16.0 CLIMATE CHANGE

Introduction

16.1 This Chapter has been prepared by Mott MacDonald and reviews the Proposed Development's potential effect on climate change and Greenhouse Gas (GHG) emissions[i] in the construction and operation phases, including how the project will affect the ability of the Cherwell District Council and Oxfordshire County Council to meet its Net Zero targets[ii].

16.2 The Chapter further considers the risks due to future climate change on the project assets and the operation of the Proposed Development, including potential impacts on staff and site users, and the ways in which the design and long-term management of the site integrate resilience and adaptation measures.

16.3 The Chapter describes the technical consultation that has been undertaken during the EIA, the scope of assessment and the assessment methodology, and a summary of baseline information that has informed the assessment.

16.4 In line with the Institute of Environmental Management and Assessment (IEMA)'s Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance[iii], the assessments report on likely significant effects and climate risks, the further mitigation measures required to prevent, reduce or offset any significant adverse effects.

16.5 This Climate Change Assessment has been prepared following guidance set out by IEMA. After the introductory sections, the Assessment Process described in this Chapter is split into two sections; an assessment of the Proposed Development's Greenhouse Gas emissions followed by an assessment of the Climate Resilience of the Proposed Development.

16.6 The terms "carbon", "carbon dioxide (CO2)", "carbon dioxide equivalent (CO2e)" and "greenhouse gases (GHGs)" are used interchangeably depending on the terminology of referenced documents.

Legislation and Policy

16.7 On 27th June 2019 the UK government amended the Climate Change Act (2008)[iv] and set a legally binding target to achieve Net Zero GHG emissions from across the UK economy by 2050. The Act also legally requires the government to assess the risks and opportunities from climate change for the UK and to adapt to them. In October 2021 the UK government released their Net-Zero strategy, further outlining how this reduction is to be achieved.

16.8 The National Adaptation Programme (NAP)[v] and National Planning Policy Framework (NPPF)[vi] are both national policies which sets out clear objectives to mitigate and adapt to climate change.

16.9 The Town and Country Planning (Environmental Impact Assessment) Regulations 2017[vii] require the consideration of contributions from projects to climate change through the release of GHG emissions and how such effects will be reduced ("climate change mitigation").

16.10 The Government's Future Buildings Standard (FBS)[viii] Interim standard came into force in 2022, requiring non-residential development to achieve an aggregated 27% improvement beyond Part L 2013, from 2025 it is anticipated that a similar improvement as noted in the 2025 Future Homes Standard (FHS) will be required.

16.11 On a regional level, the Oxfordshire Climate Action Framework[ix] outlines the Council's aim to operate at Net Zero by 2030 and enable a Net Zero Oxfordshire by 2050. In support of this, the local Cherwell District Council have also declared a climate emergency and declared to work in collaboration with Oxfordshire County Council to achieve their Net Zero targets. New developments therefore need to reflect the need to achieve Net Zero through assessment of whole life carbon and through appropriate design and operational choices.

16.12 The Cherwell Local Plan 2011-2031[x] - contains specific policies for development and the use of land:

- Policy ESD1 'Mitigating and Adapting to Climate Change' - sets out measures that will need to be taken to mitigate the impact of development within the District on climate change.
- Policy ESD2 'Energy Hierarchy and Allowable Solutions' - seeks to achieve carbon emissions reductions through the use of an energy hierarchy.
- Policy ESD3 'Sustainable Construction' - requires new developments to incorporate sustainable design and construction technologies to achieve wider net zero carbon goals.
- Policy ESD4 'Decentralised Energy Systems' - encourages the use of decentralised energy systems.
- Policy ESD5 'Renewable Energy' - sets out the expectation to use renewable and low carbon energy sources where possible.

Assessment Methodology and Significance Criteria

GHG Emissions

16.13 The assessment quantifies the GHG emissions from the Proposed Development over its lifetime. To fully capture the Proposed Development's carbon impact a whole life cycle approach is taken, which will account for embodied carbon emissions (emissions generally associated with materials and products used in Construction) as well as operational carbon emissions (emissions generally associated with occupant's energy usage and travel).

16.14 The best practice guidance for the assessment has been drawn from the following sources:

- IEMA Guide to Assessing GHG emissions and evaluating their Significance.[xi]
- Royal Institute of Chartered Surveyors (RICS) Whole Life Carbon Assessment for Built Environment[xii]
- Publicly Available Specification (PAS) 2080:2023: Carbon Management in Buildings and Infrastructure[xiii]
- BS EN 15978: 2011 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings[xiv]

16.15 Whole life carbon calculations are undertaken using proprietary life cycle assessment software (OneClick LCA with Carbon designer Plugin) for the Proposed Development in line with RICS Whole Life Carbon Assessment (WLC) guidance. The scope of the emissions will be aligned to the lifecycle stages defined in the BS EN 15978: 2011 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings.

16.16 The GHG emissions during construction stage are calculated as a part of the Life Cycle Carbon Assessments (LCA) embodied carbon emissions in line with BREEAM Mat 01 specifications[xv].

16.17 As the application for the Proposed Development is submitted at the initial outline design stage, the operational carbon is assumed from the results of the Building Regulations Part 2 model assessment done by IES in compliance with the calculation procedures of the Approved Document Part L2 of the Building Regulations 2021.

16.18 The results from the calculations are compared against the current baseline and the wider national and regional carbon budgets to illustrate the magnitude of the GHG emissions associated with the Proposed Development as outlined in the IEMA Greenhouse Gas Guidance.

16.19 The IEMA Guidance provides the methodology to assess the significance of the resultant effects. However, for maintaining coherence and uniformity among the EIA Chapters, the terminologies used are in line with the methodology provided in Chapter 2.

Sensitivity of receptor

16.20 In line with IEMA Greenhouse Gas Guidance, the sensitivity of the receptor (i.e., the global atmosphere) in relation to GHG emissions is always considered to be 'High', based on the value and vulnerability of the resource and irreversibility of the effect.

Magnitude of impact

16.21 The magnitude of impact has been considered as the change experienced from the current baseline conditions at the sensitive receptor and has been considered on the scale of High, Medium, Low, Negligible. The **Table 16.1** below has the magnitude of impact mapped against the criteria set out in IEMA Guidance to maintain consistency.

Table 16.1 Magnitude of impact criteria

Magnitude of impact	Description of change
High	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with high effect is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.
Medium	The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with medium adverse effect falls short of fully contributing to the UK's trajectory towards net zero.
Low	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with low adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero
Negligible	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.
No change	No change in GHG emissions.

Source: Ridge and Partners LLP 2023 – Scoping request for new stadium development

Significance of effect

16.22 The sensitivity of a receptor combined with the magnitude of the effect upon the receptor is then compared within the significance of effect matrix (**Table 16.2**) to define the overall effect.

Table 16.2 Significance of Effect Matrix (effects can be either adverse or beneficial)

Magnitude of Effect	**Sensitivity of Receptor**			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major/ Moderate	Moderate/ Minor	Negligible
Medium	Major/ Moderate	Moderate	Minor	Negligible
Low	Moderate/ Minor	Minor	Minor/ Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Source: Adapted from Ridge and Partners LLP 2023 – Scoping request for new stadium development

16.23 Where an effect is classified as falling into one of two levels of significance (Major/Moderate, Moderate/Minor or Minor/Negligible), professional judgement is used to define which of the levels of significance is most applicable.

16.24 Effects classified as Moderate or above are considered to be significant effects, and secondary mitigation may be required to reduce these effects. Effects classified as Minor are not considered significant, but it may be prudent to implement secondary mitigation. Negligible effects equate to no perceptible change and secondary mitigation will have no measurable or perceptible effect.

16.25 There is currently no standard methodology for quantifying GHG emissions within the EIA process. IEMA GHG Guidance instead advocates for flexibility and proportionality to suit the Proposed Development under assessment.

16.26 In order to determine whether the Proposed Development is aligned with the UK's trajectory to net zero it is necessary to provide context for the magnitude of GHG emissions. RIBA Climate Challenge targets for embodied carbon and operational energy use, take into account the latest recommendations of the Green Construction Board, to ensure the construction industry delivers the significant reductions necessary by 2030 in order to have a realistic prospect of achieving net zero for the whole UK building stock by 2050. The potential emissions from the building is compared against these targets.

