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AtkinsRéalis



MANCHESTER DIGITAL CAMPUS

Environmental Statement
Volume 2 - Chapter 9: Climate Vulnerability

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Executive Summary

Climate change and climate variability present both challenges and opportunities for the successful construction and operation of the Proposed Development. This Environmental Statement assesses these factors in two separate chapters:

- Chapter 9: Vulnerability of the Proposed Development to climate change (this chapter); and
- Chapter 10: Effects of the Proposed Development on climate.

The Climate Vulnerability chapter provides an assessment of the vulnerability of the Proposed Development to climate change, including:

- An examination of the current climate baseline using the latest Met Office regional dataset of 30-year averages and data from nearby long running meteorological stations.
- A consideration of the projected future climate baseline for the study area using United Kingdom Climate Projections 2018 (UKCP18) (the most up-to-date assessment of how the climate of the UK may change over the 21st century).
- An assessment of how during its construction and operation climate change and extreme weather could affect the Proposed Development's assets, as well as how they could affect the potential environmental impacts identified in the other chapters of this ES, i.e. how it could impact environmental receptors.
- Identification of specific mitigation to adapt the design and operational processes to reduce the Proposed Development's potential adverse climate vulnerabilities; and
- An assessment of the residual climate change vulnerability of the Proposed Development that considers both adverse and beneficial vulnerability affects.

A key outcome of the assessment is to ensure that climate change, and impacts associated with extreme weather, are considered during planning so that they can be avoided and, if that is not possible, mitigated during the construction and operation of the Proposed Development.

The baseline examination of climate projections has confirmed that the study areas climate is expected to change in the future.

Embedded mitigation measures will include the use of best practice design and construction methods, water efficiency strategies, emergency power supplies, diverse species planting, and thermal comfort solutions to provide resilience against climate change impacts.

After considering mitigation measures, which are primarily integrated into the design, climate change will neither worsen the effects of Manchester Digital Campus to result in significant adverse effects or create new significantly adverse effects. All effects are therefore not significant

Manchester Digital Campus is therefore well-prepared to handle potential climate-related challenges. The implementation of climate resilience measures ensure that the project will not be adversely affected by climate change, thereby safeguarding the investment and providing a secure environment for future users.

9. Climate Vulnerability

9.1. Introduction

9.1.1. This chapter of the Environmental Statement (ES) assesses the likely effects of the Proposed Development with respect to climate vulnerability. It outlines the assessment methodology, describes the existing baseline conditions, identifies potential impacts and provides an assessment of effects. The chapter also details the mitigation measures necessary to prevent, reduce, or offset any significant adverse effects, and discusses the likely residual effects after these measures have been implemented.

9.1.2. This chapter reports on two different types of cumulative effects: intra-project cumulative effects, which are the combined effects of individual topic impacts on a particular sensitive receptor; and inter-project cumulative effects, which consider the way in which the Proposed Development may give rise to impacts in combination with other developments the study area, termed RFFPs. The outlined cumulative effects are then used to inform the overall assessment of cross-topic cumulative effects, which is reported in ES (Volume 2) Chapter 22: Cumulative Effects.

9.1.3. This chapter is supported by a technical appendix contained within ES Volume 4:

- ES (Volume 4) Appendix 9.1 – Climate Vulnerability Baseline.

9.2. Competent expert evidence

9.2.1. This climate vulnerability assessment has been undertaken by:

- A Chartered Member of the Institute of Environmental Sciences (IES) who has 7 years professional experience; and
- A Chartered Water and Environmental Manager who is also a Chartered Environmentalist and holds professional memberships including Member of the Chartered Institution of Water and Environmental Management (M.CIWEM) and Fellowship of the Royal Geographical Society (F-RGS). They have 17 years of experience in environmental impact assessment.

9.2.2. The above listed individuals have used their knowledge and professional judgement to undertake this assessment.

9.3. Relevant legislation and guidance

9.3.1. Table 9-1 below summaries the legislation and regulations applicable to climate vulnerability

Table 9-1 - Legislation and guidance for climate vulnerability

Legislation / regulation	Summary of requirements
National	
Climate Change Act, 2008[1]	The UK passed legislation that introduced the world's first long term legally binding framework to tackle the risks posed by climate change. The Climate Change Act 2008[2] (hereafter referred to as the 'Act') created a new approach to managing and responding to climate change in the UK, by: ▪ Setting ambitious, legally binding reduction targets. ▪ Taking powers to help meet those targets. ▪ Strengthening the institutional framework. ▪ Enhancing the UK's ability to adapt to the impacts of climate change. ▪ Establishing clear and regular accountability to the UK Parliament and to the developed legislatures. The Act requires the UK Government to produce a UK Climate Change Risk Assessment (CCRA) every five years that sets out the UK Governments position on current and future risks to and opportunities for the UK from climate change. The latest CCRA, 20223, states that: "The government accepts that climate hazards will cause increasing threats to our supply chains through our infrastructure and transport routes. Consideration will need to be given to the potential vulnerabilities for the transport system including rail, roads, ports and airports." (Priority risk area 5, page 31) In addition to the CCRA, the Climate Change Act also requires the UK government to produce a National Adaptation Programme (NAP). The NAP covers England, while the devolved administrations produce their own programmes and policies. The Act also gives powers to the UK Government to require certain organisations, public bodies and statutory undertakers, to report on how they are adapting to climate change. The Adaptation Sub-Committee of the Climate Change Committee provides advice to, and scrutiny of, the Government's adaptation work.
Town and Country Planning Environmental Impact Assessment (EIA) Regulations 2017 (as amended)[4]	The EIA Regulations set out the requirement to undertake an EIA, implementing the EIA Directive 2011/52/EU (as amended). Amendments included the introduction of a requirement to describe the likely significant effects resulting from the impact of a Proposed Development on climate and the vulnerability of a Proposed Development to climate change.

