

LEGISLATIVE FRAMEWORK

13.3.2 A summary of the relevant legislation is given in **Table 13-1**.

Table 13-1 – Legislation relevant to the Climate Resilience assessment

Legislation	Legislative context
UK Climate Change Act 2008 (as amended) [2]	The Climate Change Act 2008 requires the Government to lay before Parliament five-yearly climate change risk assessments (CCRA) detailing current and predicted impacts of climate change in the UK. The Act requires a Climate Change Risk Assessment to be used to assess the risks from the impact of Climate Change to the UK. The third Climate Change Risk Assessment (CCRA) was published in 2022. The overall aim of the CCRA 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.

PLANNING POLICY

13.3.3 A summary of the relevant national and local planning policy is given in **Table 13-2**. The Planning Statement covers the detail of actual policies.

Table 13-2 - Planning policy relevant to the Climate Resilience assessment

Policy	Policy context
National planning policy:	
National Planning Policy Framework (NPPF) 2023[3]	The NPPF sets out the Government's planning policies for England. The planning process aims to achieve sustainable development following three overarching objectives: economic, social and environmental including adapting to climate change. Paragraph 153 of the framework suggests plans should take a proactive approach to adapting to climate change. *Paragraph 154 states "New Development should be planned for in ways that: avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure."*

[2] HM Government (2008) Climate Change Act 2008. Accessed from: https://www.legislation.gov.uk/ukpga/2008/27/contents

[3] Department for Levelling Up, Housing and Communities (2023) National Planning Policy Framework. (online) Accessed from: https://www.gov.uk/government/publications/national-planning-policy-framework--2

Policy	Policy context
National Adaptation Programme (NAP) [4]	The NAP sets out the actions that government and others will take to adapt to climate change in England over a five-year period. The third NAP runs from 2023 to 2028.
25 Year Environment Plan[5]	This plan sets out how government action will help the natural world and how we will tackle the effects of climate change.
Local planning policy:	
South Gloucestershire Local Plan: Core Strategy 2006-2027 (adopted 2013). **Policy CS1 – High quality design**[6]	This policy seeks the highest possible standards with respect to design. It also requires development proposals to assist in meeting climate change objectives which include achieving energy conservation, protection of environmental resources and renewable and low carbon energy installations and infrastructure. Proposals will be expected to take account of Strategic Flood Risk Assessments and provide measures to manage flood risk include surface water management plans.

13.3.4 In addition, this Chapter has been prepared in accordance with the Government's National Planning Practice Guidance (2020).

TECHNICAL GUIDANCE

13.3.5 A summary of the technical guidance for Climate Resilience is given in **Table 13-3**.

Table 13-3 -– Technical guidance relevant to the Climate Resilience assessment

Technical guidance document	Context
UK Climate Projections 2018 (UKCP18)[1]	UKCP18 has been produced by the Met Office and provides the latest set of climate change projections for the UK. It includes projections of how key climate parameters could change in the coming decades, through absolute values or anomalies from the baseline. UKCP18 projections have been used in the CCR assessment and represent the most appropriate, downscaled projection data to use for the UK at the time of preparing this chapter.
UKCP18 technical notes including: Science Overview Report UKCP18 Land	The UKCP18 technical notes provide qualitative information on projections for future time periods. These technical notes will be used in the CCR assessment when relevant quantitative projections are not available.

[4] Department for Environment, Food & Rural Affairs (2023) Third National Adaptation Programme. (online) Accessed from: https://www.gov.uk/government/publications/third-national-adaptation-programme-nap3
[5] Department for Environment, Food & Rural Affairs (2018) 25 Year Environment Plan. (online) Accessed from: https://www.gov.uk/government/publications/25-year-environment-plan#full-publication-update-history
[6] South Gloucestershire Council (2013) Core Strategy 2006-2027. (online) Accessed from: https://beta.southglos.gov.uk/core-strategy-2006-2027/

Technical guidance document	Context
projections: Science Report UKCP18 Factsheets[7] [8] [9]	
State of the UK Climate 2022[10]	The report provides a summary of the UK's weather and climate during 2022 alongside the historical context for a number of climate variables.
ISO14091:2021 Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment[11]	This international standard provides guidelines on approaches to assessing climate change-related risks. It states that *"risk assessments improve planning of adaptation to climate change and inform the implementation and monitoring of climate change adaptation activities".*
Commission Notice – Technical guidance on the climate proofing of infrastructure in the period 2021 - 2027[12]	This note gives technical guidance on the climate proofing of infrastructure, which includes the adaptation to climate change (climate resilience). The note contains guidance on the methodology of assessments, include the role within EIAs.
Institute of Environmental Assessment and Management (IEMA) EIA Guide to: Climate Change Resilience and Adaptation (2020)[13]	This IEMA guidance provides a framework for the effective consideration of climate change resilience and adaptation in the EIA process, including a robust methodology.
UK Climate Change Risk Assessment 2022[14]	The Climate Change Risk Assessment (CCRA) fulfils the requirement under the Climate Change Act 2008 for the Government to produce a five-yearly assessment of the risks for the UK of the current and predicted impacts of climate change. It reports the key areas and urgency of climate risk.

[7] Met Office (2019) UKCP18 Science Overview Report. (online) Accessed from: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

[8] Met Office (2019) UKCP18 Land Projections: Science Report. (online) Accessed from: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Land-report.pdf

[9] Met Office (N.D.) UKCP18 Data Factsheets. (online) Accessed from: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/data/factsheets

[10] Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Williams, J., Sparks, T., & West, F. (2023). State of the UK Climate 2022. International Journal of Climatology, 43(S1), 1–82. https://doi.org/10.1002/joc.8167

[11] ISO14091:2021 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment (Online) Accessed from: https://www.iso.org/standard/68508.html

[12] Commission Notice – Technical guidance on the climate proofing of infrastructure in the period 2021 – 2017. 2021 (Online). Official Journal of the European Union 2021/C 373/01 pp. 1 – 92. Accessed from: https://op.europa.eu/en/publication-detail/-/publication/23a24b21-16d0-11ec-b4fe-01aa75ed71a1/language-en.