16.27 For the purposes of the assessment, the Proposed Development has been split up into lifecycle stages, as per BS EN 15978: 2011 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Calculation Method, as shown in **Figure 16.1.**

Embodied carbon (A1-A5, B1-B5, C1-C4)

16.28 The construction carbon assessment has been undertaken as a part of the Embodied carbon assessments (A4-A5) of LCA to demonstrate compliance with the Mat 01 requirements in BREEAM New Construction 2018.

16.29 The assessment on the impact of the proposed development is presented by lifecycle stage of the project as presented in **Table 16.3.**

Table 16.3 Life cycle scope for embodied carbon assessment

Life Cycle Stage	Description
A1-A5 Product Stage	GHG emissions associated with the material extraction, transportation and manufacturing of construction products and GHG emissions associated with product delivery to Site and the installation process.
B1-B5 Replacement and refurbishment	This use stage captures GHG emissions associated with the operation of the built asset over its entire lifecycle, from practical completion to the end of its service life.

C1-C4 Deconstruction	GHG emissions associated with the demolition and disassembly of the Proposed Development, as well as the exploration of circular economy principles.

16.30 The LCA options appraisal have been carried out as per the BREEAM Methodology for RIBA Stage 2. The options assessed are for the following elements:

- Superstructure
- Substructure
- External hard landscaping

16.31 At this RIBA Stage 2 LCA, options appraisal for Core Building services have not been completed.

16.32 Carbon dioxide equivalency (CO2e) is a quantity that describes, for a given mixture and amount of GHG, the amount of CO2 that would have the same global warming potential (GWP), when measured over a specified timescale.

Operation (B6-B7)

16.33 The operational emissions have been qualitatively assessed using the data from energy assessment carried out for compliance to Part L 2021 regulations.

16.34 The energy assessment has been calculated through Dynamic Thermal Modelling (DTM) using representative values for compliance.

16.35 The emissions from staff and fan travel will be considered as a part of the operational carbon. The transport emissions from match day travel visits will be compared against the baseline of the existing stadium as provided in the sustainability statement.

Study area

16.36 The Site and Proposed Development form the principal study area for the GHG assessment, however the effects of climate change on the Proposed Development and the Site are linked to climatic changes which are a global phenomenon and result from GHG emissions. Additionally, the GHG emissions from the proposed development include off-site emissions such as those associated with the manufacture and transport of construction materials, and those associated with the generation (e.g., at a power station) of grid electricity consumed by the operational development are also included, although it is not possible at this stage to predict the off-site locations where these emissions will occur. The GHG emissions due to travel and transport during match days are also included.

Assumptions and limitations

16.37 The proposed scope of LCA made assumption for the embodied caron based on available data at RIBA stage 2 and is subject to change as the design progresses.

16.38 As mentioned in the BREEAM MAT 01 LCA report,[xvi] the results of the LCA for BREEAM have not been compared against the BRE benchmark as the proposed development is a sports stadium and the BRE benchmark is not applicable to this scheme.

16.39 Due to the early stage of the development, the specifications and weights used for the LCA are an approximation and will be reviewed again during RIBA Stage 3 and 4.

16.40 The LCA is undertaken taking into consideration a 60-year timescale as per BREEAM requirements.

16.41 The operational carbon emissions qualitatively assess the representative energy use values. The actual values may vary when the proposed development progresses to further RIBA Stages. The operational emissions will be calculated at later stages to comply with BREEAM requirements.

16.42 There is a degree of uncertainty within carbon footprint calculation as carbon emissions factors represent industry averages and are calculated on a set of assumptions, and thus may not reflect real world scenarios or specific products that are later used in the construction. The final carbon footprint of the constructed design is likely to be different to any prior estimation as it is dependent on the final products selected, their location, and the fuel used on site.

Climate Resilience

16.43 A climate change risk assessment (CCRA) has been undertaken to assess the climate resilience of the Proposed Development's current design and to inform future design stages. The CCRA methodology has been adapted from IEMA's climate resilience guidance, which takes a qualitative approach informed by the future climate baseline. The approach considers the magnitude of climate change risks and sensitivity of receptors, along with consideration of embedded mitigation measures within the design, to determine whether identified climate change risks to the Proposed Development are considered significant.

16.44 The construction phase has been scoped out of the climate resilience assessment due to the short construction period during which climate is not anticipated to change significantly from the present day.

Magnitude of impact

16.45 The criteria for defining the magnitude of impacts of climate change on the climate resilience of the Proposed Development are described in **Table 16.4**.

16.46 The magnitude is based on information from the climate change projections, together with the knowledge and professional judgement on the nature of the impacts and level of certainty associated with the projections. For example, there is a higher degree of certainty within climate projections in relation to temperature change; however, there is a lower level of certainty in relation to the exact change in rainfall patterns or the frequency of extreme rainfall or temperature maximums.

Table 16.4 Magnitude of Impact Criteria

Magnitude	Criteria	Examples
Major (High*)	Large change to climate condition and large increase in the frequency of the event.	Increased and prolonged maximum summer temperatures that create extreme regional heatwaves throughout each summer.
Moderate (Medium*)	A large, measurable change in climate conditions at a regular frequency.	Increase in the intensity and volume of extreme rain events of an intensity that could lead to surface water flooding.
Minor (Low*)	Change in climate conditions that may have measurable effect on an asset, but which are low likelihood / infrequent.	Increased average annual frequency of lightning strikes.
Negligible	Small or undetectable change in climatic or weather conditions.	Change in average wind direction for a few days in a year.
No change	No change in climate condition.	No change in climate condition.

** Magnitude equivalent to align with general EIA terminology.*

Sensitivity of Receptor

16.47 The criteria for defining sensitivity for the assessment of receptors of the Proposed Development are described in **Table 16.5**.

16.48 The sensitivity of the receptors is the ability of the receptor to withstand and recover from a climate impact while keeping or shortly returning to its normal functionality. The sensitivity of a receptor considers its susceptibility to a change in climatic conditions or an extreme weather event, and the consequences of this change.

Table 16.5 Sensitivity of Receptor

Sensitivity	Definition	Examples
Very high	Adverse: Short-term, acute impact to receptor functionality or a substantial, measurable decrease in receptor lifespan following the occurrence of a climate impact. Substantial increase in need for periodic maintenance or in maintenance costs.	Buildings and public spaces located in existing flood risk zones are highly susceptible to surface water flooding during an extreme rainfall event and may incur significant repair costs.

	Benefit: Very strong improvement to matter's performance, lifespan or a large reduction maintenance requirements.	None identified.
High	Adverse: Large, measurable decrease in receptor lifespan following the occurrence of a climate impact. Large increase in need for periodic maintenance or in maintenance costs.	Periodic cycles of drought or dry periods followed by severe rainfall events can result in continuous shrink-swell of soils, potentially leading to ground subsidence.
	Benefit: strong improvement to matter's performance, lifespan or a large reduction in maintenance requirements.	None identified.
Medium	Adverse: measurable decrease in receptor performance (short-term or long-term) or lifespan or increase in necessary maintenance frequency and costs following the occurrence of climate impact.	Landscaping vegetation that is susceptible / reactive to changes in weather conditions –the climate impact of longer growing season will lead to increased growth (impact on the receptor) and associated maintenance costs.
	Benefit: moderate measurable increase in matter lifespan or performance, or a measurable reduced need for maintenance.	None identified.
Low	Adverse: small, measurable impact to a receptor's performance following climate impact, or small reduction in receptors lifespan due to chronic deterioration (e.g. slight decrease in lifespan of an asset due to increased higher temperatures).	Ability of reinforced concrete receptors to withstand daily changes in temperature, which can result in a small but noticeable increase in the rate of spalling and deterioration (due to expansion of metal components).
	Beneficial: small, measurable increase in matter lifespan due to less severe deterioration, increase performance or reduced need for maintenance.	Key personnel onsite attendance improves as the inability to travel to work on days of severe snow and ice will reduce slightly due to increase in average temperatures, leading to fewer snow and ice events.
Negligible	No change to the integrity of receptor or a small, temporary, reversible change to receptor performance following the occurrence of a climate impact	Underground/buried assets have negligible susceptibility to higher temperatures due to being buried below ground.

Significance of effect

16.49 The significance of each effect is calculated through quantifying magnitude and sensitivity ratings to determine overall significance using the significance matrix shown in **Table 16.6** Where an effect is determined to be Moderate or above, this will be considered significant.