[1] http://www.legislation.gov.uk/ukpga/2008/27/contents

[2] UK Government (2008). Climate Change Act 2008 (online). Available at: http://www.legislation.gov.uk/ukpga/2008/27/contents

[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

[4] https://www.legislation.gov.uk/uksi/2017/571/contents/made

Local	
Manchester City Council Climate Change Action Plan 2022 refresh[5]	The action plan "supports city wide adaptation to climate change". This includes a commitment under workstream 4 that supports the installation of green infrastructure and nature-based solutions.

9.3.2. The climate vulnerability assessment follows the framework set out in Institute of Environmental Management and Assessment (IEMA) Guidance[6]. It incorporates a Climate Risk Assessment (CRA) and an In-Combination Climate Change Impact (ICCI) Assessment. The assessments are multi staged and the method is summarised in the following section.

9.4. Assessment methodology

Study area

9.4.1. The area for assessing the Proposed Development's vulnerability to climate change includes the Red Line Boundary, see ES (Volume 2) Chapter 2 Description of the Site and Proposed Development, plus the area of any environmental receptors considered by the other assessment chapters in this report where impacts could be intensified by climate change (see study area section within each environmental topic chapter).

9.4.2. The climate vulnerability assessment covers the design life (50 years) of the Proposed Development assets with consideration of how the developments life span could exceed this with ongoing management and maintenance. It is noted that it is not unusual for a development's design life to be exceeded by its life span as many developments remain in situ long after they have fulfilled their original objectives. With this in mind the climate vulnerability baseline uses long term climate projections for the period 2071 to 2089.

Methodology

Desk Study

9.4.3. The climate projections presented in this chapter are from United Kingdom Climate Projections 2018 (UKCP18). These projections have been developed by the Meteorological Office (Met Office) Hadley Centre Climate Programme which is supported by the Department for Business, Energy & Industrial Strategy (BEIS) and the Defra[7]. They provide the most up-to-date assessment of how the climate of the UK may change over the 21st century.

9.4.4. The baseline and impact assessment sections from the other assessment chapters also informs the climate vulnerability assessment.

[5] https://www.manchester.gov.uk/downloads/download/7523/climate_change_action_plan_2022_refresh

[6] Institute of Environmental Management and Assessment, 2020, IEMA Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020

[7] Met Office, UK Climate Projections (UKCP). Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

Determining sensitivity

9.4.5. Receptors have been identified using information gathered in the initial scoping exercise from the other assessment chapters of this ES.

9.4.6. In accordance with IEMA guidance, receptors considered include:

- Human health receptors (e.g., construction workers, occupants, and Site users)
- Environmental receptors
- Climatic systems
- Assets

9.4.7. Sensitivity, in relation to climate change vulnerability, for each receptor has been determined using quantifiable data such as the level of designation as well as professional judgement. In accordance with IEMA guidance in ascribing sensitivity the following have been considered:

- Susceptibility – ability for the receptor to be affected by climate change
- Vulnerability – potential exposure of receptor to climate change
- Value – importance of receptor

9.4.8. Susceptibility and vulnerability have been determined based on the criteria set out in the IEMA guidance and shown in Table 9-2 and Table 9-3. Criteria for defining a receptors value are set out in Table 9-4.

Table 9-2 – Guidance for determining susceptibility

Susceptibility	Criteria
High (Score: 4)	Receptor has no ability to withstand / not be substantially altered by the projected changes to the existing / prevailing climatic factors (e.g., lose much of its original function and form).
Medium (Score: 3)	Receptor has some limited ability to withstand / not be altered by the projected changes to the existing / prevailing climatic conditions (e.g., retain elements of its original function and form).
Low (Score: 2)	Receptor has the ability to withstand / not be altered much by the projected changes to the existing / prevailing climatic factors (e.g., retain much of its original function and form).
Negligible (Score: 1)	Receptor can withstand / not be altered by the projected changes to the existing / prevailing climatic factors (e.g., it will retain all of its original function and form).

