15 CLIMATE CHANGE

15.1 INTRODUCTION

This Chapter of the Environmental Statement (ES) evaluates the effects of the Proposed Development on Climate Change. This assessment was undertaken by Ecolyse Limited and Air Quality Consultants Limited.

It is presented in two parts:

- Part A assesses the likely significant effects of the Proposed Development on Climate Change through an assessment of the Proposed Development's whole life Greenhouse Gases (GHG) footprint and determines its significance in the context of national and local climate change policy; and
- Part B considers the resilience of the Proposed Development to future changes in climate.

Each part of the assessment includes the following elements:

- Legislation, Policy and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Development Design mitigation
- Assessment of likely Effects;
- Mitigation measures and Residual Effects;
- Cumulative Effect Assessment;
- Summary of likely Effects; and
- Statement of Significance.

Part A of this Chapter of the EIA Report is supported by **Volume 3 Appendix 15.1**.

15.2 LEGISLATION, POLICY AND GUIDANCE

The following guidance, legislation and information sources have been considered in carrying out this assessment (Part A and Part B).

15.2.1 Legislation

The EIA Regulations establish in broad terms what is to be considered when determining the effects of development proposals on Climate Change. In this respect the following legislation is relevant to the Proposed Development:

- Climate Change Act 2008[1];
- Climate Change Act 2008 (2050 Target Amendment) Order 2019[2]; and
- Town and Country Planning (Environmental Impact Assessment) Regulations 2017[3] (as amended)[4].

15.2.2 National and Local Policy

The NPPF (2021)[5] is the key national planning policy relevant to the Proposed Development.

[1] HMSO, (2008). Climate Change Act 2008.
[2] HMSO, (2019). The Climate Change Act 2008 (2050 Target Amendment) Order 2019.
[3] UK Government, (2017). The Town and Country Planning (Environmental Impact Assessment) Regulations (2017), [online]. Available at: https://www.legislation.gov.uk/uksi/2017/571/pdfs/uksi_20170571_en.pdf
[4] HMSO, (2018). The Town and Country Planning and Infrastructure Planning (Environmental Impact Assessment) (Amendment) Regulations 2018. The Stationary Office. October 2018.
[5] Ministry of Housing, Communities & Local Government (2021). National Planning Policy Framework. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

The following local polices are also relevant:

- The emerging Bassetlaw Local Plan: Bassetlaw Local Plan 2020-2037[6], specifically policy ST50 - Reducing carbon emissions, climate change mitigation and adaptation.
- Nottingham Minerals Local Plan (2021-2036)[7], specifically Policy SP3: Climate Change.

15.2.3 Guidance

The following documents have been considered for the assessment of potential effects of the Proposed Development on Greenhouse Gases (Part A):

- Institute of Environmental Management and Assessment (IEMA) Guidance on Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022)[8] ('IEMA Guidance');
- The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (GHG Protocol) (2001)[9];
- Publicly Available Standard (PAS) 2080: 2016 – Carbon Management in Infrastructure (2016)[10];
- Committee on Climate Change (CCC), Net Zero Technical Report (2019)[11];
- CCC, Sixth Carbon Budget (2021)[12];
- HM Government, Net Zero Strategy: Build Back Greener (2021)[13]; and
- Royal Institution of Chartered Surveyors (RICS): Whole life carbon assessment for the built environment, 1st edition (2017)[14].

