A303 Amesbury to Berwick Down

TR010025

6.3 Environmental Statement Appendices

Appendix 14.1 Climate Resilience Baseline

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APFP Regulation 5(2)(a)

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Executive Summary

A review of relevant information sources was undertaken to establish existing and future baseline data and current understanding with regards to climate and extreme weather impacts. This appendix provides detailed information on this data.

A review of the recent and current climate of the region in which the Scheme is sited has indicated that there is already evidence of gradual warming and increases in average annual precipitation amounts between 1961 and 2006. The Local Climate Impacts Profile for Wiltshire has assessed the vulnerability of the county to weather events and provides evidence to suggest that infrastructure disruption has been the most common form of severe weather related impact during the 2003 to 2010 Local Climate Impacts Profile study period. The UK Climate Change Risk Assessment (CCRA 2017) also presents the argument that the UK's transport infrastructure is already being affected by severe weather events, specifically through flooding and changes to extreme weather event frequency and severity.

The Scheme and the nearest Met Office Weather Station (Boscombe Down) sit within the UK Climate Projections' South West region. Climate observations for this region identify gradual warming, with an increase of 1.37°C in annual average temperatures between 1961 and 2006. Annual average daily maximum temperatures have increased by 1.54°C over the same period, and the annual average number of days with air frost has reduced by 20.9.

For the UK Climate Projections' South West region, climate observations indicate a 9.7% increase in average annual precipitation amounts between 1961 and 2006. This can be broken down to an average of a 4.0% average increase in precipitation levels in spring, an 8.8% average decrease in summer, a 28.6% average increase in autumn, and a 15.9% average increase in winter.

1 Climate resilience baseline

1.1 Current baseline

1.1.1 The Local Climate Impacts Profile for Wiltshire (LCLIP) (2010) (Ref 14.1) assessed the vulnerability of council services to severe weather events, and was based on a review of media stories in the local press over an eight year period between January 2003 and March 2010. The LCLIP review found that Wiltshire is already experiencing major weather events and that several highly significant events occurred over the eight year LCLIP period. The most frequent impacts of these events were infrastructure disruption which had a direct impact on frontline service delivery, as well as indirectly impacting all services through access to offices or workplaces.

1.1.2 Several events which took place during the study period were recognised as being significant:

a) Excessive rainfall / flooding in 2003 (possibly related to highway drainage being unable to discharge to the Avon), July 2007 and January and September 2008 (surface water flooding), leading to flooding of properties in several towns across Wiltshire and infrastructure disruption (particularly road and rail infrastructure in 2008);

b) High temperatures / heat waves in August 2003 and July 2006: leading to strain on water and energy utilities, significant damage to road infrastructure (and also to rail infrastructure in 2003), danger to vulnerable groups (and excess deaths reported nationally in 2003); and

c) Severe flooding events occurred between December 2013 and March 2014 resulted in over 500 properties across Wiltshire being flooded and a number of roads having to be closed to traffic, including the A360; and Frost / snow / ice in February 2009 and January 2010.

1.1.3 The LCLIP also identifies possible events arising due to weather events. Examples relevant to road infrastructure include:

a) High temperatures / heat waves: ‘melting’ roads, damage to structures;

b) High winds: health and safety risks, infrastructure disruption and damage, property damage; and

c) Excessive rainfall / flooding: health and safety risks, infrastructure disruption and damage.

1.1.4 The LCLIP also notes that subsidence can result in significant damage to infrastructure and can be the result of high temperatures and corresponding changes in the moisture content of soil or growth of vegetation.

1.1.5 There is strong evidence that the climate is changing beyond that of expected natural fluctuations. Met Office records show that Central England temperatures have increased by 1°C since the 1970s, total summer rainfall has decreased in

most parts of the UK, and the UK has experienced nine of the ten warmest years on record since 1990.

1.1.6 Met Office historic climate data (Ref 14.2) has been obtained from the Boscombe Down Weather Station (the closest Weather Station to the Scheme area) showing that for the period 1981-2010:

a) Average annual maximum daily temperature were 14.1°C;

b) July was the warmest month on average (mean maximum daily temperature of 21.9°C);

c) January was the coldest month on average (mean daily minimum temperature of 1.1°C);

d) Mean annual rainfall levels were 748.6mm;

e) November was the wettest month on average (84mm of rainfall on average for the month);

f) July was the driest month on average (48.9mm of rainfall on average for the month);

g) January was, on average, the windiest month; and

h) July and August were the least windy.