Table 9-3 – Guidance for determining vulnerability

Vulnerability	Criteria
High (Score: 4)	Receptor is directly dependent on existing / prevailing climatic factors and reliant on these specific existing climate conditions continuing in the future (e.g., river flows and groundwater level) or only able to tolerate a very limited variation in climate conditions.
Medium (Score: 3)	Receptor is dependent on some climatic factors but is able to tolerate a range of conditions e.g., a species which has a wide geographic range across the entire UK but is not found in southern Spain.
Low (Score: 2)	Climatic factors have little influence on the receptor.
Negligible (Score: 1)	Climatic factors have no influence on the receptor.

Table 9-4 – Guidance for determining value

Value	Criteria
High (Score: 4)	High importance with regard to rarity (for example red list category species), diversity (internationally important), scientific value, educational value, or experience (e.g., untouched by encroachment or important within landscape or for recreation).
Medium (Score: 3)	Medium importance with regard to rarity (for example nationally designated), diversity (nationally important), scientific value, educational value, or experience (e.g., only slightly impacted by encroachment or important within nationally important landscape or for recreation).
Low (Score: 2)	Low importance with regard to rarity (for example locally or regionally designated), diversity (nationally important), scientific value, educational value, or experience (e.g., only slightly impacted by encroachment or important within nationally important landscape or for recreation).
Negligible (Score: 1)	Negligible importance with regard to rarity (e.g., not designated), diversity (not important), scientific value, educational value, or experience (e.g., Site already heavily impacted by encroachment or not important within landscape or for recreation).

9.4.9. The receptor's sensitivity is a combination of its vulnerability, susceptibility, and value score. It is determined by the sum of these scores and then categorising as follows:

- Score 0-4: Negligible
- Score 5-7: Low
- Score 8-9: Medium
- Score 10-12: High

Impact assessment

Determining impact magnitude

9.4.10. Due to the inherent uncertainty of future climate change predictions, a risk-based approach has been used to identify impact magnitude which considers a combination of the consequence of a climate change impact occurring and the probability of occurrence, both after mitigation.

9.4.11. The probability of a specific climate variable changing is determined using available data and professional judgement. The categories range from negligible through low and medium to high. When defining probability, consideration has been given to the projected return periods of future events (where known), and the confidence in the direction of projected changes.

9.4.12. The consequence of climate change impacts has been defined as shown in Table 9-5.

Table 9-5 – Criteria for determining impact consequence

Consequence	Criteria
High	▪ Consequences have very large economic cost or affect assets that are integral to critically important systems. ▪ Consequences cause very large safety risks (long term injury/illness or risk of fatality) or very poor performance (e.g., outage or quality problems lasting >48 hours). ▪ Consequences cause prolonged negative national reporting. ▪ Consequences cause very large environmental pollution or harm resulting in a major breach in compliance and prosecution or adversely affect internationally important species or habitat. ▪ Consequences occur many times during the life of the Proposed Development, e.g., could occur seasonally or last for many months/years.
Medium	▪ Consequences have a large economic cost or affect important systems. ▪ Consequences cause large safety risks (short term injury or illness) or poor performance (e.g., moderate outage or quality problems lasting <48 hours). ▪ Consequences cause negative regional media or social media. ▪ Consequences cause large environmental pollution or harm resulting in a regulatory non-compliance or affect nationally important species or habitat. ▪ Consequences occur more than once or lasting several months.
Low	▪ Consequences have a moderate economic cost or affect systems or assets that can be replaced. ▪ Consequences cause safety risks (minor harm or near miss) or slightly reduce performance (e.g., outage or quality problems lasting <1 hour). ▪ Consequences cause negative local media or adverse local stakeholder reaction. ▪ Consequences cause moderate environmental pollution or harm that may cause non-compliance of regional or local policy or affecting locally important species or habitat. ▪ Consequences occur once or last several weeks.
Negligible	▪ Consequences have little economic cost or affect individual assets and can be easily repaired or replaced. ▪ Consequences cause very small or no safety risks or reduced performance. ▪ Consequences have little or no public interest. ▪ Consequences have no statutory controls or cause negligible environmental pollution or harm to receptors of little or no importance. ▪ Consequences unlikely to occur during projects design life or lasts for only a few days.

9.4.13. The probability of potential climate changes and events occurring are determined using available data (extreme weather event recurrence intervals) and professional judgement, based on knowledge and experience of other similar schemes, guiding criteria are provided in Table 9-6.

Table 9-6 – Determining impact probability

Probability	Criteria
High	▪ The event occurs multiple times during the project lifetime (50 years) ▪ e.g., approximately annually, typically 50 events.
Medium	▪ The event occurs limited times during the project lifetime (50 years) ▪ e.g., approximately once every 12.5 years, typically 4 events.
Low	▪ The event occurs during the project lifetime (50 years) ▪ e.g., approximately once in 50 years.
Negligible	▪ The event is unlikely to occur during the project lifetime (50 years).

9.4.14. The impact magnitude is determined by considering the impact's consequence and probability in combination as shown in Table 9-7.