The following guidance is relevant to resilience of the Proposed Development to Climate Change (Part B):

- IEMA Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation (2020)[15];
- The UK Climate Projections 2018 (UKCP18)[16];
- Met Office UK (2019) UK Climate Projections: Headline Findings[17];
- The National Adaptation Programme (NAP) and the Third Strategy for Climate Adaptation Reporting (DEFRA, 2018)[18]; and

[6]Bassetlaw Local Plan 2020-2037 Publication Version August 2021. Available at https://www.bassetlaw.gov.uk/media/6527/local-plan-publication-version-2020-2037.pdf
[7] Nottinghamshire Minerals Local Plan, Adopted March 2021. Available at https://www.nottinghamshire.gov.uk/media/5077595/adoptedmineralslocalplan.pdf
[8] IEMA, (2022). Assessing Greenhouse Gas Emissions and Evaluating their Significance. 2nd Edition.
[9] World Resources Institute, World Business Council for Sustainable Development, (2001). The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard. World Resource Institute, Revised Edition.
[10] Various, (2016). Publicly Available Standard (PAS) 2080 Carbon Management in Infrastructure. BSI.
[11] CCC, (2019). Net Zero, Technical report.
[12] CCC, (2021). Sixth Carbon Budget. Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/
[13] HM Government (2021). Net Zero Strategy: Build Back Greener
[14] RICS, (2017). Whole life carbon assessment for the built environment. 1st edition.
[15] IEMA, (2020). Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation
[16] Met Office UK, (2018). UK Climate Projections. [Online]. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index
[17] Met Office UK, (2019). UK Climate Projections: Headline Findings. [Online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp-headline-findings-v2.pdf
[18] Department for Environment, Food & Rural Affairs (Defra), (2018). The National Adaptation Programme (NAP) and the Third Strategy for Climate Adaptation Reporting. [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727252/national-adaptation-programme-2018.pdf

- UK Climate Change Risk Assessment 2022 (HM Government, 2022)[19].

Part A: Greenhouse Gas Assessment

15.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

15.3.1 Scoping Responses and Consultations

Consultation for this EIA Report topic was undertaken with Nottinghamshire County Council (NCC) shown in **Table 15-1**

Table 15-1: Scoping and Consultation Response

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
Nottinghamshire County Council (NCC)	Scoping opinion, 4th November 2022	*Sustainability and Climate Change - Scope in* The Minerals and Waste Planning Authority (MWPA) considers this to be a matter of significance and would benefit from a section within the ES. Section 5.1.1.5 of the Scoping Report explains that a sustainability and carbon review will be undertaken and included as a separate report and that the ES will report the results within the introductory chapters. The MWPA considers the findings should instead be set out in a dedicated chapter. Much of the applicant's case for the need for the proposed development rests on the potential significant beneficial impacts for the climate and wider sustainable development objectives by providing a supply of PFA which can be recycled and displace traditional primary minerals used in construction. There are particular uses in cementitious applications where there is a need for decarbonisation. The potential emissions savings of using PFA are then balanced against the operational emissions of extraction, including transport emissions, as part of calculating a whole life greenhouse gas footprint for the development. These are significant environmental considerations in the context of the proposed project and should be explored within the ES. In addition, the interaction of the development with the climate- notably from flooding- may also require some summary assessment and cross referencing from other chapters.	This chapter has been prepared to provide an assessment of the likely significant climate change effects of the Proposed Development. Consistent with EIA regulations these include: (Part A) an assessment of the likely significant effects of the Proposed Development on Climate Change through an assessment of the Proposed Development's whole life Greenhouse gases (GHG) footprint, and (Part B), an assessment of the resilience of the Proposed Development to future changes in climate (e.g., due to increased flooding

[19] Her Majesty's Government, (2022). UK Climate Change Risk Assessment 2022. [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

15.4 SCOPE OF ASSESSMENT

GHG are gaseous compounds that have been identified as contributing to a warming effect in the earth's atmosphere. The primary GHG of concern with respect to the Proposed Development is carbon dioxide (CO_2) which is emitted from combustion sources such as vehicular transport and heating and energy plant. Other GHGs also contribute to climate change, and these are accounted for based on their Global Warming Potential (GWP). The combined GWP effect of all GHG emissions is presented as carbon dioxide equivalent (CO_2e).

The scope of the GHG assessment was defined through its:

- Geographic scope;
- Temporal scope; and
- The activities contributing to GHG emissions.