Table 16.6 Significance Matrix (effects can be either adverse or beneficial)

Magnitude	**Sensitivity**				
	Very high	**High**	**Medium**	**Low**	**Negligible**
Major-(High*)	Major	Major	Moderate	Moderate	Minor
Moderate (Medium*)	Major	Moderate	Moderate	Minor	Negligible
Minor (Low*)	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

** Magnitude equivalent to align with general EIA terminology.*

Study area

16.50 The spatial study area for the assessment of climate resilience is defined as the spatial extent of the Site with respect to effects of climate change on the Proposed Development.

16.51 Receptors at risk from future changes in climate and extreme weather events have been considered for the operational phase of the Proposed Development only. The temporal study period for climate resilience will include climate changes up to the end of this century, or interim periods as appropriate to specific design elements and asset design life.

Assumptions and Limitations

16.52 The assessment in this Chapter is based on freely available information available from third parties for reporting purposes, being observational data from local weather stations, a number of readily available climate change projections and a range of existing climate change datasets and literature at the time of writing this assessment. The following limitations and disclaimer should be noted:

- Climate change projections: climate projections are not predictions or forecasts but simulations of potential scenarios of future climate under a range of hypothetical emissions scenarios and assumptions. The results, therefore, from the experiments performed by climate models cannot be treated as exact or factual, but projection options. They represent internally consistent representations of how the climate may evolve in response to a range of potential forcing scenarios and their reliability varies between climate variables. For a single emission scenario, projections can vary significantly as a function of the model used and how it is applied, so that there is a wide uncertainty band in the results. Scenarios exclude outlying "surprise" or "disaster" scenarios in the literature and any scenario necessarily includes subjective elements and is open to various interpretations. Global projections are generally more certain than regional, and temperature projections more certain than those for precipitation. Furthermore, the degree of uncertainty associated with all climate change projections increases for projections further into the future. Climate models and associated projections are updated on a regular basis, implying changes in the forecasted future climate;
- Validation of information: observational or projection data obtained at the time of writing has not independently verified for this project, including for any inaccuracies or shortcomings in this information. This assessment is relevant to the project information provided and is not intended to address changes in project configuration or modifications that occur over time, or modifications made by third parties to the source data in the future. The data is obtained to provide a general 'sense check' on the published literature on existing observational and climate projections for the region; and
- We have not undertaken any climate modelling and rely solely on freely available data on climate projections in this region. Accordingly, any further research, analysis or decision-making should

take account of the nature of the data sources and climate projections and should consider the range of literature, additional observational data, evidence and research available – and any recent developments in these.

Consultation

16.53 A scoping report setting out our proposed methodology has been submitted for comment. A scoping response from CDC, received on 29th September 2023 highlighted that Climate change and GHG emissions should be scoped into this Environmental Statement.

Baseline Conditions

GHG Emissions

16.54 The baseline considers existing GHG emissions related to the Site, which is currently undeveloped. The existing vegetation on site will provide a small amount of carbon sequestration, which is unlikely to be significant and hence has been scoped out. Therefore, there are no baseline emissions associated with the Site, and any development on the Site will result in additional emissions.

16.55 The baseline for matchday travel emissions will be the current travel emissions of the existing stadium. Based on the estimates in the OUFC Match Day Carbon Footprint report[xvii], the current stadium has 22.6% of sustainable travel modes.

16.56 The wider baseline (for construction emissions) considers emissions from the UK construction industry which will be used for context and to enable comparison of the project emissions once these are calculated in the detailed design stage.

16.57 The most recent (2020) baseline GHG emissions for Oxfordshire taken from the UK Local Authority & Regional Carbon Dioxide Emissions National Statistics is provided in below **Table 16.7**. Assumed baseline GHG emissions from the Site are also presented. This baseline data is used to contextualise GHG emissions from the Proposed Development and determine the magnitude of effect.

Table 16.7 Baseline GHG emissions

Area	CHG Emissions in tonnes
Site	0 (assumption)
Oxfordshire	3,890,000

16.58 **Table 16.8** sets out the RIBA targets for embodied carbon and operational energy use for non-domestic buildings, which have been applied to the Proposed Development. The RIBA 2030 Climate challenge report[xviii] has guidance for reporting against non-domestic buildings (new build offices) under which sports and leisure centres are also listed.

Table 16.8 RIBA Climate Challenge Target Metrics for Non domestic buildings

Climate challenge metrics	Business As Usual	2025 Targets	2030 Targets
Operational Energy kWh/m2/year	130	<75	<55
Embodied Carbon (A1-C4) kgCO2e/m2	1400	<970	<750

Climate Resilience

16.59 The future climate baseline for the Proposed Development has been obtained from the Met Office UKCP18 dataset, which comprises projected changes to the UK's climate against a range of future GHG emission scenarios.

16.60 The chosen climate scenario for this assessment consists of a high GHG emissions scenario, Representative Concentration Pathway (RCP) 8.5, as this represents a 'precautionary approach' or worst case within risk assessments. A time horizon of the 2090s (2080-2099) (against a 1981-2000 baseline) is used to cover the design life of the Proposed Development. The 50th percentile has been selected, representing an 'as likely as not' probability of change, and projections for the Southeast England spatial region as this provides high-level data for the region where the Proposed Development is located. **Table 16.9** presents projection data using the projected climate scenario for air temperature and precipitation.

Table 16.9: **Climate projections for Southeast England (UKCP18 Probabilistic Projections, RCP8.5, 2080-2099 (1981-2000 baseline), 50th percentile)**

Climate variable	Season	Baseline (1981-2000)	Change from baseline - 2090s	Final value
Mean Air Temperature (°C)	Summer	16.1	+5.8	21.9
	Winter	4.6	+3.5	8.1
Max Air Temperature (°C)	Summer	21	+6.3	27.3
	Winter	7.5	+3.3	10.8
Min Air Temperature (°C)	Summer	11.2	+5.3	16.5
	Winter	1.6	+3.7	5.3
Amount of precipitation per day (mm)	Summer	5	-41.4%	2.9
	Winter	7	+26%	8.82

Source: Met Office UKCP18

16.61 Climate projections from **Table 16.9** shows that the Southeast England region is projected to become warmer throughout the year with an increase in average peak summer and winter temperatures. Winters are also projected to become wetter while summers are projected to become drier.

16.62 These projected climate trends are likely to exacerbate future extreme weather events. Warmer summers may result in more frequent, severe and prolonged heatwave events. Wetter winters may result in increased flood risk while drier summers can increase the frequency and severity of drought events. Drought events may also exacerbate the severity of flooding and lead to flash flood events during summer precipitation because of reduced soil moisture which decreases soil's ability to absorb water. In addition, Environmental Agency guidance includes an uplift for rainfall intensity, which is likely to increase surface water (pluvial) flooding and surface run-off.

16.63 Climate models for wind and storms contain greater uncertainties and therefore quantitative data on future wind projections have not been published by the Met Office. Global projections however do show that there is potential for an increase in near surface wind speeds over the UK in the second half of the 21st century during the winter months, alongside an increase in the frequency of winter storms.

16.64 While research into climate change impacts on lightning is still uncertain, studies have been undertaken which show evidence of an increase in the frequency of lightning strikes by 12% with a 1°C average annual increase in air temperature.

16.65 Projection data for additional time horizons, percentiles, extremes, and climate parameters will be used within further assessments where identified as appropriate.

16.66 The Environment Agency guidance[xix] on future rainfall intensity includes climate change allowances for two future timeframes, labelled 2050s and 2070s. They recommend to use the 2050s timeframe for development with a lifetime up to 2060 and use 2070s for development with a lifetime between 2061 and 2125. The range of allowances included is based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it, and half fall above it. The central allowance is based on the 50th percentile. The upper end allowance is based on the 95th percentile. **Table 16.10** outlines the climate change allowance for rainfall intensity for the location of the Proposed Development (the Cherwell and Ray Management Catchment).

Table 16.10: **Climate change allowance for rainfall intensity of the Cherwell and Ray Management Catchment**

	3.3% annual exceedance rainfall event		**1% annual exceedance rainfall event**	
Epoch	Central allowance	Upper end allowance	Central allowance	Upper end allowance
2050s	20%	35%	20%	40%
2070s	25%	35%	25%	40%

Source: Department for Environment Food & Rural Affairs Climate Change Allowances

Potential Effects

GHG Emissions

16.67 This section will outline and describe the potential effects for climate resilience and describe the embedded mitigation in the project design.

