

APPENDIX 3-A: CLIMATE CHANGE RESILIENCE RISK ASSESSMENT

1.1 INTRODUCTION

- 1.1.1 Schedule 4, Clause 5(f) of the Town and Country Planning (EIA) Regulations 2017 notes information should be included in the ES on the likely significant effects of the development on the environment resulting from the vulnerability of the project to climate change.
- 1.1.2 In line with the Institute of Environmental Management and Assessment (IEMA) EIA Guide to Climate Change Resilience and Adaptation (IEMA, 2020), there are two key strands to assessing climate change resilience and adaptation issues within EIA, as outlined below:
- The risks of changes in the climate to the project (i.e., the resilience or conversely the vulnerability of a project to future climate changes). The IEMA (2020) guidance states that this is generally best reported in the analysis of alternatives and it is better suited to a risk assessment type process than traditional EIA 'determination of significance'. This climate change resilience risk assessment has therefore been completed for the proposed development and appended to the Environmental Statement; and
 - The extent to which climate exacerbates or ameliorates the effects of the project on the environment (i.e., 'in-combination' effects). The IEMA (2020) guidance states that this is best analysed in the existing chapters of the ES and is suited to using traditional significance criteria from the respective chapters. Therefore, this has been included in each of the technical ES chapters and completed by each technical specialist.

1.2 METHODOLOGY AND ASSESSMENT CRITERIA

Risk assessment

- 1.2.1 This climate change resilience risk assessment has been undertaken in line with the IEMA (2020) guidance. The methodology has been adapted from the C40 Cities Climate Change Risk Assessment Guidance (2018), the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Climate Risk Assessment Methodology (2015) and the Highways England Design Manual for Roads and Bridges Sustainability & Environmental Appraisal. Risk has been assessed based on the probability of an event occurring and severity of consequences as a result of that event occurring.
- 1.2.2 A baseline risk assessment has been undertaken that assesses the probability and consequence of climatic risks occurring considering current climatic conditions. A second risk assessment has then been undertaken to assess the change in probability and consequence of climatic risks as a result of future climate change.

Probability

- 1.2.3 Table 1 summarises the criteria utilised to determine the likelihood rating for an effect. The project lifetime includes both the construction and operation stages. The project lifetime is considered to be 60 years.

Table 1 Criteria used to determine likelihood

Score	Description (probability and frequency of occurrence)
1	The event occurs very rarely during the lifetime of the project (60 years). For example, once every 60 years (1 event).
2	The event occurs a limited number of times during the lifetime of the project (60 years). For example, once every 25 years (2-3 events).
3	The event occurs regularly during the lifetime of the project (60 years) For example, once every 2-5 years (12-30 events).

Score	Description (probability and frequency of occurrence)
4	The event occurs frequently during lifetime of the project (60 years). For example, once per year (60 events).
5	The event occurs very frequently during the lifetime of the project (60 years). For example, multiple times per year (more than 60 events).

Consequence

- 1.2.4 Table 2 summarises the criteria used to determine the consequence rating for effects relating to a climate risk. Consequence has been determined based on the extent to which the climate risk may impact on the amenity value and function of the proposed development. The amenity value is the positive element or elements that contribute to the overall character or enjoyment of the proposed development. The function is the extent to which the proposed development meets the purpose or purposes that it is designed to fulfil (i.e., a place for residents to live).

Table 2 Criteria used to determine consequence

Score	Description
1	Very low but measurable effect on site users and the proposed development itself. Slight negative change in amenity value of the proposed development and slight negative change in function.
2	Low but measurable effect on site users and the proposed development itself. Low negative change in amenity value of the proposed development and slight negative change in function.
3	Moderate effect on site users and the proposed development itself. Moderate negative change in amenity value of the proposed development and slight negative change in function.
4	Moderate effect on site users and the proposed development itself. Major negative change in amenity value of the proposed development and low negative change in function.
5	Moderate effect on site users and the proposed development itself. Major negative change in amenity value of the proposed development and moderate negative change in function.
6	Major effect on site users and the proposed development itself. Major negative change in amenity value of the proposed development and major negative change in function.
7	Extreme effect on site users and the proposed development itself. Loss of asset.

Risk rating

- 1.2.5 Table 3 summarises the matrix used to determine the risk rating, based on probability of the event occurring and the consequences as a result of the event occurring.