Each is described further below.

15.4.1 Geographic Scope

GHGs contribute to climate change, which is a global environmental effect and as such the study area for the assessment is not limited by any specific geographical scope or defined by specific sensitive receptors.

The geographic scope was therefore determined by identifying emission sources associated with the Proposed Development over which the Applicant has some ability to control or influence, as detailed further below.

15.4.2 Temporal Scope

The temporal scope was consistent with assessing the whole lifecycle GHG emissions from the Development. The construction and operational phase of the Development was considered as follows:

- Construction Phase: Direct and indirect GHG emissions resulting from the Proposed Development over the main construction period relating to the site processing facilities. It is assumed the construction of these facilities would occur over an approximate 12-month period during 2023.
- Operational Phase: Direct and indirect GHG emissions resulting from the Proposed Development in the assessment year of the completed Proposed Development, which has been assumed to be in around 2024 for the purposes of the assessment. To ensure a conservative assessment of the Proposed Development's GHG emissions, a full year of production has been assumed to occur in 2024. If the project is still in ramp up phase at this time, the GHG emissions will be lower than presented for the assessment year in this Chapter, but it would not materially affect the assessment. Consideration has also been given to Proposed Development's GHG emissions over its whole lifetime, which would result in circa 6.5 million tonnes of PFA being extracted over a number of phases (see Table 5.1 in Chapter 5 for precise total tonnage of PFA to be extracted).

15.4.3 Activities Contributing to GHG Emissions

The following activities contribute to GHG emissions from the construction of the Proposed Development and are included in the scope of the assessment:

- Emissions embodied in the materials used to construct the Proposed Development; and
- Transport of construction materials to the Site.

The following activities contribute to GHG emissions from the operation of the completed Proposed Development and are included in the scope of the assessment:

- Operational energy used by the Proposed Development;
- Operational transport activities related to the Proposed Development; and
- Repair, maintenance and refurbishment of the Proposed Development during its lifetime.

A small number of minor activities were scoped out consistent with the IEMA Guidance[8]. IEMA recommends that activities with emissions that individually are less than 1% and in total equal less than 5% of the lifecycle emissions of the Proposed Development are scoped out of the assessment. These are as follows:

Construction:

- GHG emissions due to land use change – Likely to be minimal and to be less than 1% of lifetime emissions. Any net increase in land use GHG emissions from the Proposed Development would be minimised through the biodiversity and landscape planning for the Site; and
- GHG emissions from construction site activities. These are unlikely to be more than 1% of the whole lifetime GHG footprint for the Proposed Development and would be minimised through the good construction site practices and adherence to the CEMP.

Completed Development:

- GHG emissions from the treatment and disposal of waste. These are a small component of the GHG emissions of the Proposed Development and would be minimised through standard best practice including the implementation of operational waste management plans;
- GHG emissions associated with water use (including water treatment and supply) – these are expected to result in very small contributions to lifetime GHG emissions; and
- Emissions from decommissioning of the Proposed Development at the end of its life. End of life emissions include demolition of buildings and structures, transport of waste, processing of waste and disposal. The UK has committed to achieve net zero carbon emissions from 2050 onwards, therefore by the end of the Proposed Development's life, it can reasonably be expected that emissions from demolition, transport and waste processing would be well on the way to net zero and as such would be small. As such, it is not considered necessary to include end of life emissions estimates within this assessment.

15.5 BASELINE METHODOLOGY

The Site is currently used as agricultural land (grazing). There would be some emissions associated with pastural agriculture on the Site, balanced in some part by sequestration of small amounts of carbon from the natural habitats on the Site. In any case, the existing and future baseline GHG emissions associated with the existing Site would be very small and as such have been assumed to be zero for simplicity.

In addition to the existing use of the Site, IEMA guidance[8] acknowledges that for GHG assessment, it is sometimes appropriate to consider an alternative baseline scenario, such as an alternative location or development that serves the same purpose as the proposals.