16.68 The specifications of the mitigation measures will be outlined in the following documents which will be finalised during the future design stages:

- Sustainability Statement
- Energy Statement
- Low and Zero Carbon Technologies summary

Embedded mitigation

16.69 The following mitigation measures are embedded to reduce the emissions in the construction phase of the Proposed Development:

- The design will identify and maximise opportunities for reduce, reuse, recycle and recovery of waste materials thereby reducing the volume of construction waste to landfill.
- A Resource Management Plan (RMP) will be produced to procure reused, recycled and locally sourced materials.
- Design Out Waste Workshops will be conducted to identify waste management that may be adopted during the construction phase.
- The Route map for Zero avoidable Waste in Construction and/or Zero Waste hierarchy will be applied. This will include resource efficiency, diversion from landfill, reuse, recycling and closed loop recycling.
- As part of the tender process, the contractor will be expected to sign up to the considerate contractor's scheme.
- The Proposed Development would adhere to a Construction Environmental Management Plan (CEMP) which will set out how the project will avoid, minimise or mitigate effects on the environment and surrounding area.
- Mitigation measures outlined in the Construction Traffic Management Plan (CTMP) will be implemented to minimise effects associated with transport during construction phase.

16.70 The following mitigation measures are embedded in the design of the Proposed Development:

- Low and zero carbon technology feasibility study is being undertaken to implement energy efficient equipment and technology and will be available in further design stages. The following range of measures will be embedded in the design:
    - Photovoltaics (PV) Panels
    - LED lighting

    - Heat recovery systems
    - Heat pumps
    - ASHP (Air Source Heat Pump)
- The sustainability statement which will be available in further design stages outlines that waste reduction would be addressed as a part of the project's sustainability agenda in line with the WRAP guidance 'Designing out Waste: design team guide for Buildings'.
- Opportunities for circular economy will be considered, that will feed in the Site Waste Management Plan.
- Waste storage options will be provided, and a monitoring strategy will be implemented to establish the baseline for operational waste.
- The proposed design has a commitment to locate 150 Sheffield stands for cycle parking onsite, with further spaces at Oxford Parkway, including electric bike charging.
- Match day and non-match day Framework Travel Plans outline a package of measures to reduce number of single occupancy car trips, thereby promoting sustainable travel modes.
- Enhanced public bus services including increased frequency and longer operating hours of public bus services to the stadium on match days if demand/ticket sales require.

Embodied carbon

16.71 The LCA[xx] conducted for embodied emissions has indicated that the Proposed Development would result in emissions of approximately 9,670 tCO2e (**Table 16.11**).

16.72 The embodied emissions from the product stage, which also includes construction (A1-A5) make up majority of the emissions at 83.4%, with the replacement and refurbishment (B1-B5) and deconstruction (C1-C4) making up 11.6% and 5% respectively.

Table 16.11: Embodied carbon emissions.

Lifecycle stage	Carbon emissions (tCO_{2e})	Percentage of total construction carbon
A1-A5 Product Stage	8,060	83.4%
B1-B5 Replacement and refurbishment	1,120	11.6%
C1-C4 Deconstruction	490	5%
Total	9,670	

16.73 **Table 16.12** below presents the embodied carbon emissions against the baseline. In addition, the total embodied emissions accounts for 0.25 % of the Oxfordshire baseline carbon emission (**Table 16.12)** meaning the Proposed Development is considered to accord with the UK's net zero trajectory.

Table 16.12: Embodied carbon emissions against baseline.

Stage	GHG emissions (tCO_2e)
Baseline	0
Proposed Development	9,670

16.74 In line with IEMA Greenhouse Gas Guidance, the sensitivity of the receptor (i.e., the global atmosphere) in relation to GHG emissions is always considered to be 'High', based on the value and vulnerability of the resource and irreversibility of the effect.

16.75 As the Proposed Development is fully consistent with existing and emerging national and regional policy requirements and good practice design standards including BREEAM and Building Regulations Part L2, the magnitude of impact is considered to be Low.

16.76 Based on mapping the magnitude of impact (Low) and the sensitivity of receptor (High) in line with the matrix in **Table 16.2**, and because the embodied emission of the Proposed Development is very Minor when compared to the regional baseline, the significance of effect is defined as **Minor**. There is likely to be a direct, temporary, adverse effect which is considered to be **not significant**.

Operation

16.77 The operation of the Proposed Development will result in GHG emissions form the generation and consumption of energy for the buildings.

16.78 The Energy statement, which will be available at further design stages has found that the development is likely to be complaint with the requirements of Building Regulations Part L2 (2021)[xxi]. The assessment concludes that the operational energy use of the building is likely to result in 6.27 $kgCO_2/m^2$/annum emission, which is below the compliance requirement of 6.31 $kgCO_2/m^2$/annum.

16.79 It is also understood through the energy strategy for the Proposed Development installation solar PV panels and air source heat pumps are to be installed.

16.80 The national grid is continually decarbonising making the use of gas systems less preferential over electrically fuelled systems as the carbon factor of grid electricity is predicted to continue to decrease over time. The Low and Zero Carbon Technologies report and the Energy Statement which will be available in further design stages, references the predicted grid decarbonisation trajectory, and given that the Proposed Development's heating and cooling demands are to be met via electricity, the building will produce fewer emissions in operation over time compared to a gas fuelled system in line with the decarbonisation of the grid electrical network.

16.81 Based on estimates from the current stadium, the largest contributor to total match day emissions is emissions from fan travel to and from matches, accounting for 55% of total match day emissions.

This high proportion of travel emissions is largely due to the limited public transport access to the existing stadium, resulting in heavy reliance on private car use amongst attendees.

16.82 The new stadium has a target to achieve 90% sustainable travel modes compared to the current 22.6%. As this is predicted to reduce matchday travel emission from the current baseline, the magnitude of impact is conservatively considered to be Low and beneficial.

16.83 In addition to match day travel emissions, attendance of non-football events will also result in travel emissions. Assuming they follow similar sustainable travel methods and are in line with the transport electrification trajectory to meet Net zero targets, this non-football event transport movement is not significant to change the magnitude of impact that is identified in section 16.83 to be Low and beneficial to the global climate receptor.

16.84 Due to the proposed Low Carbon measures, the Proposed Development's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards (Building Regulations Part L and BREEAM). Hence, the magnitude of impact is considered to be Low. The sensitivity of the climate system is considered to be High in line with the IEMA guidance. There is likely to be a direct, long term, adverse effect due to the operation of the Proposed Development. In line with the significance of effect matrix in **Table 16.2** and the effect of Proposed Development would be very Minor compared to the regional baseline and would not affect the regional and national trajectory to net zero, the significance is **Minor**.

Climate Resilience

16.85 This section will outline and describe the potential effects for climate resilience and describe the embedded mitigation in the project design.

Embedded Mitigation

Structural design

16.86 The Proposed Development's design is in line with the latest structural design Eurocodes and includes:

- Thermal loading using an uplift for future winter and summer temperatures.
- Additional climate uplift of temperatures for horizontal and south-facing elements of stadium
- Movement joints incorporated into the building.
- The design of the roof to factor in wind speeds and gusts for a 1 in 50 year storm event, such that local failure of specific elements does not lead to a disproportionate collapse response.

- Consideration of planting species which favour high plasticity clays, thirst of tree species and distance between planting and stadium foundations.
- Assessment of underlying Oxford Clay which is prone to shrinking and swelling to inform the piled foundations and swell risks.
- Further details of the design standards to be applied will be outlined in Structural Engineering Stage 2 Report (OUFC-MMD-XX-XX-RP-S-00001), and further refinement of the standards will be carried out at detailed design stage.

Mechanical and engineering design

16.87 The Proposed Development has been designed with consideration of future temperatures and rainfall patterns and intensity. The following measures have been embedded within design:

- Consideration of climate severity with future temperatures and rainfall included and with reference to the operational lifespans of assets in order to minimise the need for significant construction for modifications to accommodate future climate conditions. This is further outlined in section 2.7, 2.8.2, 2.10 and 3.15.1 of the Oxford United Football Club – New Stadium Development Sustainability Strategy[xxii].
- Coordination between mechanical and electrical design to locate all rooms with significant electrical equipment (i.e. transformer rooms, generator rooms, LW switchboard rooms, main comms rooms) so that they can be provided with adequate ventilation and cooling (mechanical or natural) to reduce the chance of ambient temperatures affecting the equipment and its efficiency.
- Design of naturally ventilated spaces modelled against future climate projection data within CIBSE industry guidance to assess the risk of overheating and optimise natural ventilation opening's location and size to optimise airflow. (CIBSE TM52: 2013 (The limits of thermal comfort: avoiding overheating in European buildings)
- Incorporation of mechanically cooled spaces in areas which lack natural ventilation.
- Main distribution pipework and ductwork shall be oversized to accommodate increased loads in the future without major works taking place to the building structure.
- Air source heat pumps will be located in areas where maximum airflow can be delivered to them to prevent the units from becoming strained and turning off in extreme weather scenarios, considering worst case scenario climate change impacts.
- Design considers varying electrical requirements for the stadium/facilities including non-essential, essential, match-continuation and life safety loads.
- Modelling and assessments carried out such that monitoring can be carried out by building management of performance such as temperature of rooms and machinery during the operation of the Proposed Development, with triggers included to highlight when too much current is being used by assets, indicating it may need to be upgraded to a different specification for the up to date climate conditions being encountered and projected.