Table 3 Risk rating determined based on the likelihood and consequence scores

Consequence	Probability					
		1	2	3	4	5
1	1	1	2	3	4	5
2	2	2	4	6	8	10
3	3	3	6	9	12	15
4	4	4	8	12	16	18
5	5	5	10	15	20	25
6	6	6	12	18	24	30
7	7	7	14	21	28	35

	Low risk
	Medium risk
	High risk

National legislation and policy

1.3.1 Schedule 4, Clause 5(f) of the UK EIA Regulations state that the Environmental Statement should include:

‘a description of the likely significant effects of the development on the environment resulting from, inter alia... (f) the impact of the project on climate (for example the nature and magnitude of GHG emissions) and the vulnerability of the project to climate change’.

National Planning Policy Framework (NPPF) (MHCLG), 2021

'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.'

1.3.4 Section 56 requires the UK Government to undertake a Climate Change Risk Assessment (CCRA) on a five-yearly cycle, with the subsequent development of an adaption programme to deliver resilience against these risks. The Act stipulates that the Government must assess 'the risks for the United Kingdom from the current and predicted impacts of climate change'.

- Flooding and coastal change risks to communities, businesses and infrastructure;
- Risks from health, well-being and productivity from high temperatures;
- Risks of shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology;

- Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity;
- Risks to domestic and international food production and trade; and
- New and emerging pests and diseases, and invasive non-native species, effecting people, plants and animals.

1.3.6 The second and most recent National Adaptation Programme sets out government's response to the second CCRA, showing the actions government is, and will be, taking to address the risks and opportunities posed by a changing climate. This breaks down the likely risks associated with climate change into the same six categories as those set out in the CCRA, which is outlined above.

1.3.7 Although this plan is yet to be adopted, the consultation period has finished, with there being a publication stage version released in August 2021. This plan includes the following objective in relation to climate change resilience:

- ## Policy JP-S 4 – Resilience

"Development will be managed so as to increase considerably the capacity of its citizens, communities, businesses and infrastructure to survive, adapt and grow in the face of physical, social, economic and environmental challenges, including climate change. Key measures will include:

- *Ensuring that developments make appropriate provision for the response and evacuation in the case of an emergency or disaster;*
- *Providing adaptable buildings and places that can easily respond to changing needs, future climate impacts and new technologies;*
- *Designing indoor and outdoor environments to provide a reduction and respite from more extreme temperatures and winds associated with climate change and greater urbanisation;*
- *Increasing the size, spread, quality and interconnectedness of the green infrastructure network, enabling the city region, its citizens and wildlife to adapt to changing conditions;*
- *Taking an integrated catchment-based approach to managing flood risk."*

1.3.9 Policy JP-S 5 – Flood Risk and the Water Environment states the following:

"An integrated catchment based approach will be taken to protect the quantity and quality of water bodies and managing flood risk by:

- *Locating and designing development so as to minimise the impacts of current and future flood risk, including retrofitting or relocating existing developments, infrastructure and places to increase resilience to flooding”*

Policy JP-G 2 – Green Infrastructure Network

1.3.10 Policy JP-G 2 – Green Infrastructure Network states the following:

“A strategic approach will be taken to the protection, management and enhancement of our Green Infrastructure in order to protect and enhance the ecosystem services which the ‘Green Infrastructure Network’ provides, including flood management, climate change mitigation and adaptation.

Manchester's Local Development Framework Core Strategy Development Plan Document (MCC, 2012)

1.3.11 The Core Strategy was adopted in July 2012, and includes the following Spatial Objectives (SO) and Policies relevant to climate change resilience and adaptation:

SO 1: Spatial Principles

1.3.12 SO 1: Spatial Principles states the following:

“Provide a framework within which the sustainable development of the City can contribute to halting climate change.

Within the context of mitigation and adaptation to climate change, the framework will guide the scale and distribution of economic, housing, transport, environmental, health, education and other service and infrastructure development across the City.”

SO 6: Environment

1.3.13 SO 6: Environment states the following:

“Protect and enhance both the natural and built environment of the City and ensure the sustainable use of natural resources, in order to mitigate and adapt to climate change, support biodiversity and wildlife, improve air, water and land quality, recreational opportunities and provide networks of high quality green infrastructure, ensuring that the City is inclusive and attractive to residents, workers, investors and visitors.”

Policy EC 1: Employment and Economic Growth in Manchester

1.3.14 Policy EC 1: Employment and Economic Growth in Manchester states the following:

“Development proposals should have regard to:

- *Climate change resilience demonstrating how CO₂ emissions will be minimised with an aim of zero carbon emissions, through energy efficiency, renewable energy and contributing to low and zero carbon decentralised energy infrastructure;*
- *Ensuring design makes the best possible use of a site or building in terms of efficient use of space, enhancing the sense of place of the wider area and minimising detrimental impacts on adjacent uses, considers the needs of users/employees of a site/building for access via walking, cycling and public transport and reduction of opportunities for crime by applying current best practice in security design;*
- *Flood risk through the Manchester- Salford- Trafford Strategic Flood Risk Assessment (SFRA).”*

Policy C 2: District centres

1.3.15 Policy C 2: District centres states the following:

“New development should deliver improvements to the quality and accessibility of the centre environment. Opportunities should be taken to adopt sustainable building design and practises to assist in adapting to climate change.”