Table 9-7 – Determining impact magnitude

		Probability			
		High	**Medium**	**Low**	**Negligible**
Consequence	**High**	High	High	Medium	Low
	Medium	High	Medium	Low	Negligible
	Low	Medium	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible

Determination of significance

9.4.15. The significance of effect is determined by considering the relationship between the sensitivity of the receptor and the impact magnitude as shown in Table 9-8. Major or Moderate effects are deemed to be significant. Minor and Negligible effects are deemed to be not significant. Table 9-8 acts as a guide and professional judgement is used at each step to make a reasoned judgement on whether an effect is significant or not.

Table 9-8 – Determining significance of effect

		Impact magnitude			
		High	Medium	Low	Negligible
Receptor sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

9.4.16. Where Table 9-8 identifies more than one level of significance, (e.g., Major or Moderate), the most suitable significance of effect was determined based on professional judgement and knowledge of the type of impact and the receiving receptor.

Assumptions and limitations

9.4.17. The climate vulnerability assessment identifies potential impacts of climate change on the Proposed Development based on professional judgement.

9.4.18. The climate projections used are from UKCP18. The UKCP18 projections do not provide a single precise prediction of how weather and climate will change years into the future. Instead UKCP18 provides ranges that aim to capture a spread of possible climate responses. This better represents the uncertainty of climate prediction science.

9.4.19. The climate vulnerability assessment uses data from Relative Concentration Pathway (RCP) 8.5. This is a greenhouse gas concentration trajectory under which it is assumed that emissions continue to rise throughout the 21st century. There is considerable uncertainty regarding if, how far and how quickly emissions will be reduced in the future. Using RCP 8.5 represents a conservative position.

9.4.20. It should also be noted that the level of uncertainty of the projections is dependent on the climate variable, for example, there is greater confidence around changes in temperature than there is in wind.

9.4.21. Other limitations of UKCP18 data are presented on the Met Office website[8].

Consultation

9.4.22. A Scoping Report (ES Volume 5 Appendix 4.1) was submitted to MCC on 30th September 2024 with a formal request for an EIA Scoping Opinion in accordance with Regulation 15 of the EIA Regulations.

9.4.23. A summary of the key points raised in the EIA Scoping Opinion relevant to the Climate Vulnerability chapter are presented in ES Volume 5 Appendix 4.2, including a response as to where the comments have been addressed within this chapter.

9.5. Baseline conditions

9.5.1. The baseline for climate change vulnerability is presented in the following two parts:

- Current climatic conditions – an examination of the current climate
- Climate projections – a consideration of the forecast future climate

9.5.2. The full climate vulnerability baseline for both parts is included in ES (Volume 4) Appendix 9.1 – Climate Vulnerability Baseline and summarised in the following subsections.

Current climate

9.5.3. Data from the Met Office has been examined in order to summarise the current climate in the North West England River Basin. This stretches up the west coast from Stoke on Trent to Carlisle. The Met Office's standard average data tables are used to inform the current climate, these show the latest set of 30-year averages covering the period 1981-2010[9]. Context to this is provided within ES (Volume 4)

[8] Defra, BEIS, Met Office, Environment Agency, 2018, UKCP18 Guidance: Caveats and limitations. Available at: www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---caveats-and-limitations.pdf

[9] Met Office [online]. UK climate averages. Available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages

Appendix 9.1 by including comparison to the equivalent national dataset (UK minimum, average, and maximum).

9.5.4. The current baseline is presented in ES (Volume 4) Appendix 9.1 – Climate Vulnerability Baseline. In summary the current climate in the study area is one of relatively mild winters and warm summers. Monthly average temperatures in the North West are just above the mean for the UK whilst monthly mean maximum temperatures are close to the average. Long-term average monthly rainfall is close to average for the UK as is the number of heavy rainfall days in the study area.

9.5.5. With regards to storminess, across the UK there are no compelling trends over the last five decades, as determined by maximum gust speeds from the UK wind network[10].

9.5.6. Periods of prolonged rainfall can lead to widespread flooding, especially in winter and early spring when soils are usually near saturation. The autumn of 2000 was particularly wet, with over twice the normal rainfall in much of the Pennines, Greater Manchester and Cheshire. Widespread and severe flooding affected Cumbria in January 2005 and November 2009. The January 2005 floods in Carlisle were considered to be the worst to affect the city since 1822. On 19 November 2009, Seathwaite (Cumbria) reported 253 mm in 24 hours.

Projected future climate

9.5.7. Future projections are presented as averages for the 2080s based on climate projections running from 2071 to 2089. For temperature and precipitation seasonal averages are provided for summer and winter, which represent the most extreme changes in response to climate change. The projections are probabilistic, those plotted are for the central estimate (i.e., 50th percentile) and use the emissions scenario RCP8.5. This is the most extreme emissions scenario representing a future where greenhouse gas emissions continue to rise, and the nations of the world choose not to switch to a low carbon future. This is considered appropriate as it provides a precautionary view of possible future climate responses.