- Diesel generators provide backup for external electrical infrastructure failure (i.e. the power grid) to accommodate evacuation and safety critical functions. This includes lighting, evacuation lifts, entrance/exit gates.
- 'Life safety system' equipment will be housed in a 2-hour enhanced fire rated room, separate to the main LV distribution room.
- Potential option to include all Schneider Electric EcoStructure functions, i.e. a wireless sensor or early detection of overheating wire connections or overheating cables. This will help prevent electrical distribution switchboards from being damaged by means of analysing gas and micro-particles in the air of the switchboard and sending early alerts of overheating.
- Design ensures that adequate sizes of ducting runs for groupings of cables to ensure cables can dissipate heat effectively under future loading and ambient temperatures.
- When looking into calculations for final electrical loads, balancing of the loads will be carried out to ease any equipment being overloaded.
- Design includes a rainwater harvesting system with below ground storage tank and internal storage tank which can be used for pitch irrigation during periods of water scarcity.
- Design of electrical infrastructure has been sized with 20% additional capacity to accommodate future potential increase in cooling capacity.

Flood risk and drainage design

16.88 The Proposed Development's design is in line with requirements of Planning Policy Guidance – Technical Guidance (PPG-TG) on Flood risk and coastal change which stipulates that the design should include an assessment of and mitigation against the potential impacts of climate change, including the use of climate change allowances. As such, the following measures are included in the flood risk and drainage design which provide resilience from the impacts of climate change:

- Proposed drainage has been modelled and designed for a 1 in 100 year rainfall event in any part of a building or utility plant susceptible to water within the development.
- Proposed drainage includes a further allowance of a 40% climate uplift.
- Incorporation of appropriate SuDS into the drainage system to mitigate the risk of surface water flooding. (rainwater harvesting; ponds; filter swales; rain gardens)
- Proposed discharge rate will be the estimated greenfield runoff rate.
- Provisional storage design has been modelled and designed for a 1 in 100 year rainfall event with a 40% climate uplift.
- Attenuation requirements have been estimated taking into account for a 1 in 100 year event with 40% climate uplift.
- Proposed surface water network includes two storage ponds and geocellular storage to mitigate flood risk. One of the ponds is positioned directly south of the stadium, receiving runoff from the western part of the site and pitch drainage, with the second positioned southwest of the stadium to receive runoff from the remainder of the site.

- Proposed network also includes rain gardens throughout car park and towards the southwest of the site, as well as filer drains along the western boundary and north of the stadium.
- Implementation of rainwater harvesting within proposed design to reduce the volume of runoff from impermeable areas
- In the event of a flood event exceeding the 1 in 100 year threshold with a 40% climate uplift, the exceedance flows will drain towards a low spot in the car parking area, to accumulate at this lowest level before entering the drainage network via the proposed drainage channel.
- Additional secondary point of access and egress to site for vehicles during peak rainfall events to northeast, connecting to Oxford Road carriageway. Pedestrians have several other means of access and egress located on the east and west of the Site.
- The site is located within Flood Zone 1, meaning there is no risk for fluvial flooding (less than 1 in 1000 annual probability).

People/users

- Provision of spaces in the hospitality and medical treatment areas of the stadium to provide cool areas for heat vulnerable users to occupy freely to avoid overheating or to cool body temperatures down in the event of heat exhaustion. Temperature controlled sensory rooms for users that need a calm or sensory space to cool down.
- Planting and retention of trees in outdoor public areas, which will provide shade during summer months.
- Design includes a fully covered players area on the west stand at pitch level to provide shading and shelter for players.
- Secondary point of access for vehicles in the event of an intense rainfall event, located to the northeast of the Site, connecting to Oxford Road carriageway.
- The concourses surrounding the north, east and southern sides of the stadium, and home to food and beverage outlets, are all fully covered to provide shading from summer sunshine and shelter from rainfall events.
- Location of restaurant kitchen in the north stand to avoid direct sunlight and additional heating of the building.
- Outside broadcast area for match days will be predominantly inside a van or building to ensure provision of shading.
- Hotel design includes automatic monitoring with alarms for out-of-range values for the ventilation system.
- An overheating assessment within building ventilation design has been undertaken which considers future temperatures based on industry guidance on climate change scenarios and projections.

16.89 The potential effects for climate resilience are outlined in the climate resilience risk assessment table in **Table 16.13** against magnitude and sensitivity criteria for this section with regard to operational use. The sensitivity ratings take into account the embedded mitigation outlined above, which are summarised in the table against each relevant risk.

Table 16.13: Potential climate change impacts and resilience mitigation

Asset or user	Climate variable	Climate hazard	Potential risk	Embedded mitigation	Magnitude	Sensitivity	Significance rating
Stadium structures	Temperature	Increasing temperature (summer) Extreme temperatures Heatwaves	Increasing and/or extreme temperatures, particularly during summer months, have the potential to result in overheating and thermal expansion of metallic and plastic structures.	The Proposed Development is designed using Eurocodes standards for thermal loading, using an uplift for future winter and summer temperatures. Additional uplift calculations applied to horizontal and south-facing elements of the stadium. Thermal expansion taken into account in the stadium structures, including through using movement joins. For further information, refer to the Stage Structural Engineering Report.	Medium	Low	Minor
	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Increases in seasonal precipitation, particularly in winter months, in addition to extreme precipitation events, may result in increased deterioration rates for structural joints within the stadium structure.	The Proposed Development has been designed so that drainage pipework, including roof drainage has been sized with a 40% uplift to accommodate for increases in precipitation and extreme precipitation events. The Proposed Development has been designed so that the metal used for external doors will have anticorrosion metal paint.	Medium	Low	Minor
	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Increases in precipitation, particularly during winter months, and extreme precipitation events could lead to surface water flooding, and subsequent disruption and closure of shared use paths around the Site.	The Proposed Development includes a comprehensive flood risk and drainage design which has been modelled and designed with consideration of climate change allowances. Shared use paths have been modelled and designed with consideration of climate change. Paths around the Site have been designed with a fall to allow surface runoff.	Medium	Low	Minor
	Precipitation	Decreasing precipitation (summer) Droughts	Periods with decreased precipitation followed by extreme precipitation events or periods with increased precipitation	The design takes into consideration the presence of Oxford Clay, which is prone to shrinking and swelling. Additionally, existing willow trees are present within the ZoI (Zone of Influence) of the Proposed Development.	Low	Low	Negligible

		Extreme precipitation events Increasing precipitation (winter) Greater variation between summer and winter rainfall	could cause ground shrink and swell, and subsequent ground movement and subsidence. Especially vulnerable due to Oxford Clay comprising the ground conditions.	This is being assessed as part of the GI and will be used to inform the piled foundations and swell risks ground engineering standards, for cut and fill material as needed.			
	Storms	High wind speeds	Storm events and high winds could result in damage to cladding and roofing structures. Canopy roof is known to be a vulnerable part of the structure to wind. Potential damage to other buildings and injury to site users from flying debris.	The Proposed Development has been designed in line with the latest structural design code, which includes consideration for wind loading and is designed for a 1 in 50 year storm. The structure is designed to not have a disproportionate collapse response.	Low	Low	Negligible
Mechanical and electrical and power assets	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Increasing and/or extreme temperatures, particularly during summer months, have the potential to result in overheating of electrical components, wiring and cabinets, leading to higher risk of electrical failure and fires.	The Proposed Development has been designed with consideration of future climate scenarios, based upon worst case scenario and for the operational lifetime. The Proposed Development includes a monitoring and management regime of mechanical assets and systems to detect early signs of overheating.	Medium	Low	Minor
	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Overheating of electrical components, wiring and cabinets, leading to higher risk of electrical failure and fires	The Proposed Development has been designed with varying electrical requirements for the stadium/facilities including non-essential, essential, match-continuation and life safety loads and following that assessment, has been designed to ensure a required separation in electrical infrastructure between the varying elements. The Proposed Development includes a potentially advanced monitoring system to	Medium	Low	Minor