1.1.7 As noted by the UK Climate Change Risk Assessment (CCRA 2017) (Ref 14.4), the UK's transport infrastructure is already being affected by severe weather events. Specifically for transport infrastructure, the CCRA identifies two key risks:

a) Changes in extreme weather conditions, which will affect infrastructure, in particular through storm damage, flooding and high temperatures; and

b) Flooding of transport, including roads and rail is likely to increase, affecting both urban and rural access routes.

1.2 Future baseline – Climate resilience assessment

Construction Year Baseline (2021)

1.2.1 The UK Climate Projections 2009 (UKCP09) (Ref 14.5) provides the best scientific picture of how global climate change is likely to affect the South West region of England. UKCP09 provides climate change projections for pre-defined 30-year periods (e.g. 2020s (2010-2039), 2050s (2040-2069) and 2080s (2070-2099)), at annual and seasonal levels for changes to mean climatic conditions over land areas. For the purpose of this project, UKCP09 projections for temperature and precipitation variables have been obtained and analysed

1.2.2 Tables 14.1 and 14.2 provide a summary of projections for changes to mean daily conditions, including projections for temperature and precipitation for the 2020s (2010-2039), the 2050s (2040-2069) and the 2080s (2070-2099) time periods.

Projections for annual, summer (June, July and August) and winter (December, January and February) are included in this summary.

Table 14-1 Projected changes to temperature variables (°C)[1]

Climate variable	Time period		
	2020s	**2050s**	**2080s**
Change in mean annual daily temperature (°C)	+1.45 (+0.79 to +2.15)	+2.85 (+1.81 to + 4.10)	+4.43 (+2.93 to +6.34)
Change in mean summer daily temperature (°C)	+1.54 (+0.52 to +2.60)	+3.14 (+1.44 to +5.10)	+4.90 (+2.70 to +7.90)
Change in mean winter daily temperature (°C)	+1.20 (+0.54 to +2.19)	+2.30 (+1.34 to +3.50)	+3.40 (+2.10 to +5.10)
Change in mean daily maximum summer temperature (°C)	+1.96 (+0.67 to +3.57)	+4.18 (+1.80 to +7.10)	+6.53 (+3.00 to +11.26)
Change in mean daily minimum winter temperature (°C)	+1.47 (+0.64 to +2.38)	+2.73 (+1.31 to +4.40)	+3.95 (+1.65 to +6.70)

Table 14-2 Projected changes to precipitation variables (%)

Climate variable	Time period		
	2020s	**2050s**	**2080s**
Change in mean annual daily precipitation (%)	+0.40 (-5.50 to +7.00)	+0.45 (-6.46 to +7.35)	+0.82 (-7.80 to +10.8)
Change in mean summer daily precipitation (%)	-4.80 (-24.40 to +18.10)	-20.13 (-45.20 to +8.40)	-30.15 (-58.40 to +4.40)
Change in mean winter daily precipitation (%)	+6.5 (-2.40 to +19.00)	+17.60 (+2.87 to +38.50)	+28.00 (+7.00 to +63.00)
Change in mean winter precipitation on the wettest day (%)	+7.85 (-4.00 to +21.9)	+16.90 (+1.00to +36.90)	+28.00 (+7.10 to +58.00)

1.2.3 These projections represent average weather conditions and do not capture the full range of possible future severe weather events (i.e. droughts, heatwaves and prolonged heavy rainfall).

1.2.4 UKCP09 climate change projections have been used qualitatively to identify how events associated with climatic variables change over time. Baseline climatic conditions (as identified through the LCLIP and Met Office datasets) can subsequently be compared against climate change projections to indicate the direction and degree of change. This approach allows these events to be prioritised over the duration of a Scheme and the requirement for

[1]The main central number for each variable at each time period represents the 50 per cent probability level, indicating that the particular change is 'as likely as not' to occur. The figures in brackets show the wider range of probability and potential change (10 per and 90 per cent probability levels).

mitigation and adaptation responses to be identified and programmed accordingly.