[13] IEMA EIA Guide to: Climate Change Resilience and Adaptation (Online). Accessed from: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020

[14] HM Government (2022)) UK Climate Change Risk Assessment 2022 (online). Accessed from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

Technical guidance document	Context
Climate Change Adaptation Manual (NE751)[15]	The Climate Change Adaptation Manual (NE751) has been updated in 2020. It is designed to support practical and pragmatic decision-making on considering climate change adaptation for impacts on habitats, green infrastructure, geology and geomorphology, and access and recreation.

13.4 DATA GATHERING METHODOLOGY

STUDY AREA

13.4.1 The scope for the climate resilience assessment relates to the impact of climate on the Proposed Scheme (rather than the impact of the Proposed Scheme on climate). As such, the study area for the Proposed Scheme is the site within the red line boundary.

DESK STUDY

13.4.2 A review of published current and historical regional weather data in the location of the Proposed Scheme was completed to establish the baseline for the CCR and adaptation assessment. The following desk-based sources were utilised:

- State of the UK Climate 2022 used to information the current baseline[16].
- Met Office Climate Averages, providing local, regional and national climate trend data to inform the current baseline[17].
- Met Office Midlands: Climate. This document describes the main features of the climate over a 30-year average period of 1981 – 2010[18].
- Met Office Past Weather Events, used to inform the current baseline[19].
- UKCP18 probabilistic climate change regional projections[20].
- Climate Risk Indicators[21].

SITE VISIT AND SURVEY WORK

13.4.3 No survey work was undertaken for this assessment.

[15] Natural England and RSPB, 2019. Climate Change Adaptation Manual - Evidence to support nature conservation in a changing climate, 2nd Edition. Natural England, York, UK (Online). Accessed from: http://publications.naturalengland.org.uk/publication/5679197848862720

[16] Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Williams, J., Sparks, T., & West, F. (2023). State of the UK Climate 2022. International Journal of Climatology, 43(S1), 1–82. https://doi.org/10.1002/joc.8167

[17] Met Office UK Climate averages (online). Available from: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcj9q6c2v

[18] Met Office Midlands: Climate (online). Available from: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/midlands_-climate---met-office.pdf

[19] Met Office. Past Weather Events Available from: https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events

[20] Met Office. UK Climate Projections Available from: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp

[21] Nigel Arnell. (2021). The Climate Risk Indicators. Available at: https://uk-cri.org/

13.5 OVERALL BASELINE

CURRENT BASELINE

13.5.1 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. Sea level rise has been excluded due to the location of the Project being over 7km from the River Severn and at an elevation of approximately 100m above sea level.

13.5.2 The current baseline conditions provide 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 Filton weather station (approximately 9km northeast of the Study Area)[22].

UK Context

13.5.3 According to the latest State of the UK Climate Report, the UK's climate is changing, with recent decades warmer, wetter and sunnier than the 20th century[23]. The Report highlights that the UK has warmed at a broadly consistent (but slightly higher) rate than the observed change in global mean temperature. The key findings from the latest 2022 report are:

- The observations show that in the UK extremes of temperature are changing much faster than the average temperature.
- 40°C was recorded in the UK for the first time during a heatwave which exceeded previous records by a large margin. The UK's record warm year of 2022 and unprecedented July heatwave were both made more likely by climate change.
- 2022 was the warmest year in the UK series from 1884; temperatures were 0.9°C above the 1991–2020 average. It was the first year to record a UK annual mean temperature above 10°C. All the top-10 warmest years for the UK in the series from 1884 have occurred in this century.
- Cooling degree days[24] are dominated by annual variability; however, for England, the most recent decade (2013–2022) has had 7 more CDD than 1991–2020 and 15 more than 1961–1990 – the latter representing a doubling over this period.
- For the most recent decade (2013–2022), UK winters have been 10% wetter than 1991–2020 and 25% wetter than 1961–1990.
- In recent years, widespread and substantial snow events have occurred in 2021, 2018, 2013, 2010 and 2009, but their number and severity have generally declined since the 1960s.
- The UK annual mean wind speed from 1969 to 2022 shows a downward trend, consistent with that observed globally.
- Over the past 30 years (1993–2022) the sea level has risen by 11.4cm. The rate of sea-level rise is increasing.
- The most widespread storm surges of 2022 came with storm Eunice on 18 February, with the northern Irish Sea experiencing over 1m skew surges.

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[22] Met Office UK Climate averages (online). Available from: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcj9q6c2v. (Accessed 18 July 2023).

[23] Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Williams, J., Sparks, T., & West, F. (2023). State of the UK Climate 2022. International Journal of Climatology, 43(S1), 1–82. https://doi.org/10.1002/joc.8167

[24] Day-by-day sum of number of degrees by which the mean temperature is more than 22°C

- The period January–August was the driest across England and Wales since 1976, with drought status declared across parts of England and all of Wales.

Local Climate

Precipitation - rainfall

13.5.4 Average seasonal rainfall at Filton weather station, within the Midlands region, and for the UK – for the period 1991 to 2020 – is presented in **Table 13-4**. It shows that the weather station received less rainfall than both the region and the UK average in summer. In winter, the weather station receives more rainfall in winter in comparison to the region but experiences less rainfall than the UK average.

Table 13-4 - Long Term Average Seasonal Rainfall (mm) (1991–2020) for Filton Weather Station, the Midlands Region, and the Rest of the UK

Season	Filton Weather Station	District: Midlands	UK
Summer (June, July, August)	190.1mm	200.9mm	253.4mm
Winter (December, January, February)	230.1mm	214.5mm	344.9mm

13.5.5 The Proposed Scheme is located in Flood Zone 1 which has a low probability of flooding from rivers and the sea[25]. Surface water flooding is low across the site, where there is a chance of flooding of less than 0.1% each year[26]. However, there are areas at high risk of surface water flooding (a chance of flooding of greater than 3.3% each year) adjacent to the Project boundary.

Precipitation – snow and ice

13.5.6 Snowfall is closely linked with temperature, with falls rarely occurring if the temperature is higher than 4°C. In the local area, snowfall is normally confined to the months from November to April, but upland areas may have brief falls in October and May. Snow rarely lies outside the period from December to March.

Temperature

13.5.7 **Table 13-5** shows the long-term average seasonal mean temperature for Filton weather station, the Midlands region, and the UK between 1991-2020. It shows that the weather station is warmer than both the region and UK average, during summer and winter.