				allow for early detection of overheating. More to be detailed during RIBA Stage 3 / 4.			
	Precipitation Storms	Extreme precipitation events High wind speeds	Extreme precipitation events and high wind speeds, typically associated with storm conditions, may result in loss of power of mechanical and electrical assets and disruption to site use.	The Proposed Development has been designed with the incorporation of backup generators to ensure that should electrical failure occur, critical safety functions such as evacuation lifts, entrance/exit gates and lighting will still operate as usual.	Medium	Low	Minor
Landscape planting	Temperature Precipitation	Increasing temperatures (summer) Heatwaves Decreasing precipitation (summer) Drought	Increasing and/or extreme temperature events, and reduced precipitation, particularly during summer months may affect vegetation planted as part of the Proposed Development. Such affects may include vegetation dieback, tree failure, soil desiccation and erosion, failure of habitats to establish.	The Proposed Development will consider planting species which favour high plasticity clays, thirst of tree species and distance between planting and stadium foundations.	Medium	Medium	Moderate
	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Increasing and/or extreme precipitation events, particularly during winter months may affect vegetation planted as part of the Proposed Development. Such affects may include waterlogging of areas of vegetation and subsequent failure of habitats to establish.	The Proposed Development includes a series of SUDS, including swales, filter drains, ponds and rain gardens to reduce the risk of waterlogging areas of vegetation, by acting as storage and reducing the flow of water in these areas. Further information can be found in the Flood Risk Assessment.	Medium	Low	Minor
Stadium staff	Temperature	Increasing temperatures (summer) Extreme temperatures	Inability to complete work activities in high temperatures due to increased level of discomfort for staff. This	The Proposed Development's design and orientation is such to minimise these risks by providing areas of shading in main working areas and kitchen, in addition to the provision of mechanically cooled areas.	Medium	Low	Minor

		Heatwaves	may disrupt game days or events management, i.e. Food and beverage outlets situated on concourse which runs around north, east and southern stands outside.	The Proposed Development's has been designed against the CIBSE TM52 guidance for the limits of thermal comfort to avoid overheating.			
	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Inability to complete work activities in high rainfall and intense rainfall conditions due to increased risk of dangerous working conditions. This may disrupt game days or commercial events i.e. security who are required on site 24hours a day.	The Proposed Development's design includes a comprehensive flood risk and drainage design. This includes a requirement for all footpaths to have a fall, allowing runoff and convey surface water towards a drainpipe to prevent pooling. Additional secondary point of access and egress to site for vehicles during peak rainfall events to northeast, connecting to Oxford Road carriageway.	Medium	Low	Minor
Players	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Increasing and/or extreme temperatures, particularly during summer months may lead to heat related illness, and inability of players to participate in games. This may have a disproportionate effect on younger players, in particular children and teenagers playing in junior leagues or football academies.	During Proposed Development operation, there are 43 football games projected to occur annually, the majority of which are likely to be held in the afternoon/early evening. This will generally avoid the peak daily maximum temperatures, though afternoons and evenings in summer times will get hotter in future decades. The Proposed Development design incorporates a fully covered players and officials' area on the west stand at the pitch level of the stadium to provide shading for players.	Medium	Medium	Moderate
	Temperature	Low temperatures	The occurrence of snow and ice may decrease with the overall warming trend that is projected; however periods of cold weather will still occur. During these cold events, surfaces, including	Pavements and drainage design have been designed to avoid standing water that could potentially freeze into slippery walking surfaces.	Low	Low	Negligible

			pavements may become slippery.				
	Precipitation	Increasing precipitation Extreme precipitation events Flooding	Difficult playing conditions and safe travel conditions Travel to and from the games may encounter dangerous conditions	The Proposed Development's design does not incorporate a cover for the pitch, with the design team stating no intention to incorporate this in the future. However, the comprehensive drainage design means the pitch is capable of absorbing heavy rainfall. Refer to Flood Risk Assessment for further information. Additional secondary point of access and egress to site for vehicles during peak rainfall events to northeast, connecting to Oxford Road carriageway.	Medium	Low	Minor
	Storms	Lightning strike associated with storm frequency and intensity	Lightning strike hitting players with risk of severe injury or fatality	Risks are reduced in part due to the stands and building structures being of a level that would attract lightning strikes, in particular with lightning protection built in to the design. While climate trends around storms are uncertain, there is potential for them to increase in severity and frequency.	Low	High	Minor
Fans/spectators	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Heat related illness of fans/spectators, in stands hospitality areas, and travelling to and from the stadium.	The Proposed Development's design includes mechanical cooling within the hospitality areas, including the restaurant and bar, in addition to mechanically cooled sensory room available for the use of heat-vulnerable users or any other users to cool down in the event of a heat-related event. The Proposed Development also includes a community plaza and fan zone to the North of stadium of which the location avoids direct sunlight.	Medium	Medium	Moderate
	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Difficulty in accessing travel routes due to surface water flooding, including walking and cycling during adverse wet weather	The Proposed Development includes a comprehensive flood risk and drainage design which has been modelled and designed with consideration of climate change allowances. Measures include the design of footpaths which have a fall on them to allow runoff and convey surface	Medium	Low	Minor

		Flooding		water to a drainpipe to prevent pooling. Further design measures allow for exceedance flows to drain towards a low spot within the car park. The Proposed Development includes a secondary point of access for vehicles in the event of an intense rainfall event. Refer to embedded mitigation section for further information.			
	Precipitation	Decreasing precipitation (summer) Drought	Reduced water availability for event management	The Proposed Development includes a rainwater harvesting system in order to provide water for event management in the event of mains failure.	Low	Low	Negligible
Hotel guests	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Heat related illness of hotel guests	Hotel located within the North-Stand situated North-West of the Site, 2nd and 4th floor. The Proposed Development design includes automatic monitoring for out-of-range values within hotel ventilation system.	Medium	Low	Minor
Conference/ exhibition events users	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Heat related illness of conference and event users	The Proposed Development includes large mechanically cooled commercial spaces located within the North stand ground floor.	Medium	Low	Minor
Pitch	Temperature	Increasing temperatures (summer) Extreme temperatures Heatwaves	Reduced water availability for maintenance. Scorching of grass, grass dieback and desiccation and erosion of pitch.	A rainwater harvesting system with below ground storage tank and an internal storage tank is included within design which will provide resilience in the event of mains water failure.	Medium	Low	Minor
	Precipitation	Increasing precipitation Extreme precipitation events Flooding	Flooding and waterlogging of pitch during intense rainfall	The Proposed Development includes a comprehensive flood risk and drainage design which has been modelled and designed with consideration of climate change allowances, and use of SuDS to attenuate runoff and reduce peak flows whilst providing biodiversity benefits. The	Medium	Low	Minor

				position of one of the storage ponds accommodates runoff from the pitch.			
Whole site, structures, assets and site users people	Temperature Precipitation	Increasing temperatures (summer) Decreasing precipitation (summer) Droughts Wildfire	Increase risk of wildfire. Damage to assets and direct safety risks. Wildfire smoke from a wider area may cause health issues for visitors, staff and players.	No formal consideration has been included for firebreaks, however fire safety team will consider the need for the woodland to be offset from the stadium by a suitable distance. This will be further assessed during detailed design in line with fire safety requirements.	Medium	Medium	Moderate
Drainage system	Precipitation	Increasing precipitation (winter) Extreme precipitation events	Increasing precipitation, particularly during winter, as well as extreme precipitation events may result in drainage systems becoming overwhelmed.	The Proposed Development comprises a comprehensive Flood Risk and drainage design which has been modelled with consideration of climate change at an uplift of 40%. Drainage design measures include filter drains, ponds and rain gardens which act as storage and reduce flow of water. For further information, refer to the Flood Risk Assessment.	Medium	Low	Minor

Mitigation Measures and Residual Effects

GHG Emissions

16.90 Post implementing the embedded mitigation measures, there are no significant residual effects. While the embedded measures will mitigate the significant effects of the Proposed Development to a certain extent, measures outlined in this section are further recommended to mitigate the effects on the wider climate.