9.5.8. The projected future baseline is presented in ES (Volume 4) Appendix 9.1 – Climate Vulnerability Baseline. In summary North West England is likely to experience hotter and drier summers and warmer and wetter winters. Alongside these changes in average conditions, it is possible, but less certain, that climate change will also increase the frequency and severity of extreme weather events such as: heavy rainfall, storms, and heatwaves.

Receptors

9.5.9. Table 9-9 shows the receptors that have been considered in the climate vulnerability assessment and shows how their sensitivity has been derived.

Table 9-9 – Receptors

Receptor	Susceptibility	Vulnerability	Value	Sensitivity
Landscape assets – all planted vegetation and anything retained from the baseline	Medium (3)	Medium (3)	Medium (3)	Medium (9)
Materials	Low (2)	Low (2)	Low (2)	Low (6)

[10] Royal Meteorological Society (2020). State of the UK Climate 2019, July 2020. Available at: https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.6726 Last accessed: December 2020.

Receptor	Susceptibility	Vulnerability	Value	Sensitivity
Electrical equipment	Low (2)	Low (2)	Low (2)	Low (6)
Structures	Medium (3)	Medium (3)	High (4)	High (10)
Resilient water supply	High (4)	High (4)	High (4)	High (12)
Resilient energy supply	Medium (3)	Medium (3)	High (4)	High (10)
End users – access to the Site	Medium (3)	Low (2)	Medium (3)	Medium (8)

9.6. Potential impacts

9.6.1. Potential construction and operational phase impacts that have been assessed for climate vulnerability are set out in the following subsections.

9.6.2. The Site's inland position (>20km from the coast) means that sea level changes are not expected to affect the Site during its operation and this impact was therefore scoped out of further assessment for the Proposed Development.

Construction phase

9.6.3. Construction impacts associated with the current climate are not expected to occur unless construction coincides with extreme weather event(s) such as heatwaves, droughts or storms, the frequency, duration, and intensity of which can be linked to climate change.

9.6.4. Potentially significant construction climate vulnerability impacts are addressed by the relevant topics in this ES, for example:

- Polluted stormwater runoff could affect water environment receptors following extreme rainfall. Appropriate construction controls are identified in the ES (Volume 2) Chapter 19 Water Resources and Flood Risk to manage construction related flood risk effects; and
- Heatwaves and drought could intensify impacts on air quality receptors, e.g. increasing dust formation. Appropriate construction controls are considered in the ES (Volume 2) Chapter 7 Air Quality to manage dust suppression requirements which would increase during hot and dry weather.

9.6.5. As well as affecting environmental receptors extreme weather during construction could also create unsafe working conditions that delay the construction programme by, for example, stopping or slowing construction activities/processes, preventing or reducing access to the Site (e.g. due to flooding) or disrupting supply chains.

9.6.6. The ES (Volume 4) Appendix 4.1 Scoping Report (Section 21.3) considered potential impacts on the project from Major Accidents and Disasters. This included consideration of "Meteorological disasters, such as extreme weather events" and how non weather related accidents and disasters could be affected by, i.e. intensified by, extreme weather. The assessment followed IEMA guidance[11] and only identified flooding as a potentially significant adverse construction effect. Appropriate construction controls are identified in the Water Resources and Flood Risk Chapter of this ES (Chapter 19) to manage construction related flood risk effects.

[11] Institute of Environmental Management and Assessment (2020) Major Accidents and Disasters in EIA: A Primer [online]. https://www.iema.net/resources/blog/2020/09/23/iema-major-accidents-and-disasters-in-eia-primer

9.6.7. Accordingly extreme weather affects during construction are not considered further in this Chapter.

Operation phase

9.6.8. Climate change could impact the Proposed Development in eight ways. These impacts are described below and are grouped based on the broad receptor group they would affect; assets, utilities and end users.

Potential impacts from climate change and extreme weather that could affect the Proposed Developments asset's:

- **Impact 1 – Impacts on landscaping**

9.6.9. Changes to the climate could make the landscaping that is part of the Proposed Development less successful, for example by reducing plant health, changing irrigation or drainage requirements, increasing maintenance/management (longer growing season), increasing its vulnerability to pests (or by introducing new pests) or by negatively affecting its functionality/seasonal appeal and/or biodiversity value.

9.6.10. Extreme weather induced by climate change, particularly drought, could increase the risk of failure of newly planted vegetation. In severe cases it could cause tree mortality.

- **Impact 2 – Impacts on exposed materials**

9.6.11. Hotter summers could damage the Proposed Development's materials, for example by causing: rutting, shrinkage, fading, more extreme wetting and drying cycles (leading to accelerated asset deterioration) and/or overexpansion.

- **Impact 3 – Impacts on electrical equipment**

9.6.12. Potential extreme weather impacts on electrical equipment:

  - More regular and intense storms in the future could increase the regularity of lightning strikes on infrastructure which could damage electrical equipment.
  - Extreme hot temperatures increase thermal loadings on electrical and control equipment reducing their life.
  - Changes in humidity may affect reliability of electrical equipment (higher humidity increases condensation) which can lead to corrosion, e.g. rust, causing short circuits, premature deterioration of performance, overheating or even electrical fires.