Policy EN 6: Target Framework for CO₂ reductions from low or zero carbon energy supplies

1.3.16 Policy EN 6: Target Framework for CO₂ reductions from low or zero carbon energy supplies states the following:

“Developers will be permitted to use green infrastructure elements such as green roofs, green walls, street trees and waterways to contribute to compliance with CO₂ mitigation, subject to the energy statement incorporating evidence such as modelling to demonstrate compliance. ”

Policy EN 8: Adaptation to Climate Change

1.3.17 Policy EN 8: Adaptation to Climate Change states the following:

“All new development will be expected to be adaptable to climate change in terms of the design, layout, siting and function of both buildings and associated external spaces. In achieving developments which are adaptable to climate change developers should have regard to the following, although this is not an exhaustive list:

- *Minimisation of flood risk by appropriate siting, drainage, and treatment of surface areas to ensure rain water permeability*
- *Reduction in urban heat island effect through the use of Green Infrastructure such as green roofs, green walls, increased tree cover and waterways*
- *The need to control overheating of buildings through passive design*
- *The opportunity to provide linked and diverse green space to enhance natural habitats which will assist species adaptation*

Developers will be permitted to use green infrastructure elements such as green roofs, green walls, street trees and waterways to contribute to compliance with CO₂ mitigation under Policy EN6, subject to sufficient evidence to quantify their contribution to compliance.”

Policy EN 9: Green Infrastructure

1.3.18 Policy EN 9: Green Infrastructure states the following:

“New development will be expected to maintain existing green infrastructure in terms of its quantity, quality and multiple function. Where the opportunity arises and in accordance with current Green Infrastructure Strategies the Council will encourage developers to enhance the quality and quantity of green infrastructure, improve the performance of its functions and create and improve linkages to and between areas of green infrastructure. Where the benefits of a proposed development are considered to outweigh the loss of an existing element of green infrastructure, the developer will be required to demonstrate how this loss will be mitigated in terms of quantity, quality, function and future management.

Key features of Manchester's green infrastructure will include:

- *The continued development of a network of green spaces, water bodies, canals, paths and cycleways, with priority given to those parts of the City where there is an identified existing lack of open space. The Council will seek to protect existing street trees and promote new planting, particularly where this can enhance green links in the urban area.*

- The continued maintenance and management of the Rivers Mersey and Irwell and their tributaries, for example the River Irk, River Medlock, Chorlton Platt Gore, Gatley Brook, Moston Brook and adjoining land, with regard to their multiple functions including recreation, flood management, and biodiversity.
- The provision of new, and improvements to the quality and accessibility of existing green infrastructure assets, to mitigate for any loss of green infrastructure as a result of development such as the Metrolink extension programme.
- The encouragement of green roofs, green walls, tree planting and other forms of green infrastructure to allow for the adaption to climate change in heavily urbanised areas.

New green infrastructure provision should be an exemplar of best practice and innovation in terms of both its design and management."

Policy EN 14: Flood risk

1.3.19 Policy EN 14: Flood risk states the following:

"In line with the risk-based sequential approach contained within PPS25, development should be directed away from sites at the greatest risk of flooding, and towards sites with little or no risk of flooding; this should take account of all sources of flooding identified in the Manchester-Salford-Trafford Strategic Flood Risk Assessment (SFRA).

In addition to the requirements for site-specific Flood Risk Assessments (FRAs) set out in PPS25, an appropriate FRA will also be required for all development proposals, including changes of use, on sites greater than 0.5ha within Critical Drainage Areas (CDAs) and Canal Hazard Zones identified in the SFRA.

All new development should minimise surface water run-off, including through Sustainable Drainage Systems (SUDS) and the appropriate use of Green Infrastructure. Developers should have regard to the surface water run-off rates in the SFRA User Guide. In CDAs, evidence to justify the surface water run-off approach / rates will be required.

The City of Manchester contains many sections of rivers which are culverted or 'hidden'; where these are indicated in the SFRA beneath the proposed development site, further investigation will be required and the development proposal should take this into account; where feasible and appropriate development should seek to open up culverted/hidden rivers to reduce the associated flood risk and danger of collapse, taking advantage of opportunities to enhance biodiversity and Green Infrastructure."