Construction

16.91 As part of the construction phase, it is recommended that the CEMP set out good practice considerations for reducing construction stage operational emissions, for example:

- Use of biofuels in site vehicles which has a lower emissions factor than diesel.
- Use of hydrogen or electric site vehicles and equipment.
- Use of temporary energy storage systems.
- Requiring the contractors to purchase renewable energy; and
- Use of renewable energy generating systems such as PV cells on construction buildings

Operation

16.92 Over and above the embedded mitigation which has led to minor effect, further measures outlined below are recommended to mitigate the Proposed Development's impact.

- It is recommended that a maintenance strategy be produced to ensure durability and use of materials that require less maintenance, repair and replacement and to mitigate the residual emissions.
- Emissions from match day activities like energy and water use, waste generation, and food consumption need to be minimized. Energy efficient technologies, renewable energy sources, robust waste management processes, and sustainably sourced, low carbon food and beverage options should be implemented where possible.
- The new stadium has set an ambitious emissions reduction target of 51%, major changes will be made to fan travel patterns. Proposed measures should include improving public transport links, providing incentives for car sharing, cycling and walking, and discouraging single-occupancy car use through parking restrictions.
- Careful planning and integration of emissions reduction measures across all aspects of travel, operations, resource use and procurement will be required for the new

stadium to meet its emissions goals. Monitoring and refinement of approaches will also be needed over time.

Climate Resilience

16.93 This section describes further mitigation measures for the operational stage to manage residual risks, to be implemented as the climate changes throughout the lifetime of the project.

16.94 While the embedded mitigation measures included within the design will provide a level of resilience to future climate change, additional measures will be required to maintain the Proposed Development's resilience during the operation phase, and will include monitoring the response of the Proposed Development to extreme climate events and seasonal trends, the upgrading of assets to tolerate changing temperatures and precipitation patterns, and the amendment of the operation of the site to ensure the safe working environments and use by staff, players and visitors.

Moderate risks

16.95 The risk assessment in **Table 16.14** outlines the following Moderate significance rating due to future climate changes that are not mitigated by the design. All of these risks relate to increased summer temperatures, in particular heatwaves, which are projected to become more extreme and frequent. No significance ratings were identified as being Major. The recommended mitigation measures are outlined for each risk or group of similar risks. With these further mitigation measures in place and monitored and updated through the operational lifetime of the Proposed Development, these risks can be reduced to **Minor,** which is **not significant**.

Table 16.14: Moderate Risks and Further Mitigation Requirements

Risk	Further Mitigation
Increasing and/or extreme temperature events, and reduced precipitation, particularly during summer months may affect vegetation planted as part of the Proposed Development. Such affects may include vegetation dieback, tree failure, soil desiccation and erosion, failure of habitats to establish. A related minor risk is increasing and/or extreme precipitation events, particularly during winter months may affect vegetation planted as part of the Proposed Development. Such affects may include waterlogging of areas of vegetation and subsequent failure of habitats to establish	Incorporation of vegetation species considered suitable for the Oxford Clay geology under future precipitation patterns and temperatures into detailed design and specifications for landscape design. Detailed drainage design to include retention of summer rainfall, irrigation of planting, and drainage of excess winter or summer storm rainfall. This should take into account the risks of winter waterlogging as well as the risks of soils drying out and cracking in prolonged dry and hot summers, within the same years.

	Monitoring the tree species within vegetation plantation design and how they respond to increasing temperatures and temperature extremes, as well as changes in precipitation, review and embed lessons learnt.
Increasing and/or extreme temperatures, particularly during summer months may lead to heat related illness, and inability of players to participate in games. This may have a disproportionate effect on younger players, in particular children and teenagers playing in junior leagues or football academies. Heat related illness of fans/spectators, in stands hospitality areas, and travelling to and from the stadium.	The risks of heat related illnesses of fans/spectators and of players should be managed through the development and implementation of heat management plans with weather forecast alerts and appropriate temperature trigger levels, and procedures for before, during and after periods of extreme heat. This should consider the risks associated with travel and movement of people, the use of cool spaces within the Proposed Development buildings, and the training of staff to recognise and identify heat related symptoms. The timing of training, matches and other events should consider the hottest parts of the day over future decades and consider moving timings to cooler parts of the day, for example training in the cooler parts of the morning, and matches later in the afternoon or evening. The cancellation of events should additionally be planned for as a response to extreme heatwaves. This risk should take into account industry best practice as it develops in relation to hotter summers and heatwaves, plus taking best practice from countries already experiencing hotter summers, and review and amend the heat management plans and procedures periodically. Actions within the heat management plans should include review of the response of the Proposed Development to heatwaves as they occur, and update of the plans according to lessons learnt.
Increase risk of wildfire. Damage to assets and direct safety risks. Wildfire smoke from a wider area may cause health issues for visitors, staff and players	The fire safety team will consider the need for the woodland to be offset from the stadium by a suitable distance. This will be further assessed during detailed design in line with fire safety requirements.

Minor Risks

16.96 Minor risks have been identified in relation to increase in the deterioration rate of assets and also risks to the future operation of the Proposed Development as the climate changes. While these are considered minor risks, the following further mitigation measures are recommended to ensure they can be monitored and managed during the operational lifetime of the Proposed Development, and that mitigation can be tailored according to climate change as it and its effects are observed. It should be noted that as the effects of climate change are observed, the level of risk may change.

Table 16.15: Minor Risks and Further Mitigation Requirements

Risk	Further Mitigation
Increasing and/or extreme temperatures, particularly during summer months, have the potential to result in overheating and thermal expansion of metallic and plastic structures	Inspections and maintenance regimes to consider increasing winter seasonal rainfall, intense summer and winter storms, drought and ground cracking, higher seasonal temperatures, and hotter and more frequent heatwaves. Review of climate projection data at the time of asset upgrades and specification of replacement assets to be tolerant to projected climate change across their design life. Upgrades of assets in line with the adaptive capacity embedded within the design, for example the addition of additional chillers and air conditioning equipment for indoor climate control in the ceiling and plant room areas with an allowance included for them. Inspection as part of a regular programme plus additional inspections following extreme weather events such as storms, floods and heatwaves to determine damage and repairs. Inspections to include structures, M&E assets, drainage and earthworks. Monitoring of electrical assets using early warning systems associated with overheating due to increasing temperatures and temperature extremes. Monitoring and review of structural assets to ensure appropriate maintenance arising from potential deterioration due to climate change impacts
Increases in seasonal precipitation, particularly in winter months, in addition to extreme precipitation events, may result in increased deterioration rates for structural joints within the stadium structure	
Increasing and/or extreme temperatures, particularly during summer months, have the potential to result in overheating of electrical components, wiring and cabinets, leading to higher risk of electrical failure and fires	
Increases in precipitation, particularly during winter months, and extreme precipitation events could lead to surface water flooding, and subsequent disruption and closure of shared use paths around the Site	
Overheating of electrical components, wiring and cabinets, leading to higher risk of electrical failure and fires	
Reduced water availability for maintenance. Scorching of grass, grass dieback and desiccation and erosion of pitch	Monitoring the effects of droughts and intense rainfall on the pitch, including the effectiveness and capacity of irrigation and drainage systems. Consideration of additional capacity for rainwater or drainage to be planned in for pitch maintenance. Use of industry best practice and technology in maintaining a pitch during drought conditions, including drought-tolerant grass species.
Flooding and waterlogging of pitch during intense rainfall	
Extreme precipitation events and high wind speeds, typically associated with storm conditions, may result in loss of power of mechanical and electrical assets and disruption to site use	Adverse weather plans to include operational actions ahead of, during and after intense rainstorms & flooding, storms and heatwaves, including receiving weather alerts from the Met Office and setting of trigger levels for forecast wind, heat, rainfall and lightning. Adverse weather plans should consider roles and responsibilities of various staff members in ensuring site functions are maintained, in communicating decisions relating to adverse weather, and in managing site users. As highlighted in Flood Risk Assessment, it is recommended that a Flood Emergency Access plan is developed and distributed to the stadium and local
Inability to complete work activities in high rainfall and intense rainfall conditions due to increased risk of dangerous working conditions. This may disrupt game days or commercial events i.e. security who are required on site 24 hours a day	
Increasing precipitation, particularly during winter, as well as extreme precipitation events may result in drainage systems becoming overwhelmed	

Risk	Further Mitigation
Difficult playing conditions and safe travel conditions. Travel to and from the games may encounter dangerous conditions	emergency services due to potential for large masses of people on site. Monitoring the Site as a whole and see how it responds to extreme weather events, and planning for reviews of procedures, including identifying and embedding lessons learnt (positive and negative lessons learnt) Train staff in weather and climate change risk awareness in order to drive safe behaviours and decision making in approach to outdoor working during extreme events and emergency response procedures.
Difficulty in accessing travel routes due to surface water flooding, including walking and cycling during adverse wet weather	
Lightning strike hitting players with risk of severe injury or fatality	
Heat related illness of hotel guests	
Heat related illness of conference and event users	
Inability to complete work activities in high temperatures due to increased level of discomfort for staff. This may disrupt game days or events management, i.e. Food and beverage outlets situated on concourse which runs around north, east and southern stands outside.	