- **Impact 4 – Impacts on soil stability**

9.6.13. Groundworks are proposed which will require embankments to create several changes in level across the Site. Climate change could adversely affect soil stability impacting embankments and structures on the Site. Potential impact pathways include:

  - The expected reduction in summer average rainfall is likely to intensify and extend soil moisture deficits and impact groundwater levels and earth pressures. This could impact soil stability, for example causing subsidence or increasing earth pressures.
  - Wetter winters could cause soil instability as heave causes the upward movement of the ground; usually associated with the expansion of clay soils which swell when wet.
  - Wetter winters and heavier rain could cause weakening or washout of structural soils.
  - Wetter winters may increase regularity of soil saturation and increase risk of embankment collapse, i.e., landslip.

Potential impacts from climate change and extreme weather that could affect the Proposed Developments utilities:

- **Impact 5 – Impacts on water supply resilience**

9.6.14. Regionally climate change will reduce future water availability. The Proposed Development will require water during operation and this water demand is likely to increase in the future as a result of climate change. Climate change will therefore cause the Proposed Development to contribute toward the increasing stress on regional water resources.

- **Impact 6 – Impacts on energy supply resilience**

9.6.15. The Site could be affected by more regular loss of power resulting from increasingly regular and intense extreme weather, such as storms with high wind.

Potential impacts that could affect the Proposed Developments end users:

- **Impact 7 – Impacts on flood risk**

9.6.16. Heavier rain and wetter winters could increase the risk of flooding. This could affect how the Site is accessed and used by end users. It could also directly damage Proposed Development assets.

9.6.17. The following potential impacts are assessed in ES (Volume 2) Chapter 19 with consideration of climate change:

  - Potential increase of surface water flood risk as a consequence of increase runoff rates and/ or volumes due to new impermeable surfaces or reduce capacity in the drainage network due to increase drainage.
  - Disturbance of groundwater flow paths where subsurface structures or deep foundations remain after construction, which may form a barrier to groundwater flow. This may result in groundwater emergence above surface, thus, increase surface water flood risk.
  - Permanent alteration and increase drainage to the existing drainage network via Shooters Brook culvert which discharges into the River Medlock. Changes

- **Impact 8 – Impacts on thermal comfort**

9.6.18. Hotter summers could affect users of the Proposed Development by exposing them to uncomfortably high temperatures that, in severe cases could result in health problems such as heat stroke.

9.7. Assessment of effects

Construction phase

9.7.1. As set out in Section 9.6 no further assessment of construction effects is required. They are considered by the other chapters in this ES. Embedded mitigation will also be captured by other chapters.

Operation phase

Embedded mitigation

9.7.2. During operation, mitigation will primarily be included as design modifications. Details of the proposed climate vulnerability mitigation are set out in below.

Embedded mitigation for potential impacts from climate change and extreme weather that could affect the Proposed Developments asset's:

- **Mitigation for impact 1 – Impacts on landscaping**
  - Planting mixes will be species diverse to increase overall resilience to climate change.
  - The mix will include drought tolerant species, whilst still having regard to the local character.
  - Plants will be planted in the winter season, to assist the establishment of stronger root systems and thus, enable the plants to better adapt to the drier summer months.
  - Maintenance will involve the replacement of plant species that don't thrive to maintain and enhance biodiversity on Site.

- **Mitigation for impact 2 – Impacts on exposed materials**
  - Best practice construction techniques.
  - Appropriate material quality standards to be followed to ensure the design lives specified can be met. An appropriate specification will be confirmed during detailed design.

- **Mitigation for impact 3 – Impacts on electrical equipment**
  - Type 2 surge protection which protects against overvoltage and indirect lighting strikes (i.e. nearby structures/ grid infrastructure).

- **Mitigation for impact 4 – Impacts on soil stability**

9.7.3. Risk will be managed by best practice design and construction.

9.7.4. The Ground Conditions and Contamination Chapter (Chapter 10) of this ES specifically addresses risks associated with ground stability. Control measures will include:

- The embankments will be designed through slope-stability analysis using Site specific soil parameters.
- Embankments will be compacted and constructed in line with best practice.
- Completing stability assessments as part of design.
- Undertaking an appropriate ground investigation.
- Design of the temporary and permanent works to minimise movement.
- Appropriate analysis to predict magnitude of movements; and
- Drainage will be included to avoid waterlogging around embankments.

Embedded mitigation for potential impacts from climate change and extreme weather that could affect the Proposed Developments utility requirements:

- **Mitigation for impact 5 – Impacts on water supply resilience**
  - Water required for the Proposed Development will be supplied by United Utilities who abstract it in accordance with abstraction licences from the Environment Agency.
  - United Utilities set out their plans for managing the regions water resource demands with consideration of population growth in their Water Resources Management Plan and have a detailed Drought Plan that sets out how they would mitigate against impacts from various drought scenarios.
  - Water efficiency measures such as water efficient fittings and appliances will be considered during detailed design.
  - Rainwater Harvesting has not been proposed however there is a potential at later design stages for rainwater harvesting due to the BREEAM aspirations for the development. At this stage rainwater harvesting has not been considered.