[25] Environment Agency (2021) Flood map for planning. Available at: https://flood-map-for-planning.service.gov.uk/flood-zone-results?polygon=[[365676,187907],[365853,188076],[365681,188250],[365563,188075],[365676,187907]]&center=[365708,188078]&location=GL12%25208UW

[26] Environment Agency (2019) Check your long term flood risk. Available at https://check-long-term-flood-risk.service.gov.uk/map?easting=365647.07&northing=188728.61&map=SurfaceWater

Table 13-5 - Long Term Average Mean Seasonal Temperature (°C) (1991–2020) for Filton Weather Station, the Midlands Region, and the Rest of the UK

Season	Filton Weather Station	District: Midlands	UK
Summer (June, July, August)	16.8 °C	15.7 °C	14.6 °C
Winter (December, January, February)	5.44 °C	4.4 °C	4.1 °C

Wind

13.5.8 The Midlands is one of the more sheltered parts of the UK, the windiest areas being in western and northern Britain, closer to the Atlantic. The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter, especially from December to February, and this is when mean speeds and gusts (short duration peak values) are strongest.

Humidity

13.5.9 The annual average relative humidity for the Study Area is 80-82%.

Solar Radiation

13.5.10 Average seasonal sunshine hours at Filton weather station, the Midlands region, and the UK for the period 1991–2020 is presented in **Table 13-6**. The table shows that the weather station receives greater sunshine than the region during summer and the UK during both seasons, but slightly less than the regional average in winter.

Table 13-6 - Long Term average Seasonal Sunshine (hours) (1991–2020) for Filton Weather Station, the Midlands Region, and the Rest of the UK

Season	Filton Weather Station	District: Midlands	UK
Summer (June, July, August)	629 hours	546 hours	507 hours
Winter (December, January, February)	196 hours	180 hours	162 hours

Past major events

13.5.11 Flood events in the region have occurred, with news reports noting road closures around Tytherington in March 2016 and Thornbury in April 2023[27] [28]. Storm Alex occurred in October 2022

[27] Gazette (2016) Flooding causes chaos on the region's roads. Available from https://www.gazetteseries.co.uk/news/14331057.flooding-causes-chaos-on-the-regions-roads/

[28] Gazette (2023) Thornbury road floods again despite South Glos council 'repairs' Available from https://www.gazetteseries.co.uk/news/23447849.thornbury-road-floods-despite-south-glos-council-repairs/

and storm Noa in April 2023 and saw strong winds and heavy rain causing travel disruption and power cuts to southwest England[29] [30].

13.5.12 In February 2022, Storm Eunice led to wind speeds reaching gusts of 52 knots (approximately 60 mph) in the area of the Proposed Scheme. Across the UK and Ireland, fallen trees resulted in four deaths, the Humber bridge and both Severn bridges were closed for the first time in their history, and buildings were damaged[31].

13.5.13 In July 2022, the UK experienced a brief but unprecedented extreme heatwave from 16 to 19 July 2022, as hot air moved north from the near continent, with extreme temperatures recorded on both 18 and 19 July. This heatwave marked a milestone in UK climate history, with 40°C being recorded for the first time in the UK, with a large part of England exceeding 37°C. Nationally, the heat brought challenging conditions for the NHS with a spike in 999 calls, and care services supporting the elderly and vulnerable were put under increased stress. Many schools remained open but ran a shorter day in parts of the country. There were several fatalities associated with open water swimming. Several fire services declared major incidents after multiple fires broke out. The UK Health Security Agency (UKHSA) published analysis of deaths during heat-periods in 2022 and which suggests that the 5-heat periods in the summer of 2022 resulted in a total of 2,803 excess deaths (excl. COVID-19) in people aged 65 and over across England as a whole[32].

13.5.14 December 2022 saw a week of cold temperatures and snow. The 12 December was recorded as the coldest day in the UK since December 2010, according to provisional data from the Met Office. A Level 3 Cold Weather Alert was issued from 9-16 December by the UKHSA, with concerns for serious health consequence, particularly for the elderly and those with heart or lung conditions. The prolonged spell of low temperatures resulted in ice forming on many inland lakes and waterways. Widespread snow and icy conditions made difficult driving conditions[33].

[29] Met Office (2020) Storm Alex and heavy rain 2 to 4 October 2020. Available from https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2020/2020_09_storm_alex_1.pdf

[30] Met Office (2023) Storm Noa, 12 April 2023. Available from https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2023/2023_02_storm_noa.pdf

[31] Met Office (2022) Storms Dudley, Eunice and Franklin. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_01_storms_dudley_eunice_franklin_r1.pdf

[32] Met Office (2022) Unprecedented extreme heatwave, July 2022. Available from https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_03_july_heatwave.pdf

[33] Met Office (2022) Prolonged spell of low temperatures, December 2022. Available from https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_04_december_low_temperatures_v1.pdf

PREDICTED FUTURE BASLINE

13.5.15 The UKCP18 probabilistic projections for RCP8.5[34,35] (high emission scenarios) have been used to infer future changes in a range of climate variables that may affect the vulnerability of the Proposed Scheme to climate change. The Climate Risk Indicators (CRI), developed as part of the UK Climate Resilience Programme have been used to infer this assessment. The CRI utilises the UKCP18 projections and allows for a range of climate related indicators (including but not limited to, Met Office Heatwaves and heat stress). The CRI data for the local authority area of South Gloucester has been used to inform this assessment.

13.5.16 The future climate has been presented for the 2030s (2020-2049) and the 2050s (2040-2069) to identify the anticipated climate conditions relevant to the extant permission for the site (2042). 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.

13.5.17 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 site of the Proposed Scheme by the end of the century.

13.5.18 **Table 13-7** provides an overview of current and projected summer and winter temperature and rainfall for the location of the Proposed Scheme.

Table 13-7 - Future Climate Projections for the Model Reference (1981-2010), Current (1991-2020) and Future Climate (2030s, 2050s) 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)	RCP8.5		Trend (50th percentile)
			2030	2050	
Mean Annual Temperature (°C)	10.6°C	10.9°C	+1.1°C (0.5°C to 1.8°C)	+2.0°C (1.0°C to 3.1°C)	↑
Mean Summer Temperature (°C)	16.6°C	16.8°C	+1.4°C (0.6°C to 2.3°C)	+2.6°C (1.1°C to 4.2°C)	↑
Mean Winter Temperature (°C)	5.0°C	5.4°C	+0.9°C (0.1°C to 1.8°C)	+1.7°C (0.7°C to 2.8°C)	↑

[34] Representative Concentration Pathways (RCPs) specify concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to pre-industrial levels. Radiative forcing targets for 2100 have been set at 2.6, 4.5, 6.0 and 8.5 W m-2 named RCP2.6, RCP4.5, RCP6.0 and RCP8.5, respectively.