Policy PA 1: Developer Contributions

1.3.20 Policy PA 1: Developer Contributions states the following:

"Where needs arise as a result of development, the Council will seek to secure planning obligations in line with Circular 5/2005, Community Infrastructure Levy regulations or successor regulations/guidance. Through such obligations, the Council may seek contributions for the following with priority assessed on a site by site basis:

- Provision of Green Infrastructure including open space
- Protection or enhancement of environmental value
- Climate change mitigation / adaptation"

Manchester City Council Climate Change Action Plan 2020-2025

1.3.21 Purpose of the plan:

"The document sets out MCC's commitments to tackling climate change over the next 5 years and builds on previous action plans over the last decade

It covers MCC's plans for adapting to the expected impacts of climate change and supporting and influencing others, including through the implementation of the Manchester Green and Blue Infrastructure Strategy 2015-2025"

1.3.22 Recommended targets and objectives:

"To adapt the city's buildings, infrastructure and natural environment to the changing climate and to increase the climate resilience of our residents and organisations.

To improve the health and wellbeing of everyone in Manchester through actions that also contribute to our objectives for CO₂ reduction and adaptation and resilience, with particular focus on those most in need.

To ensure that Manchester establishes an inclusive, zero carbon and climate resilient economy where everyone can benefit from playing an active role in decarbonising and adapting the city to the changing climate."

"We recognise that limiting CO₂ emissions is not enough. Depending on how successful the world is at reducing emissions, global temperatures by 2100 are likely to rise by between 1.5°C and 4°C above pre-industrial levels. As such, we need to accept that some level of change is inevitable. Climate change is happening now and we need to assess the risks to our communities in order to reduce their vulnerability to these changes. Adopting appropriate mitigation measures will be essential if we are to create resilient communities of the future in Manchester."

1.3.23 Adaptation to Climate Change

"Despite the increased international efforts to tackle climate change, we recognise that the world's climate is already changing and that adaptation is required to protect the city's people. We are committed to ensuring that climate change adaptation, including green and blue infrastructure, is included in new developments and across Council owned buildings and land.

Further work needs to be done at a local level through ward plans and neighbourhoods to adapt to make communities more resilient to climate change. This will form part of the Council's work through Neighbourhoods Teams, Highways and also through the development of improved communication information and guidance."

1.3.24 Citywide emissions

"The Council also recognises the importance of supporting and influencing our residents and organisations to take action to reduce their direct and indirect CO₂ emissions and to adapt to the changing climate."

1.3.25 What is included in the 2020-2025 Action Plan?

"This action plan details the activity that we will undertake over the next five years but also includes activities that will need to be developed and investigated further in order to ensure that we are on the right path to being zero carbon by 2038. The actions include activities to deliver a reduction in emissions from energy, transport and consumption (mitigation) but also adaptation and promoting investment in nature based solutions and green infrastructure."

Manchester Climate Change Framework 2020-2025

- 1.3.26
- The Manchester Climate Change Framework 2020-25 is the city’s high-level strategy for tackling climate change. It sets out how Manchester will ‘play its full part in limiting the impacts of climate change’, a commitment in the Our Manchester Strategy 2016-25.
- 1.3.27
- The objectives and targets are set out below:
 - ‘Staying within our carbon budgets – based on recommendations by the Tyndall Centre for Climate change Research in 2020
 - Climate adaptation and resilience
 - Health and wellbeing; and
 - Inclusive, zero carbon and climate resilient economy’
- 1.3.28
- Areas for action to meet objectives and targets include the following:
 - ‘Buildings (existing and new)’; and
 - ‘Green infrastructure and nature-based solutions’

Manchester Green and Blue Infrastructure Strategy 2015-2025

- 1.3.29
- Green and blue infrastructure can provide multiple social economic and environmental benefits.
- 1.3.30
- Actions include:
 - ‘Investment in river valleys and canals to restore biodiversity value and flood resilience’;
 - ‘Embed green infrastructure as part of residential and city centre developments’; and
 - ‘Smaller scale green infrastructure in Central Manchester such as tree planting and community greening have the potential for increasing an areas climate resilience’

Climate Emergency Declaration

Manchester City Council Climate Emergency Declaration – 10th July 2019

“This Council agrees to:

- Declare a Climate Emergency.
- Continue working with partners across Manchester and GMCA to deliver the 2038 target, and determine if an earlier target can be possible, through a transparent and open review. Become carbon neutral by the earliest possible date.
- Encourage involvement in all wards by April 2020 through meetings as part of the Our Manchester strategy, to identify residents and partners who want to be actively involved in achieving the target, with provision for those who cannot attend. Ensure ward plans contain specific, measurable, achievable steps.
- Review all policies, processes and procedures to ensure the council can become carbon neutral. Present an action plan by March 2020 detailing how the city can stay within its carbon budget. Report back regularly to the NESC. Review the corporate plan.