Cumulative Effects

GHG Emissions

16.97 Effects from GHG emissions are not localised but contribute to the global atmospheric concentration of greenhouse gasses and consequently contribute to the global climate change effect. Therefore, assessing emissions from the Proposed Development in terms of combined effects with other nearby developments is irrelevant in terms of localised effects.

16.98 The Proposed Development should be viewed, rather, in the context of developments and construction projects globally as it contributes to a global climatic effect.

16.99 This Chapter has inherently assessed the effects regionally and globally in the previous sections. The cumulative effects of the proposed development are considered to be **not significant** when compared against the regional and global net zero targets.

16.100 However, as there are GHG emissions associated with all new developments globally and that global climate models are complex, increase in emissions should be taken alongside overall commitments. If the global net zero trajectory and commitments are not adhered to, cumulative effects of all new development would contribute to the global climate tipping point.

Climate Resilience

16.101 In line with Schedule 4 (5)(e) of the EIA regulations, a description of the likely significant cumulative effects has been considered as part of the technical assessment to assess chronic risk.

16.102 For climate resilience, cumulative effects are those arising from impacts of the proposed development in combination with impacts of other proposed development projects that are not yet built or operational.

16.103 For the Proposed Development and future development of the surrounding area, the Site is bound by a number of site allocations within the adopted Local Plan. As outlined in Chapter 2 there are a number of proposed developments within the immediate vicinity of the Proposed Development and beyond, including significant urban development throughout Oxford and the Oxford Green Belt. In addition to this, there is likely to be further development in the Oxford area over the timescales considered by the climate resilience assessment (i.e. between now and the end of the century), which is not quantifiable.

16.104 Due to this level of local urban density within proximity of the proposed development area, it is plausible that the future built-up nature could increase an urban heat island effect, though noting that Oxford is a relatively small city surrounded by countryside so this effect would not be as significant as larger cities. The urban heat island effect describes the effect whereby hard materials and surfaces prevalent in cities absorb heat during the day and release it at night, leading to higher night temperatures relative to green areas.

16.105 Such effects may be exacerbated by future rising average seasonal temperatures, and may have an effect or bringing forward upgrades or changing asset specifications, or a need for additional cooling infrastructure sooner than if an urban heat island weren't experienced. It is difficult to attribute a level of significance to this affect due to the level of uncertainty relating to future development, local climate effects and development of an urban heat island. The mitigation to this within the Proposed Development is captured in the further mitigation relating to monitoring and management of the effects of future climate change.

16.106 The mitigation to the Proposed Development's contribution to an urban heat island effect includes the proposed retention of vegetation, new planting of trees, and construction of areas of green roof that will provide a degree of local cooling at the Development location, and reduce the overall heat emitted from the site compared to a development without planting.

16.107 The quantification of this effect and its level of significance cannot be readily assessed due to the uncertainties noted above around future development and the local future climate conditions.

Conclusions

GHG Emissions

16.108 Overall, the Proposed Development's effects on climate for embodied (including construction) and operation are anticipated to be **Minor** in significance (in line with the IEMA guidance) as the increase in emissions compared to the baseline would not impact the UK and regional Oxfordshire carbon budgets and will not significantly affect the ability of the Government to meet its carbon reduction targets.

16.109 In addition, the embedded mitigation measures and the proposed sustainability measures have the potential to minimise the effect of the Proposed Development.

16.110 Recognising the importance of impacts on climate change, the Proposed Development shall seek to reduce GHG emissions as far as practicable. It is anticipated that due to the scheme being at the initial design stage, a further as-built carbon assessment, including GHGs, should be undertaken post-construction.

Table 16.16: Summary of residual effects - GHG

Effect	Receptor (Sensitivity)	Magnitude	Nature/Level of Effect	Mitigation	Residual Effect
Construction Phase					
Effects on the global climate system from the release of greenhouse gas (GHG) emissions	Global climate system (High)	Low	Short-term, temporary, direct,	Mitigation is required to minimise the impact of construction stage emissions	Minor, not significant
Operational Phase					
Effects on the global climate system from the release of greenhouse gas (GHG) emissions – Energy use.	Global climate system (High)	Low	Long-term, permanent, direct effect	Mitigation is required to minimise the impact of operational stage emissions	Minor, not significant.
Effects on the global	Global climate	Low	Long-term, permanent, direct,		Minor, beneficial,

climate system from the release of greenhouse gas (GHG) emissions – traffic emissions.	system (High)		beneficial effect		not significant.
Cumulative Effects					
Effects on the global climate system from the release of greenhouse gas (GHG) emissions	Global climate system (High)	Low	Long-term, permanent, direct effect	Mitigation is required to minimise the cumulative impact	Minor, not significant

Climate resilience

16.111 There is potential for climate change to adversely affect the Proposed Development throughout its operational lifetime, including physical risks to the structural, M&E and drainage assets, landscaping, and health and safety of staff and all site users. The embedded mitigation measures within the Proposed Development's design provide a degree of resilience to future climate conditions, in particular for the infrastructure, reducing risks to the Proposed Development. The embedded mitigation measures include designing to the appropriate structural design codes and industry guidance on climate adaptation, and an extensive flood risk and drainage design which accommodates climate change allowances, and appropriate monitoring regimes incorporated for electrical systems.

16.112 Risks of moderate significance have been identified for the future landscaping and risks of heat-related illness to site users due to projected future summer temperatures and heatwaves. Future mitigation measures that will monitor, plan for and respond to seasonal changes and extreme climate events have been outlined will provide additional resilience that, if implemented across the lifetime of the Proposed Development, should reduce risks to not be significant.

Table 16.17: Summary of residual effects – Climate Resilience

Effect	Receptor (Sensitivity)	Magnitude	Nature/Level of Effect	Mitigation	Residual Effect
Construction Phase					
Construction Phase not assessed.	N/A	N/A	N/A	N/A	N/A
Operational Phase					
Increasing and/ or extreme	Stadium structure (low)	Medium	Long term Minor	Monitoring and management	Minor, not significant

Effect	Receptor (Sensitivity)	Magnitude	Nature/Level of Effect	Mitigation	Residual Effect
temperature events, and reduced summer precipitation. Embedded mitigation includes design measures to account for extreme temperatures.	Mechanical, electrical and power assets (low)			plans throughout operational lifetime, including as part of inspection and maintenance, and to respond to gradually increasing severity of extreme weather events.	
	Landscape planting (medium)		Long term Moderate		
	Players (medium)				
	Fans/spectators (medium)				
Increasing and/or extreme precipitation events, particularly during winter months. Embedded mitigation includes drainage uplifts and comprehensive flood risk design.	Stadium structure (low)	Medium	Long term Minor	Monitoring and management plans throughout operational lifetime, including as part of inspection and maintenance regimes and response to extreme weather events.	Minor, not significant
	Mechanical, electrical and power assets (low)				
	Landscape planting (low)				
	Players (low)				
	Fans/spectators (low)				
Decreasing in precipitation (during summer months)	Landscape plating (medium)	Medium	Long term Moderate	Consideration of future climate conditions within detailed landscape design and maintenance specifications.	Minor, not significant
	Fans/spectators (low)	Low	Long term Negligible	Monitoring and management plans throughout operational lifetime.	Negligible, not significant
Cumulative Effects					
Potential contribution to an Urban Heat Island effect. Embedded mitigation includes retention of vegetation, new planting of trees, and construction of areas of green roof.	N/A	The quantification of this effect and its level of significance cannot be readily assessed due to the uncertainties around future development and local future climate conditions.		Monitoring and management of the effects of future climate change, including effects on landscape planting and users of the Proposed Development.	N/A

References

[i] Greenhouse Gases (GHGs) refer to the seven gases covered by the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3). These are measured in units of carbon dioxide equivalent (CO2e) which expresses the impact of each gas in terms of the amount of CO2 that would create the same impact. GHGs are commonly referred to as carbon.

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