[35] RCP8.5 (high emission scenarios) is used to ensure a suitable conservative approach in line with IEMA guidance.

Climate Variable	Model Reference (1981-2010)	Current Baseline (1991-2020)	RCP8.5		Trend (50th percentile)
			2030	2050	
Maximum Summer Temperature (°C)	20.8°C	20.9°C	+1.6°C (0.6°C to 2.7°C)	+2.9°C (1.1°C to 4.9°C)	↑
Minimum Winter Temperature (°C)	2.2°C	2.5°C	+0.9°C (0.0°C to 2.0°C)	+1.7°C (0.5°C to 3.0°C)	↑
Mean Annual Rainfall	802mm	819mm	+0.6% (-4.2% to +5.4%)	-0.6% (-7.2% to +6.5%)	↑
Mean Winter Rainfall	222mm	230mm	+6.3% (-2.1% to +15.0%)	+11.7% (-0.3% to +25.4%)	↑
Mean Summer Rainfall	174mm	190mm	-12.9% (-28.0% to +3.0%)	-24.5% (-43.7% to -3.6%)	↓
Met office heatwave*[36] (events per year)	0.58	0.66	1.19 (0.77 to 1.80)	2.12 (1.00 to 3.75)	↑
Heat stress*[37] (days per year)	0.07	0.14	0.45 (0.19 to 0.95)	1.14 (0.34 to 3.54)	↑
Frost days*[38] (days per year)	41.70	39.86	30.32 (23.19 to 37.77)	23.13 (15.94 to 32.13)	↓
SPEI Drought*[39] (proportion of time)	0.067	0.072	0.13 (0.07 to 0.22)	0.22 (0.10 to 0.33)	↑
Relative Humidity (%)	80-82%	--	-1.9% (-3.3% to -1.3%)	-3.1% (-4.7% to -2.7%)	↓

[36] A UK heatwave threshold is met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. The threshold for the local area is 25ºC.

[37] Days with shade Wet Bulb Globe Temperature (WBGT) above 25ºC

[38] Days with minimum temperature below 0ºC.

[39] Time in drought defined as precipitation and potential evaporation. Standardised Precipitation Evaporation Index.

Climate Variable	Model Reference (1981-2010)	Current Baseline (1991-2020)	RCP8.5		Trend (50th percentile)
			2030	2050	
Wildfire events*[40] (days per year)	19.7	21.3	31.1 (20.4 to 46.6)	45.5 (24.3 to 72.7)	↑
Soil Moisture[41] (% change) – Winter / Summer	0	-0.5% / -2.6%	-3.0% (-4.8% to +0.4%) / -13.4% (-25.3% to -10.8%)	-4.2% (-6.2% to -1.6%) / -22.3% (-33.1% to -17.8%)	↓
Sea level rise (m)[42]	--	--	+0.16 (+0.12 to +0.20)	+0.29 (+0.23 to +0.37)	↑

*absolute values

Flood Risk

13.5.19 The future climate projections indicate an increased winter rainfall (as described in **Table 13-7**) of 25.4% in the 2050s under the 90th percentile. Increased rainfall will lead to additional volumes of surface water runoff into watercourses which can also exacerbate fluvial and pluvial flood risk.

Soil erosion and degradation

13.5.20 There are many factors which cause or worsen soil erosion, both natural and anthropogenically induced. These include slope angle, precipitation, soil texture, organic matter content of the soil, vegetation cover, human activity (e.g., construction, deforestation, agriculture), wind speed and intensity and flood events. It was estimated in 2017 that every year, approximately 36 billion tonnes of fertile soil is lost due to erosion.[43] To put this into perspective, another study estimated this loss to be approximately 1% of the world's topsoil every year[44].

13.5.21 The British Geological Survey (BGS) identifies that the increased risk of clay shrink-swell at the site due to climate change is highly unlikely for both the 2030s and the 2070s[45].

Wind and Storms

13.5.22 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

[40] Days with Met Office Wildfire Index at the Very High Fire Severity level or above
[41] Potential soil moisture deficit measured by the maximum difference between accumulated rainfall and potential evaporation
[42] At the closest data point 11.5km west of the scheme
[43] Pasquale Borrelli, David A. Robinson, Larissa R. Fleischer, Emanuele Lugato, Cristiano Ballabio, Christine Alewell, Katrin Meusburger, Sirio Modugno, Brigitta Schütt, Vito Ferro, Vincenzo Bagarello, Kristof Van Oost, Luca Montanarella, Panos Panagos. An assessment of the global impact of 21st century land use change on soil erosion. Nature Communications, 2017; 8 (1) DOI: 10.1038/s41467-017-02142-7
[44] Montgomery, DR. Dirt: The Erosion of Civilizations, 2nd Ed. (University of California Press, 2012)
[45] BGS (2020) GeoClimate UKCP18 0pen Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html

contributes to much of this uncertainty. It is therefore difficult to represent regional extreme winds and gusts within regional climate models. Central estimates of change in mean wind speed for the 2050s are small in all ensemble runs (<0.2ms-1). A wind speed of 0.2ms^{-1} (approximately 0.4 knots) is small compared with the typical magnitude of summer mean wind speed of about 3.6–5.1ms^{-1} (7 – 10 knots) over much of England. Seasonal changes at individual locations across the UK lie within the range of –15% to +10%.

13.6 CONSULTATION

13.6.1 The assessment has been informed by consultation responses and ongoing stakeholder engagement. An overview of the approach to consultation is provided in **Section 2.4** of **Chapter 2: Approach to Environment Impact Assessment**.

SCOPING

13.6.2 A Scoping Opinion was issued by South Gloucestershire Council (SGC) on 18 January 2024. The scoping opinion provided no specific responses or commentary in relation to Climate Resilience.

13.7 ENVIRONMENTAL MEASURES INCOPORATED INTO THE PROPOSED SCHEME

13.7.1 A range of environmental measures have been embedded into the development proposals as outlined in **Chapter 3 (Section 3.3)**. **Table 13-8** outlines how these embedded measures will influence Climate Resilience assessment.