- There will be no formal irrigation system installed in the landscaping around the Proposed Development. By not having irrigation the Scheme's water demand is reduced - this will contribute to improving the resilience of water resources in the region.

- **Mitigation for impact 6 – Impacts on energy supply resilience**
  - Emergency power sources will be included in the detailed design if critical services / infrastructure are identified.
  - It is noted that the building will have solar panels with battery storage which may, subject to confirmation at a later design stage, be able to support the buildings power requirements in the event of a loss of power from the Grid.

Embedded mitigation for potential impacts that could affect the Proposed Developments end users:

- **Mitigation for impact 7 – Impacts on flood risk**

9.7.5. The Proposed Development has been designed to be resilient to the projected future changes to climate. Further information can be found in Chapter 17 (Water Resources and Flood Risk), the project's Drainage Strategy and in the project's FRA (Appendix 17.1). Key information is summarised below.

9.7.6. Surface water from the Proposed Development will discharge to the Shooters Brook culvert. However, in the event that the discharge to the culvert is not viable, after consideration of climate change factors, due to capacity issues, surface water will be discharged into the combined sewers.

9.7.7. The maximum permitted discharge rate from the Proposed Development will be limited, if possible, 'to the greenfield equivalent runoff rate for the Site for all rainfall events up to and including the 1% Annual Exceedance Probability (AEP) plus climate change event (45%). The storage to achieve this is also designed to provide the necessary flow attenuation for all rainfall events up to and including the 1% AEP + 45% climate change event.

- **Mitigation for impact 8 – Impacts on thermal comfort**

9.7.8. Buildings throughout the development are designed to achieve thermal comfort for users. Consideration has also been taken to incorporate daylight and views to the outside to promote user wellbeing.

9.7.9. Landscaping will wrap around the buildings which will themselves provide shade in different areas around the building throughout the day.

9.7.10. Chapter 11 (Daylight, Sunlight, Overshadowing and Solar Glare) assesses, with consideration of climate change, how the Proposed Development could affect the thermal comfort of users outside of the Site, for example by altering the baseline for glare.

Operation effects

9.7.11. Climate change could impact the Proposed Development during operation in eight ways and are grouped based on the broad receptor group they would affect; assets, utilities and end users as described above. Following the implementation of the embedded mitigation measures set out in Section 9.7.2 and other related ES chapters, none of the potential climate change operation impacts outlined in Section 9.6 are anticipated to be significant.

9.7.12. The following not significant residual effects can be expected:

- In extreme conditions some replanting of landscaping may be required.
- Exposed materials and electrical equipment may have increased maintenance requirements.
- Operational functionality of the Site may be affected during power cuts.

9.8. Additional mitigation and enhancement measures

9.8.1. No additional mitigation or enhancement in addition to that set out in Section 9.7 is required for any of the potential climate vulnerability impacts.

9.9. Residual effects

9.9.1. After implementing the embedded mitigation described above, residual effects are minimal to minor and not considered significant.

Residual effects of potential impacts from climate change and extreme weather that could affect the Proposed Developments asset's:

- During a drought landscaping would be sufficiently tolerant to cope with the conditions. However, in extreme conditions some replanting may be required.
- Exposed materials and electrical equipment may have increased maintenance requirements.

Residual effects of potential impacts from climate change and extreme weather that could affect the Proposed Developments utility requirements:

- Some of the operational functionality of the Site may be affected during power cuts but this would not affect critical systems and would quickly be restored after the outage.

Residual effects of potential impacts that could affect the Proposed Developments end users:

- Residual effects for flood risk are presented in Chapter 19 (Water Resources and Flood Risk).

9.10. Cumulative effects

9.10.1. This section considers the cumulative effects of the Proposed Development (intra-project cumulative effects) and the Proposed Development interacting with other RFFPs (inter-project cumulative effects) from the perspective of impacts within the scope of the Climate Vulnerability topic.

Cumulative effects assessment

9.10.2. The further consideration of cross-topic intra-project and inter-project cumulative effects is reported in Chapter 22: Cumulative Effects.

Intra-project in-combination cumulative effects assessment (single project impacts) within topic

9.10.3. The focus of intra-project CEA is understanding how receptors may experience a number of different types of impacts from the Proposed Development at the same time. Within this topic assessment, the methodology is inherently cumulative. The topic considers the combined impact of multiple effects relevant to the Proposed Development on a single receptor, for example, consideration is given to how climate change could intensify any of the impacts on environmental receptors that are reported by the other topic chapters within this report (also known as an in-combination Climate Change Impacts (ICCI) Assessment). Intra-project effects are also inherently considered when the topic gives consideration of

how future changes to multiple metrological variables could combine to affect receptors, for example how hotter and drier future summers could combine to intensify impacts.