1.2.5 Increases in rate of discharge during the period of run-off after a heavy rainfall event (peak flow), as a result of climate change, are considered in Chapter 11 Road Drainage and the Water Environment. These potential increases in peak flow are being assessed using hydraulic models of both the fluvial and pluvial systems. These hydraulic models have been created to represent the baseline scenario (current state of region, 100 years from now in terms of climate change) against what the impacts of the current Scheme would look like in 100 years' time.

1.2.6 In order to understand the likelihood of future severe weather events, the UKCP09 Weather Generator (WG) has been used to develop probabilistic daily weather conditions for the 2020s (2010-2039), the 2050s (2040-2069) and the 2080s (2070-2099). The WG's Threshold Detector (TD) is a post-processing tool that can be applied to outputs from the WG. It allows users to investigate how often thresholds, such as temperatures or daily rainfall greater or less than a certain level, are likely to be exceeded in the future.

1.2.7 The WG develops statistical relationships among daily weather variables to produce possible daily and hourly weather scenarios for future time periods for temperature, rainfall and humidity variables. The scenarios generated are consistent with the underlying probabilistic projections and are provided at a 5km resolution[2] .

1.2.8 The following severe weather events have been identified as potentially being relevant to the Scheme's construction and operation, and have therefore been assessed using outputs from the WG and TD:

a) Annual number of heatwaves (3+ consecutive days with a maximum daily temperature of >30°C and a minimum daily temperature of >15°C);

b) Annual number of days when the temperature is greater than 28ºC;

c) Annual number of prolonged periods of cold weather (5+ consecutive days where the temperature falls below 0°C);

d) Annual number of dry spells (days with no precipitation) lasting greater than 10 consecutive days;

e) Number of short sharp storms/days per year when precipitation is greater than 40mm. This is defined as likely to cause flooding if exceeded in a three hour period by the Flood Forecasting Centre (Ref 14.19); and

f) Number of days per year when precipitation is greater than 25mm (Met Office definition of 'heavy rain').

[2] It should be noted that WG and TD outputs are not associated with a specific, actual day (e.g. a historical date, or a forecast for a real date in the future). Rather, they are just statistically credible representations of what may occur.

1.2.9 Table 14-3 summarises the outputs from the WG and TD for the projected changes to the frequency of extreme weather events for the different time periods; 2020s, 2050s and 2080s. The 50 per cent probability level has been analysed and thereby applied as part of the resilience assessment, as it provides the central estimate for the projections at this specific scenario, which is the projected change that is 'as likely as not' to occur.

Table 14-3 Projected for the frequency of UK severe weather events under the high emissions scenario at the 50% probability level

Variable parameter	Baseline (average for 1961-90 for rainfall and 1961-1995 for the other variables)	2020s (2010-2039)	2050s (2040-2069	2080s (2070-2099)
Annual number of heatwaves (3+ days with max daily temp of >30˚C and min daily temp of >15˚C)	Up to 1	Up to 2	Up to 6	Up to 8
Annual number of days when temperature is >28˚C	Up to 2	Up to 24	Up to 73	Up to 95
Annual number of prolonged periods of cold weather (5+ consecutive days where the temperature falls below 0°C)	Up to 5	Up to 4	Up to 3	Up to 4
Annual number of dry spells (10+ days with no precipitation)	Up to 7	Up to 9	Up to 10	Up to 10
Number of days per year when precipitation is greater than 40mm per day	Up to 1	Up to 1	Up to 2	Up to 2
Number of days per year when precipitation is greater than 25mm	Up to 3	Up to 4	Up to 6	Up to 6

Abbreviations List

LCLIP	Local Climate Impacts Profile for Wiltshire
TD	Threshold Generator
UKCP09	United Kingdom Climate Projections 2009
WG	Weather Generator

References

Ref 14.1 The Local Climate Impacts Profile for Wiltshire (LCLIP) (2010)

Ref 14.2 The Met Office historic climate data. Link: www.metoffice.gov.uk/public/weather/climate/gcqfp5e8q (Accessed 01/06/2018)

Ref 14.3 England SE & Central S climate variations average table. Accessed at: https://www.metoffice.gov.uk/public/weather/climate/gcng01df2

Ref 14.4 UK Climate Change Risk Assessment, Committee for Climate Change, 2017

Ref 14.5 UK Climate Projections (UKCP09). Accessed at: http://ukclimateprojections.metoffice.gov.uk/

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