Table 13-8 - Summary of the embedded environmental measures and how they influence the Climate Resilience assessment

Receptor	Change and effects	Embedded measure and influence on assessment
Operation of Plant and Machinery	Extreme temperature events: ■ Overheating due to extreme temperature events. ■ Increased pressure on cooling systems. ■ Increased risk of fire.	■ Fire extinguishers are present across site. ■ The site maintains a 30,000L water bowser on-site which can be deployed in the event of a small fire. ■ As part of regular maintenance activities, the coolant level of vehicles is regularly monitored and topped up as required. ■ During times of high temperature, the doors to generator pumps can be opened to increase cooling. ■ Equipment (including vehicle) are fitted with temperature gauges, overheating sensors and warnings.
	Gales and high winds:	■ During strong winds or severe weather, the site will reduce or cease operations until it is safe to re-commence. Full

Receptor	Change and effects	Embedded measure and influence on assessment
	▪ Damage to aboveground plant and equipment from gales and high winds / wind blown debris.	closure of the site will occur where deemed necessary. ▪ Lorries will be underloaded during bad weather events to ensure the load can be safely transported. ▪ The site undertakes structural inspections every year, which includes loose cladding on buildings, for example. Any defects are reported for repair. ▪ An anemometer is used to monitor wind levels when undertaking any work at height (such as MEWP or crane work). ▪ Following high wind events, inspections of the quarry and equipment is undertaken to identify and report any damage. ▪ The site monitors Met Office weather warning and will put in place proactive measures (such as pump installation in response to forecast rain or storm events) to proactively manage potential impacts.
	Storms and lightning: ▪ Damage / power outages from storms and lightning.	▪ There is no tall equipment at ground levels on the Site that would be at risk of lightning strike. ▪ Quarry operations are reliant on gas/oil rather than electricity and therefore are unlikely to be impacted by such a risk. ▪ The site can access high voltage generators to provide power if required.
Quarry operations and inputs	Drought: ▪ Instability of ground and earthworks through reduction in soil strength and ground movement from changes in soil moisture content during drought conditions.	▪ Topsoils on the site are planted with vegetation which provide slope stabilisation. ▪ The geotechnical team conduct bi-weekly checks to assess ground conditions and ensure works are conducted if faults are found. ▪ The quarry has installed meshing to catch potential rock fall.
	Gales and high winds: ▪ Suspension of quarry operations during gales and high winds.	▪ The site has suitable dust suppression measures in place.

Receptor	Change and effects	Embedded measure and influence on assessment
	▪ Increased dust levels during high wind events.	▪ In high winds, site operatives can dampen the haul road to reduce dust levels. ▪ During strong winds or severe weather, the site will reduce or cease operations until it is safe to re-commence. Full closure of the site will occur where deemed necessary. ▪ Lorries will be underloaded during bad weather events to ensure the load can be safely transported. ▪ The site undertakes structural inspections every year, which includes loose cladding on buildings, for example. Any defects are reported for repair. ▪ An anemometer is used to monitor wind levels when undertaking any work at height (such as MEWP or crane work). ▪ Following high wind events, inspections of the quarry and equipment is undertaken to identify and report any damage. ▪ The site monitors Met Office weather warning and will put in place proactive measures (such as pump installation in response to forecast rain or storm events) to proactively manage potential impacts
	Storms and lightning: ▪ Disruption to electricity supply during storms and lightning or high wind events. ▪ Increased risk of fire.	▪ Quarry operations are reliant on gas/oil rather than electricity. ▪ The site can access high voltage generators to provide power if required. ▪ Fire extinguishers are present across site. ▪ The site maintains a 30,000L water bowser on-site which can be deployed in the event of a small fire.
Transport links	Extreme temperature events: ▪ Deformation of melting of road and rail links due to extreme temperatures, impacting transportation of goods / materials.	▪ The on-site rail line was replaced in 2022 with wider cooling joints installed to prevent buckling. ▪ Dust is used to cover vulnerable road surface areas to prevent melting. ▪ In the instance of rail buckling, transport via train is ceased until maintenance

Receptor	Change and effects	Embedded measure and influence on assessment
		has resolved the issue, with some additional capacity picked up by road.
Site operatives	Extreme precipitation events: ■ Health and safety risks to site operatives during extreme precipitation events which result in flooding. ■ Access / egress issues from flooding.	■ During high rainfall / potential flood events, no machinery left on lower levels (Level 5) to prevent machinery being left in flood waters. ■ Plant and equipment are designed to withstand high rainfall. ■ As part of regular maintenance activities, water pumping levels are adjusted to the levels of rainfall to prevent of risk of flooding within the quarry. ■ The quarry operates using a risk assessment regime for high rainfall / flood events.
	Extreme temperature events: ■ Sunstroke and heat exhaustion amongst operational personnel during heat waves or extreme temperature events.	■ Risk assessment method statements used by contractors at the site always have a consideration for adverse weather and will be adhered to in such situations. ■ Equipment (including vehicles), offices, canteens and other buildings are fitted with air conditioning. ■ For vehicles without air conditioning, operations are to be ceased. ■ Additional water is supplied to operatives on site to mitigate heat stroke and dehydration. ■ There is a 'hot work risk assessment' in place and is adhered to in extreme temperatures.
	Gales and high winds; Storms and lightning: ■ Health and safety risks to site operatives during gales and high winds, storms and lightning.	■ During strong winds or severe weather, the site will reduce or cease operations until it is safe to re-commence. Full closure of the site will occur where deemed necessary. ■ An anemometer is used to monitor wind levels when undertaking any work at height (such as MEWP or crane work). ■ The site monitors Met Office weather warning and will put in place proactive measures (such as pump installation in response to forecast rain or storm