9.10.4. On the basis of the above, there are no additional intra-project cumulative effects from the assessment of climate vulnerability to report in this section.

Inter-project cumulative effects assessment (different project impacts) within topic

9.10.5. The inter-project cumulative effects assessment 'within topic' element for the climate vulnerability assessment has been completed with reference to the shortlist list of RFFPs that has been developed for the Proposed Development. The list is based on a review of all developments known to the planning system using the methodology described in ES (Volume 2) Chapter 22: Cumulative Effects.

9.10.6. All RFFPs within the shortlist were assessed from the perspective of climate vulnerability.

9.10.7. No inter-project effects have been identified for climate vulnerability.

9.11. Summary and conclusions

9.11.1. This chapter presents the assessment of climate vulnerability effects associated with the construction and operation of the Proposed Development considering the impact of extreme weather and future climatic conditions.

9.11.2. The study area is currently exposed to extreme weather events and climate projections show that it is likely the current climate will change in the future; summers getting warmer and wetter and winters becoming hotter and drier.

9.11.3. An assessment following IEMA Guidance that is presented in Table 9-10 shows that after consideration of mitigation, which is primarily embedded into the design, climate change will neither worsen the effects of the Proposed Development to result in significant adverse effects or create new significant effects.

Table 9-10 – Summary of effects

Resource / Receptor / affected group	Sensitivity of receptor	Activity or impact	Embedded design mitigation	Effect Magnitude Type Spatial extent Duration Likelihood	Significance of effect	Additional mitigation	Residual effect
Operation							
Landscaping assets (particularly newly planted vegetation)	Medium	Damage to the Proposed Development's landscaping.	Planting mixes will be species diverse to increase overall resilience to climate change and shall be planted over the winter.	Adverse Minor Direct Local Permanent Unlikely	Not Significant	N/A	Not Significant
Materials	Low	Damage to the Proposed Development's materials	Implementation of best practice construction techniques and appropriate material quality standards	Adverse Minor Direct Local Permanent Unlikely	Not Significant	N/A	N/A
Electrical equipment	Low	Reduction in the lifespan of electrical equipment	The inclusion of Type 2 surge protection measures which protect against overvoltage and indirect lighting strikes	Adverse Negligible Direct Local Permanent Unlikely	Not Significant	N/A	Not Significant
Structures	High	Soil instability affecting structures and embankments and potentially increasing maintenance requirements.	Best practice design and construction. Chapter 10 (Ground Conditions and Contamination) includes measures e.g. embankment design slope-stability analysis	Adverse Minor Direct Local Permanent Unlikely	Not Significant	N/A	N/A
Utilities – Resilience of water supply	High	Increased stress on regional water resources.	United Utilities abstraction licenses, WRMP and Drought Plan. Water efficient fittings and appliances.	Adverse Negligible Indirect Local Permanent Unlikely	Not Significant	N/A	N/A
Utilities – Resilience of energy supply	High	Loss of energy supply and power from increasing extreme weather.	Emergency power sources will be included in the detailed design if critical services / infrastructure are identified. Inclusion of solar panels on building roof.	Adverse Minor Direct Local Temporary Unlikely	Not Significant	N/A	Not Significant
End users – Access to the Site, includes maintenance staff (flooding could also directly damage ground level assets)	Medium	Increased risk of pluvial or surface flooding.	Flood risk assessment and other measures part of Chapter 17 (Water Resources and Flood Risk). Project drainage strategy.	Adverse Minor Direct Local Temporary Unlikely	Not Significant	N/A	Re Chapter 19 (Water Resources and Flood Risk).

End users – Thermal comfort	Medium	User exposed to high temperatures resulting in health issues	Building design to achieve thermal comfort and promote user wellbeing. Chapter 11 (DSO and Solar Glare) assesses, with consideration of climate change the thermal comfort of users outside of the Site.	Adverse Negligible Direct Local Permanent Unlikely	Not Significant	N/A	N/A

9.12. Glossary and Acronyms

Table 9-11 – Glossary and acronyms

Term	Definition
BEIS	Department for Business, Energy & Industrial Strategy
BREEAM	Building Research Establishment Environmental Assessment Methodology
Climate Risk Assessment	Climate Risk Assessment
ES	Environmental Statement
FRA	Flood Risk Assessment
F-RGS	Fellowship of the Royal Geographical Society
GHG	Green House Gas
ICCI	In-Combination Climate Change Impact
IEMA	Institute of Environmental Management and Assessment
IES	Institute of Environmental Sciences
M.CIWEM	Member of the Chartered Institution of Water and Environmental Management
RCP	Relative Concentration Pathway (future scenarios for GHG emissions)
RFFP	Reasonably Foreseeable Future Projects
UKCP18	United Kingdom Climate Projections 2018 - the most up-to-date assessment of how the climate of the UK may change over the 21st century.
UK	United Kingdom

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