- Work with the Tyndall Centre to review the actual emissions from aviation. Investigate the best way to include aviation in our overall carbon reduction programme in the long term.
- Make climate breakdown and the environment, an integral part of activity throughout the Council, including all decision making, ensuring key decisions take into account the impact on achieving the zero-carbon target and including an environmental impact assessment in all relevant committee reports.
- Ensure that everyone in the council receives carbon literacy training by the end of 2020. Make attendance easier by varying times and length of sessions.
- Encourage all staff on council business to use the lowest carbon, appropriate, travel
- Investigate measures to ensure future procurement is carbon neutral. Increase the percentage of social value with an additional environmental element.
- Work with suppliers to green their supply chains, and support local production.
- Work with training providers to ensure Manchester residents can take on green jobs.
- Investigate and introduce measures to help reach domestic zero carbon levels including addressing fuel poverty and retrofitting existing homes.
- Investigate ways to ensure that future local plans place a mandatory requirement for all new development to be net zero carbon by the earliest possible date.
- Push GMCA to decarbonise public transport, heat and energy as early as possible.
- Through our role on GMPF, encourage divestment in fossil fuels as early as possible.
- Call the government to:
 - Provide powers and resources to make the zero-carbon target possible including funding for big capital projects
 - Accelerate the reduction of carbon emissions from aviation
 - Accelerate the decarbonisation of the electricity grid, funding low carbon energy generation
 - Ensure that the UK prosperity fund focuses on enable the transition to a low carbon economy”

Guidance documents

IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA, 2020)

- 1.3.31
- This document acts as a revision to the IEMA guidance on Climate Resilience and Adaptation in EIA (2015) and reflects lessons learnt from emerging practice. It provides a framework for the effective consideration of climate change resilience and adaptation in the EIA process.
- ISO 14090:2019 Adaptation to Climate Change – Principles, Requirements and Guidelines (BSI, 2019)
- 1.3.32
- The main purpose of this standard is to provide organisations and projects with a consistent, structured and pragmatic approach to prevent or minimise the harm that climate change could cause and also to take advantage of opportunities.

C40 Cities Climate Change Risk Assessment Guidance (C40 Cities, 2017)

- 1.3.33 This document aims to provide a concise, easy-to-read guidance, to help cities to develop a climate risk assessment report. It provides the methodology and components of the assessment, as well as providing a comprehensive list of possible effects relating to climate change.

1.4 CURRENT BASELINE CONDITIONS

- 1.4.1 Table 4 provides a summary of the current baseline climatic conditions, taken from Rochdale weather station, approximately 14.5km to the north east of the proposed development, this being the nearest weather station. The data provides average historic average climatic conditions for 1981-2010. The monthly mean minimum/maximum temperatures are calculated from the average of the daily maximum and daily minimum temperatures for each month. The warmest month on average was August and the coolest month on average was February. The wettest month on average was December and the driest month on average was May. The sunniest month on average was July and the least sunny month on average was December.

Table 4 Summary of historic average climatic conditions for 1981-2010 taken from the Rochdale Met Office monitoring station.

Month	Mean daily maximum temperature (degrees C)	Mean daily minimum temperature (degrees C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)
January	6.58	1.12	10.27	31.47	112.17
February	6.82	0.96	11	47.01	82.95
March	9.11	2.6	6.23	91.28	92.24
April	11.8	3.98	2.87	143.25	70.47
May	15.27	6.92	0.5	169.9	62.78
June	17.78	9.6	0	143.01	77.85
July	19.7	11.76	0	167.97	79.69
August	19.45	11.53	0	153.08	91.75
September	16.76	9.55	0.03	115.66	92.57
October	13.03	6.64	1.5	80.57	119.28
November	9.26	3.52	5.13	41.82	114.53
December	6.76	1.11	10.87	27.42	122.27

1.5 IDENTIFICATION AND EVALUTION OF BASELINE RISKS

- 1.5.1 In order to provide a baseline, risks relating to the proposed development have been assessed against current baseline weather patterns (i.e. those set out in section 1.4 of this report). Table 7 provides a list of potential risks, as adapted from the C40 Cities Climate Change Risk Assessment Guidance (C40 Cities, 2017). The inclusion of certain risks in the assessment is based on availability of data and relevance of the risk to the proposed development. Probability and consequence ratings have been given to these risks, thereby generating a risk rating based on Table 3. The probability and consequence ratings outlined in Table 5 are pre-mitigation.