Receptor	Change and effects	Embedded measure and influence on assessment
		events) to proactively manage potential impacts.
Waterbodies and ground water	Drought: ▪ Decreasing groundwater levels during drought conditions resulting in water stress and water shortages. ▪ Water shortages for dust control.	▪ Operatives undertake water management procedures as part of regular maintenance activities during drought or low water conditions. ▪ If the site cannot maintain suitable dust suppression, the site will reduce or cease operations until it is safe to re-commence. Full closure of the site will occur where deemed necessary.
Restoration and habitat creation	Drought: ▪ Failure of biodiversity restoration and planting during drought or extreme temperature. ▪ Potential for increased spread of invasive species and disease drought. ▪ Increased management and associated environmental costs, e.g. water use.	▪ Planting on site is undertaken well before end of usual planting season to increase success rate. ▪ Planting on site uses rootrainer cell-grown stock in the event of need for unseasonable planting (e.g., July 2023 Level 0 edge protection) to increase success rate. ▪ Planting on site uses small-sized bare root stock to increase success rate, with watering visits undertaken in the event of extreme drought. ▪ Planting on site uses small stock sizes to allow for cheap and easy replacement of losses in the event of failure, generally more cost effective than watering visits. ▪ The landscape details plan specifies that early maintenance must be undertaken and that resilient multi-species mixtures must be used, particularly species will be selected for local site and soil conditions to increase success rate. ▪ During drought conditions, sufficient water will be available from quarry sumps in the unlikely event that watering visit(s) is necessary to increase success rate. ▪ There is consistently sufficient internal site budget available for works necessary for tree and habitat establishment.

Receptor	Change and effects	Embedded measure and influence on assessment
	Extreme precipitation events: ■ Damage to vegetation and habitat creation areas during extreme precipitation events and flooding.	■ Reclamation surfaces on site will all be vegetated at the earliest opportunity with suitable grass and grass/wildflower mixes to reduce flood risk and improve infiltration.
	Gales and high winds; Storms and lightning: ■ Damage to vegetation and habitat creation areas during gales and high winds, storms and lightning.	■ During the establishment phases of plantations, any wind damage will be made good during subsequent regular maintenance visits. ■ Windthrow damage to older plantations, e.g., after canopy is opened up during selective thinning or other habitat management works, is a normal and natural event that woodland habitats can accommodate well. ■ Mixed-species native broadleaved deciduous plantations on site are able to withstand winter gales well. ■ Glades caused by such windthrow events will either recolonise with a new age class of natural regeneration or will remain as open space, either of which further diversifies woodland structure and considered to be habitat enhancement. ■ The site monitors Met Office weather warnings and will put in place reactive measures (such as maintenance in response to storm events) to manage potential impacts.

13.8 SCOPE OF THE ASSESSMENT

THE PROPOSED SCHEME

13.8.1 The climate resilience assessment considered the operational phase activities, as described further in **Table 13-9**. Due to the Proposed Scheme being an extension of an existing operational quarry, no specific construction works are being undertaken.

SPATIAL SCOPE

13.8.2 The spatial scope of the assessment of Climate Resilience covers the area of the Proposed Scheme contained within the red line boundary, together with the Zones of Influence (ZoIs) that have formed the basis of the study area described in **Section 13.4**.

TEMPORAL SCOPE

13.8.3 The temporal scope of the assessment of Climate Resilience is consistent with the period over which the Proposed Scheme would be carried out and therefore covers the periods of the 2030s (2020 – 2049), and the 2050s (2040 – 2069).

POTENTIAL RECEPTORS

13.8.4 The following sensitive receptors have been considered as part of the climate resilience assessment:

- Plant and Machinery;
- Quarry operations and inputs;
- Transport links;
- Site operatives;
- Waterbodies and ground water; and
- Restoration and habitat creation..

POTENTIALLY SIGNIFICANT EFFECTS

Effects scoped-in to the assessment

13.8.5 The receptors that have been taken forward for further assessment in Climate Resilience are summarised in **Table 13-9**.

Table 13-9 – Scoped-in effects for Climate Resilience

Receptor	Climate variable and potential effects
Operation of Plant and Machinery	Extreme temperature events: ■ Overheating due to extreme temperature events. ■ Increased pressure on cooling systems. ■ Increased risk of fire.
	Gales and high winds: ■ Damage to aboveground plant and equipment from gales and high winds / wind blown debris.
	Storms and lightning: ■ Damage / power outages from storms and lightning.
Quarry operations and inputs	Drought: ■ Instability of ground and earthworks through reduction in soil strength and ground movement from changes in soil moisture content during drought conditions.
	Gales and high winds:

Receptor	Climate variable and potential effects
	▪ Suspension of quarry operations during gales and high winds. ▪ Increased dust levels during high wind events.
	Storms and lightning: ▪ Disruption to electricity supply during storms and lightning or high wind events. ▪ Increased risk of fire.
Transport links	Extreme temperature events: ▪ Deformation of melting of road and rail links due to extreme temperatures, impacting transportation of goods / materials.
Site operatives	Extreme precipitation events: ▪ Health and safety risks to site operatives during extreme precipitation events which result in flooding ▪ Access / egress issues from flooding
	Extreme temperature events ▪ Sunstroke and heat exhaustion amongst operational personnel during heat waves or extreme temperature events.
	Gales and high winds; Storms and lightning: ▪ Health and safety risks to site operatives during gales and high winds, storms and lightning.
Waterbodies and ground water	Drought: ▪ Decreasing groundwater levels during drought conditions resulting in water stress and water shortages. ▪ Water shortages for dust control.
Restoration and habitat creation	Drought: ▪ Failure of biodiversity restoration and planting during drought or extreme temperature. ▪ Potential for increased spread of invasive species and disease drought. ▪ Increased management and associated environmental costs, e.g., water use.
	Extreme precipitation events: ▪ Damage to vegetation and habitat creation areas during extreme precipitation events and flooding.

Receptor	Climate variable and potential effects
	Gales and high winds; Storms and lightning: ■ Damage to vegetation and habitat creation areas during gales and high winds, storms and lightning.

Effects scoped-out of the assessment

13.8.6 The following receptors have been scoped out from being subject to further assessment because the potential effects are considered to be of low vulnerability. A vulnerability assessment was completed as part of the scoping assessment, which took into account known mitigation measures at the time of writing.