Table 5 Climate change risks based on C40 Cities Climate Change Risk Assessment Guidance

Risk	Is it relevant for the proposed development?	Probability rating (1-5)	Likely consequences of climate risk occurring	Consequence rating (1-7)	Risk rating
Rainstorm	Yes	5	Damage and degradation of building materials through wetting and impact from rainfall. Discomfort for users of the proposed development.	1	5
Monsoon	No	N/A	N/A	N/A	N/A
Heavy snow	Yes	3	Damage to building materials (e.g. roofs). Discomfort and potential injury to	2	6

Risk	Is it relevant for the proposed development?	Probability rating (1-5)	Likely consequences of climate risk occurring	Consequence rating (1-7)	Risk rating
			users of the proposed development.		
Fog	Yes	6	Increased risk of accidents as a result of impaired vision.	1	6
Hail	Yes	4	Discomfort for users of the proposed development.	1	4
Severe wind	Yes	3	Damage to building materials. Discomfort and potential injury to users of the proposed development.	4	12
Tornado	No	N/A	N/A	N/A	N/A
Hurricane	No	N/A	N/A	N/A	N/A
Extra tropical storm	Yes	3	Damage to building materials. Discomfort and potential injury to users of the proposed development.	4	12
Tropical storm	No	N/A	N/A	N/A	N/A
Storm surge	No	N/A	N/A	N/A	N/A
Lightning	Yes	4	Potential damage to building materials. Injury to users of the proposed development unlikely but possible.	1	4
Extreme winter conditions	Yes	4	Damage to building materials (e.g. pipes bursting). Discomfort and potential injury to users of the proposed development.	3	12
Cold wave	Yes	4	Damage to building materials (e.g. pipes bursting). Discomfort and potential injury to users of the proposed development.	3	12
Extreme cold days	Yes	4	Damage to building materials (e.g. pipes bursting). Discomfort and potential injury to users of the proposed development.	3	12
Heat waves	Yes	3	Damage and degradation to building materials. Extended period of overheating in building affects comfort and health of occupants.	5	15
Extreme hot days	Yes	4	Damage and degradation to building materials. Intense overheating in building affects comfort and health of occupants.	4	16
Drought	Yes	3	Potential damage to building foundations in areas with clay soils. Health of flora and fauna on the site affected.	4	12
Forest fire	No	N/A	N/A	N/A	N/A
Land fire	No	N/A	N/A	N/A	N/A
Flash/surface flood	Yes	3	Damage to buildings and contents. Potential injury to users of the proposed development.	6	18
River/tidal flood	Yes	2	Damage to buildings and contents. Potential injury to users of the proposed development.	6	12
Groundwater flood	Yes	2	Damage to buildings and contents. Potential injury to users of the proposed development.	6	12
Permanent inundation	No	N/A	N/A	N/A	N/A
Salt water intrusion	No	N/A	N/A	N/A	N/A
Ocean acidification	No	N/A	N/A	N/A	N/A
Landslide	No	N/A	N/A	N/A	N/A
Avalanche	No	N/A	N/A	N/A	N/A

Risk	Is it relevant for the proposed development?	Probability rating (1-5)	Likely consequences of climate risk occurring	Consequence rating (1-7)	Risk rating
Rock fall	No	N/A	N/A	N/A	N/A
Subsidence	Yes	1	Damage to building materials. Potential injury to users of the proposed development.	6	6
Water-borne disease	Yes	1	Potential illness to users of the proposed development.	3	3
Vector borne disease	Yes	1	Potential illness to users of the proposed development.	4	4
Airborne disease	Yes	1	Potential illness to users of the proposed development.	3	3
Insect infestation	Yes	1	Potential illness to users of the proposed development.	3	3

1.6 LIKELY EFFECTS OF CLIMATE CHANGE

1.6.1 The UK Climate Projections 2018 (UKCP18) (Met Office, 2018) provide the most up-to-date assessment of how the climate of the UK may change over the 21st century. UKCP18 uses Representative Concentration Pathways (RCPs). These are named according to the concentration of greenhouse gas modelled to occur in the atmosphere in 2100. There are four RCPs available in the UKCP18 climate projections: RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. In line with the IEMA (2020) guidance, RCP 8.5 has been used, which represents the most conservative, highest-impact scenario. Table 6 summarises the projected summer and winter mean temperature and precipitation changes up to the 2090s for RCP 8.5.