Table 13-10 – Scoped-out receptors for Climate Resilience

Receptor	Variable	
Plant and machinery	Precipitation	Change in annual average
		Drought
		Extreme precipitation events (flooding)
	Temperature	Change in annual average
	Relative humidity	Changes in annual average
Quarry operation and inputs	Precipitation	Change in annual average
		Extreme precipitation events (flooding)
	Temperature	Change in annual average
		Extreme temperature events
	Relative humidity	Changes in annual average
Transport links	Precipitation	Change in annual average
		Drought
		Extreme precipitation events (flooding)
	Temperature	Change in annual average

Receptor	Variable	
	Wind	Gales and high winds
		Storms and lightning
	Relative humidity	Changes in annual average
Site operatives	Precipitation	Change in annual average
		Drought
	Temperature	Change in annual average
	Changes in annual average	Changes in annual average
Waterbodies and ground water	Precipitation	Change in annual average
		Extreme precipitation events (flooding)
	Temperature	Change in annual average
		Extreme temperature events
	Wind	Gales and high winds
		Storms and lightning
	Relative humidity	Changes in annual average
Restoration and habitat creation	Precipitation	Change in annual average
	Temperature	Change in annual average
	Relative humidity	Changes in annual average

13.9 ASSESSMENT METHODOLOGY

13.9.1 The generic project-wide approach to the assessment methodology is set out in **Chapter 4**, and specifically in **Sections 4.5 to 4.7**. However, whilst this has informed the approach that has been used in Climate Resilience assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this Climate Resilience assessment.

SIGNIFICANCE EVALUATION METHDOLOGY

13.9.2 The assessment of impacts will be undertaken using an approach based on the IEMA guidance[46], and professional judgement.

13.9.3 The significance of effects for the scoped in receptors and climate variables will be determined by considering the consequence and the likelihood of potential impacts associated with changes in climate variables on Proposed Scheme components occurring. Likelihood and consequence will be qualitatively assessed using the descriptions in **Table 13-11** and **Table 13-12**. These descriptions have been developed using professional judgement, informed by relevant guidance. It should be noted that the IEMA guidance definitions of consequence has been developed for large scale infrastructure specifically, and therefore, the description of the measure of consequence will have regard to the wider Proposed Scheme.

13.9.4 The assessment of likelihood and consequence (and therefore significance) will take embedded mitigation into account as an assumed part of the design. Embedded mitigation has been identified through engagement with the design team.

Table 13-11 - Consequence Definitions

Measure of Consequence	Description
Very large adverse	Permanent damage. Disruption lasting more than ten days. Early renewal of facility / infrastructure >90%. Severe health effects and / or fatalities. Repairs cost 50% of facility reconstruction cost.
Large adverse	Extensive facility / infrastructure damage. Disruption lasting more than three but less than ten days. Early renewal of 50-90% of infrastructure Severe health effects and / or fatalities. Significant effect on the environment, requiring remediation. Repairs cost 50% of facility reconstruction cost.
Moderate adverse	Limited facility / infrastructure damage with damage recoverable by maintenance or minor repair. Disruption lasting more than one but less than three days. Adverse effects on health and / or the environment. Repairs cost 25% of facility reconstruction cost.
Minor adverse	Localised facility / infrastructure disruption. No permanent damage, minor restoration work required: Facility closure lasting less than one day. Slight adverse health or environmental effects. Repairs cost 2% of facility reconstruction cost.
Negligible	No facility / infrastructure damage, minimal adverse effects on health, safety and the environment. Facility doesn't shut down. No financial loss.

[46] IEMA EIA Guide to: Climate Change Resilience and Adaptation (Online). Accessed from: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020

Table 13-12 - Likelihood Definitions

Measure of likelihood	Description
Very High	The event occurs multiple times during the lifetime of the Proposed Scheme e.g. approximately annually.
High	The event occurs several times during the lifetime of the Proposed Scheme e.g. approximately once every five years.
Medium	The event occurs limited times during the lifetime of the Proposed Scheme e.g. approximately once every 10 years.
Low	The event occurs occasionally during the lifetime of the Proposed Scheme e.g. once in 15 years.
Very Low	The event may occur once during the lifetime of the Proposed Scheme.

13.9.5 The likelihood and consequence are combined to assess the significance of effects on receptors, as shown in **Table 13.13**. The assessment is qualitative and based on professional judgment, engagement with the design team and a review of relevant literature.

Table 13.13 – Significance Rating Matrix

Likelihood	Consequence of Hazard Occurring				
Very High	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

13.10 ASSESSMENT OF EFFECTS

13.10.1 The assessment of effects takes into account mitigation embedded in the Scheme's design that has been agreed with the design team. **Table 13-8** sets out the embedded mitigation measures that address climate risks. **Table 13-14** assess the significance of effects identified that have potential to impact the Scheme.

Table 13-14 – Significance Rating

Receptor	Potential effect	Likelihood	Consequence	Significance
Operation of Plant and Machinery	Overheating due to extreme temperature events	Medium	Negligible	Not significant
	Increased pressure on cooling systems	Low	Minor adverse	Not significant
	Increased risk of fire	Low	Moderate adverse	Not significant
	Damage to above ground plant and equipment from gales and high winds / wind blown debris	Low	Negligible	Not significant
	Damage / power outages from storms and lightning	Medium	Negligible	Not significant
Quarry operations and inputs	Instability of ground and earthworks through reduction in soil strength and ground movement from changes in soil moisture content during drought conditions	Low	Minor adverse	Not significant
	Suspension of quarry operations during gales and high winds	Medium	Minor adverse	Not significant
	Increased dust levels during high wind events	Medium	Minor adverse	Not significant
	Disruption to electricity supply during storms and lightning or high wind events	Low	Negligible	Not significant
	Increased risk of fire	Low	Moderate adverse	Not significant
Transport links	Deformation of melting of road and rail links due to extreme temperatures, impacting transportation of goods / materials	Low	Moderate adverse	Not significant
Site operatives	Health and safety risks to site operatives during extreme precipitation events which result in flooding	Low	Minor adverse	Not significant
	Access / egress issues from flooding	Low	Minor adverse	Not significant
	Sunstroke and heat exhaustion amongst operational personnel	Low	Minor adverse	Not significant

Receptor	Potential effect	Likelihood	Consequence	Significance
	during heat waves or extreme temperature events			
	Health and safety risks to site operatives during gales and high winds, storms and lightning	Low	Minor adverse	Not significant
Waterbodies and ground water	Decreasing groundwater levels during drought conditions resulting in water stress and water shortages	Low	Moderate adverse	Not significant
	Water shortages for dust control	Low	Moderate adverse	Not significant
Restoration and habitat creation	Failure of biodiversity restoration and planting during drought or extreme temperature	Low	Negligible	Not significant
	Potential for increased spread of invasive species and disease drought	Low	Negligible	Not significant
	Increased management and associated environmental costs, e.g. water use	Low	Negligible	Not significant
	Damage to vegetation and habitat creation areas during extreme precipitation events and flooding	Low	Negligible	Not significant
	Damage to vegetation and habitat creation areas during gales and high winds, storms and lightning	Medium	Negligible	Not significant

13.11 ASSESSMENT OF CUMULATIVE EFFECTS

13.11.1 The approach to the climate resilience assessment differs from other topics in that it looks at the potential impacts of environmental (climate) change on the Proposed Scheme, rather than impacts of the Proposed Scheme on the environment: the receptor for the resilience assessment in the Proposed Scheme. Therefore, no assessment of combination effects is undertaken, as there are no receptors in common with other assessments or projects.

13.12 ASSESSMENT OF IN-COMBINATION CLIMATE IMPACTS

13.12.1 The In-combination Climate Change Impacts (ICCI) assessment considers the extent to which climate change exacerbates or ameliorates the potential effects identified within each of the environmental topics.

13.12.2 Individual topics have carried out and reported on, where appropriate, in-combination assessments which considers the extent to which Climate Change may alter the effects that have been identified during the EIA. Refer to the individual topic **Chapters 6** to **14** of this ES.

13.13 MITIGATION AND ENHANCEMENT MEASURES

13.13.1 Opportunities to mitigate potential adverse effects have already been incorporated within the development or are imposed through a number of existing regulatory controls. The Proposed Scheme with these measures and controls in place has been subject to assessment. No additional measures are proposed as mitigation in relation to the significant effects as none have been identified in this chapter.

13.14 CONCLUSIONS OF SIGNIFICANCE EVALUATION

13.14.1 **Table 13-15** provides a summary of the conclusions about the significance of the predicted effects on Climate Resilience that have been subject to assessment in this ES.

Table 13-15 - Summary of significance of predicted effects on Climate Resilience

Receptor	Potential effect	Likelihood	Consequence	Significance Level	Rationale
Operation of Plant and Machinery	Overheating due to extreme temperature events	Medium	Negligible	Not significant	Existing embedded mitigation (as outlined in **Table 13-8**) is sufficient to mitigate this risk
	Increased pressure on cooling systems	Low	Minor adverse	Not significant	Existing embedded mitigation (as outlined in **Table 13-8**) is sufficient to mitigate this risk
	Increased risk of fire	Low	Moderate adverse	Not significant	Existing embedded mitigation (as outlined in **Table 13-8**) is sufficient to mitigate this risk
	Damage to above ground plant and equipment from gales and high winds / wind blown debris	Low	Negligible	Not significant	Existing embedded mitigation (as outlined in **Table 13-8**) is sufficient to mitigate this risk
	Damage / power outages from storms and lightning	Medium	Negligible	Not significant	Existing embedded mitigation (as outlined in **Table 13-8**) is sufficient to mitigate this risk
Quarry operations and inputs	Instability of ground and earthworks through reduction in soil strength and ground movement from changes in soil moisture content during drought conditions	Low	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk

Receptor	Potential effect	Likelihood	Consequence	Significance Level	Rationale
	Suspension of quarry operations during gales and high winds	Medium	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Increased dust levels during high wind events	Medium	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Disruption to electricity supply during storms and lightning or high wind events	Low	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Increased risk of fire	Low	Moderate adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
Transport links	Deformation of melting of road and rail links due to extreme temperatures, impacting transportation of goods / materials	Low	Moderate adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
Site operatives	Health and safety risks to site operatives during extreme precipitation events which result in flooding	Low	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Access / egress issues from flooding	Low	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk

Receptor	Potential effect	Likelihood	Consequence	Significance Level	Rationale
	Sunstroke and heat exhaustion amongst operational personnel during heat waves or extreme temperature events	Low	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Health and safety risks to site operatives during gales and high winds, storms and lightning	Low	Minor adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
Waterbodies and ground water	Decreasing groundwater levels during drought conditions resulting in water stress and water shortages	Low	Moderate adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Water shortages for dust control	Low	Moderate adverse	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
Restoration and habitat creation	Failure of biodiversity restoration and planting during drought or extreme temperature	Low	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Potential for increased spread of invasive species and disease drought	Low	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Increased management and associated environmental costs, e.g. water use	Low	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk

Receptor	Potential effect	Likelihood	Consequence	Significance Level	Rationale
	Damage to vegetation and habitat creation areas during extreme precipitation events and flooding	Low	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk
	Damage to vegetation and habitat creation areas during gales and high winds, storms and lightning	Medium	Negligible	Not significant	Existing embedded mitigation is sufficient to mitigate this risk

13.15 IMPLEMENTATION OF ENVIRONMENTAL MEASURES

13.15.1 No additional environmental measures are required for the Proposed Scheme following the assessment of effects presented in **Section 13.10**.

13.16 REFERENCES

13.16.1 [Reference numbering to be pre-fixed by chapter number].

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- Reference 13.2: HM Government (2008) Climate Change Act 2008. Accessed from: https://www.legislation.gov.uk/ukpga/2008/27/contents
- Reference 13.3: Department for Levelling Up, Housing and Communities (2023) National Planning Policy Framework. (online) Accessed from: https://www.gov.uk/government/publications/national-planning-policy-framework--2
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- Reference 13.34 Representative Concentration Pathways (RCPs) specify concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to pre-industrial levels. Radiative forcing targets for 2100 have been set at 2.6, 4.5, 6.0 and 8.5 W m-2 named RCP2.6, RCP4.5, RCP6.0 and RCP8.5, respectively.
- Reference 13.35 RCP8.5 (high emission scenarios) is used to ensure a suitable conservative approach in line with IEMA guidance.
- Reference 13.36 A UK heatwave threshold is met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. The threshold for the local area is 25oC.
- Reference 13.37 Days with shade Wet Bulb Globe Temperature (WBGT) above 25oC
- Reference 13.38 Days with minimum temperature below 0oC.
- Reference 13.39 Time in drought defined as precipitation and potential evaporation. Standardised Precipitation Evaporation Index.
- Reference 13.40 Days with Met Office Wildfire Index at the Very High Fire Severity level or above
- Reference 13.41 Potential soil moisture deficit measured by the maximum difference between accumulated rainfall and potential evaporation
- Reference 13.42 At the closest data point 11.5km west of the scheme

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Canon Court West
Abbey Lawn
Shrewsbury
SY2 5DE

wsp.com