Table 6 UKCP18 data for the north west of the UK under RCP 8.5

Season	Variable	Time Period	Projected Change At		
			10 th percentile	50 th percentile	90 th percentile
Winter	Mean temperature (°C)	2020 - 2039	-1 to 0	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3
		2060 - 2079	0 to 1	2 to 3	4 to 5
		2080 – 2099	1 to 2	3 to 4	5 to 6
	Mean precipitation change (%)	2020 - 2039	-10 to 0	0 to 10	10 to 20
		2040 - 2059	-10 to 0	0 to 10	10 to 20
		2060 - 2079	-10 to 0	10 to 20	20 to 30
		2080 – 2099	0 to 10	10 to 20	30 to 40
	Mean daily maximum temp change compared to 1981-2000	2020 - 2039	-1 to 0	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3
		2060 - 2079	0 to 1	2 to 3	4 to 5
		2080 – 2099	1 to 2	3 to 4	5 to 6
	Mean daily minimum temp change compared to 1981-2000	2020 - 2039	-1 to 0	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3
		2060 - 2079	0 to 1	2 to 3	4 to 5
		2080 – 2099	1 to 2	3 to 4	5 to 6
Summer	Mean temperature (°C)	2020 - 2039	0 to 1	1 to 2	1 to 2
		2040 - 2059	0 to 1	1 to 2	3 to 4
		2060 - 2079	0 to 1	3 to 4	5 to 6
		2080 – 2099	1 to 2	4 to 5	7 to 8
	Mean precipitation change (%)	2020 - 2039	-30 to -20	-10 to 0	10 to 20
		2040 - 2059	-40 to -30	-20 to -10	0 to 10
		2060 – 2079	-60 to -50	-30 to -20	-10 to 0
		2080 – 2099	-70 to -60	-40 to -30	-10 to 0
	Mean daily maximum temp change compared to 1981-2000	2020 - 2039	0 to 1	1 to 2	2 to 3
		2040 - 2059	0 to 1	2 to 3	4 to 5
		2060 - 2079	0 to 1	3 to 4	6 to 7
		2080 – 2099	1 to 2	5 to 6	8+
	Mean daily minimum temp change compared to 1981-2000	2020 - 2039	0 to 1	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3
		2060 - 2079	1 to 2	2 to 3	4 to 5
		2080 – 2099	1 to 2	4 to 5	5 to 6

1.6.2 According to UKCP18 data, over land the projected general trends of climate changes in the 21st century show a move towards warmer, wetter winters and hotter, drier summers. However, natural variations mean that some cold winters, some dry winters, some cool summers and some wet summers will still occur.

Temperature

1.6.3 UKCP18 projections show that there is more warming in the summer than in the winter.

Precipitation

1.6.4 Rainfall patterns across the UK are not uniform and vary on seasonal and regional scales and will continue to vary in the future. While UKCP18 projections show a clear shift to higher probability levels of dry summers, they also suggest that the likelihood of individual wet summers reduces only slightly. The risk of heavy rainfall events is likely to increase.

Sea level rise

- 1.6.5 According to UKCP18 projections, global sea level has risen over the 20th century and will continue to rise over the coming centuries. The amount of sea level rise depends on the location around the UK and increases with higher emissions scenarios. Sea level rise over the coming centuries may affect tidal characteristics substantially (including tidal range).

Snow

- 1.6.6 According to UKCP18 projections, for the period 2061-2080, under a high emissions scenario (RCP8.5), the regional (12km) and local (2.2km) projections show a decrease in both falling and lying snow across the UK relative to the 1981-2000 baseline.

Wind

- 1.6.7 There are no compelling trends in storminess, as determined by maximum gust speeds, from the UK wind network over the last four decades. UKCP18 projections over the UK show an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season when more significant effects of wind are experienced. This is accompanied by an increase in frequency of winter storms over the UK. However, the increase in wind speeds is modest compared to interannual variability.
- 1.6.8 Winds associated with major storm events can be some of the most damaging and disruptive events for the UK with implications for property, power networks, road and rail transport and aviation.

1.7 IDENTIFICATION AND EVALUATION OF RISKS WITH CLIMATE CHANGE

- 1.7.1 Table 7 provides a summary of how the identified climate risks are likely to change in the future as a result of climate change. Probability and consequence ratings have been given to these risks, thereby generating a risk rating based on Table 3. The probability and consequence ratings outlined in Table 7 are pre-mitigation.

Table 7 Climate change risks based on C40 Cities Climate Change Risk Assessment Guidance

Risk	Baseline risk rating	Change in probability as a result of climate change	Probability rating (1-5)	Consequence rating (1-7)	Risk rating with climate change	Mitigation needed?
Rainstorm	5	The frequency of precipitation is likely to decrease, particularly in the summer. However, the risk of heavy rainfall events is likely to increase.	5	1	5	No
Heavy snow	6	The frequency of heavy snow events is likely to decrease.	2	2	4	No
Fog	6	It is unknown how climate change will affect the frequency of fog.	6	1	6	No
Hail	4	The frequency of hailstorms is likely to increase.	5	1	5	No
Severe wind	12	The frequency of severe wind and storms is likely to remain similar.	4	3	12	Yes
Extra tropical storm	12	The frequency of severe wind and storms is likely to remain similar.	3	4	12	Yes
Lightning	10	The frequency of lightning storms is likely to remain	4	1	4	No

Risk	Baseline risk rating	Change in probability as a result of climate change	Probability rating (1-5)	Consequence rating (1-7)	Risk rating with climate change	Mitigation needed?
		similar.				
Extreme winter conditions	12	The frequency of extreme winter conditions is likely to decrease.	2	3	6	No
Cold wave	12	The frequency of cold waves is likely to decrease.	2	3	6	No
Extreme cold days	12	The frequency of extreme cold days is likely to decrease.	2	3	6	No
Heat waves	15	The frequency of heat waves is likely to increase.	4	5	20	Yes
Extreme hot days	16	The frequency of extreme hot days is likely to increase.	5	4	20	Yes
Drought	12	The frequency of drought is likely to increase.	4	4	16	Yes
Flash/surface flood	18	The frequency of flash/surface flooding is likely to increase.	3	6	18	Yes
River/tidal flood	12	The frequency of river/tidal flooding is likely to increase.	3	6	18	Yes
Groundwater flood	12	The frequency of groundwater flooding is likely to remain at a similar level.	2	6	12	Yes
Subsidence	6	The frequency of subsidence is likely to remain low.	1	6	6	No
Water-borne disease	3	The frequency of water-borne disease is likely to increase but remain low.	2	3	6	No
Vector borne disease	4	The frequency of vector-borne disease is likely to increase but remain low.	1	4	4	No
Air-borne disease	3	The frequency of air-borne disease is likely to increase but remain low.	2	3	6	No
Insect infestation	3	The frequency of insect infestation is likely to increase but remain low.	2	3	6	No

1.8 INCREASING THE RESILIENCE OF THE PROPOSED DEVELOPMENT TO CLIMATE CHANGE

- 1.8.1 Table 8 summaries the mitigation measures that have been put in place for the proposed development that will increase resilience to the likely effects resulting from climate change. These particularly focus on the effects that scored highly in the risk assessment in Table 7.

Table 8 Climate change resilience measures

Risk	Mitigation measure
Severe Wind	The structural design of the buildings to be resilient to high wind. A wind microclimate assessment has been undertaken for the proposed development.
Extreme tropical storm	The structural design of the buildings to be resilient to high wind. A wind microclimate assessment has been undertaken for the proposed development. A Drainage Strategy has been developed for the proposed development that considers the effects of climate change.

Risk	Mitigation measure
Heat waves	Overheating analysis should be carried out for the proposed development. The design (e.g., window sizes and location) should aim regulate interior temperatures during hot periods. Where possible, lighter colours should be used on buildings and hard landscaping to reduce the albedo of surfaces.
Extreme hot days	
Drought	Buildings should be fitted with low flow sanitaryware to reduce water consumption. Where possible, grey and rainwater harvesting should be utilised.
Flash/surface flood	A Flood Risk Assessment and Drainage Strategy considering climate change have been developed for the proposed development. SUDS features should be implemented wherever possible. The landscaping strategy should aim to slow down rainwater runoff.
River/tidal flood	
Groundwater flood	
All risks	Since the effects of climate change are dynamic and constantly changing, an adaptive management approach is recommended. The climate change resilience risk assessment should be periodically revisited by the design team during construction in order re-assess likely effects.

1.9 RESIDUAL EFFECTS

Table 9 provides a summary of the residual effects of climate change on the proposed development, with low-risk items shown in yellow and medium-risk items shown in orange. Mitigation measures outlined in Table 8 have been taken into account.

Table 9 Summary of residual risks ratings based on probability and consequence taking into account mitigation measures

Risk	Probability rating (1-5)	Consequence rating (1-7)	Risk rating
Rainstorm	5	1	5
Heavy snow	2	2	4
Fog	6	1	6
Hail	5	1	5
Severe wind	4	2	8
Extra tropical storm	3	3	9
Lightning	4	2	4
Extreme winter conditions	2	3	6
Cold wave	2	3	6
Extreme cold days	2	3	6
Heat waves	4	6	16
Extreme hot days	5	3	15
Drought	4	3	12
Flash/surface flood	2	5	10
River flood	3	5	12
Groundwater flood	2	5	10
Subsidence	1	6	6
Water-borne disease	2	3	6
Vector borne disease	1	4	4
Air-borne disease	2	3	6
Insect infestation	2	3	6

1.10 REFERENCES

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