In the case of the Proposed Development, it is intended that the PFA would be used as a direct replacement for Portland Cement in concrete manufacture. Extraction and production of Portland Cement results in GHG emissions as a by-product of the chemical conversion process whereby calcium carbonate ($CaCO_3$) is converted to lime (CaO). Emissions are also associated with fossil fuel consumption required to generate heat from

the processing as well as from vehicles and machinery used to extract, process, and transport the limestone.

Baseline emissions from cradle to gate production of Portland Cement have been calculated, using a recently validated Environmental Product Declaration (EPD) for UK Portland Cement production obtained from the Mineral Products Association[25].

It is assumed that PFA would replace Portland Cement on a 1:1 ratio (i.e., 1 tonne of PFA replaces 1 tonne of Portland Cement in concrete manufacture).

15.6 METHODOLOGY FOR THE ASSESSMENT OF EFFECTS

The assessment considered the whole life GHG emissions from the Proposed Development. The effect of GHG emissions released during the construction and operational phase is not distinguishable; therefore, there is no benefit in considering the likely significant effects separately for these phases. The assessment presents the quantification of the construction and completed Proposed Development's GHG emissions together to enable an assessment on the significance of those emissions.

The GHG assessment of effects is structured as follows:

- Quantification of whole life GHG emissions from the Proposed Development.
- Assessment of the likely significant effects (following the approach described in Section 15.6.2); and
- Assessment of residual effects.

15.6.1 Quantification of whole life GHG emissions from the Proposed Development

Construction Emissions

The assessment of GHG emissions during construction followed the following approaches:

- The embodied GHG emissions from the construction of the Proposed Development were calculated using emission factors obtained from a number of sources including RICS guidance[20] and the University of Bath's Inventory of Carbon and Energy (v3.0)[21]. The factors are applied to either building areas or mass of materials used for construction of the various buildings, structures, and assets at the site; and
- GHG emissions from construction traffic were calculated based on predicted construction traffic movements provided by the Applicant, average travel distances based on RICS benchmarks[14] and latest government published[22] GHG emission factors for construction vehicles.

Completed Development Emissions

The assessment of operational effects of the completed Proposed Development adopted the following approaches:

- GHG emissions from PFA exports and materials imports were calculated using government published GHG emission factors[22] and vehicle movements, types and distance travelled data provided by the project team;
- GHG emissions associated with site maintenance and restoration including maintenance and repair of buildings and structures during its lifetime and restoration of the site following PFA extraction are based emissions factors from a range of sources including RICS[14], University of Bath[21], and others;

[20] RICS (2012) Methodology for calculating embodied carbon of materials. First edition.
[21] University of Bath (2019) Inventory of Carbon and Energy v3.0
[22] Department for Business, Energy & Industrial Strategy (BEIS), (2021). Greenhouse gas reporting: conversion factors 2021. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

- GHG emissions from natural gas consumption by the on-site CHP engines used to provide heat to the PFA drying process are based on natural gas consumption data provided by the CHP supplier;
- GHG emissions from operational diesel consumption in site plant (excavators, loaders, and tippers) has been estimated based on data on the number of plant required, site operating hours, and vehicle fuel consumption data taken from the European Environment Agency EEA/EMEP Pollution Inventory Guidebook[23]; and
- lifetime GHG emissions were also considered which include where relevant published strategies for decarbonisation of transport reflecting UK climate change policy and strategies. For some sources such as fuel consumption, no future decarbonisation has been assumed to ensure a worst-case assessment.

The net increase in GHG emissions from construction and during operation in the assessment year is compared to the emissions associated with the extraction and production of an equal mass of Portland Cement. The assessment assumes an average annual PFA extraction rate of approximately 300,000 tonnes per annum with the total PFA extracted over the lifetime of approximately 6.5 million tonnes (see Table 5.1 in Chapter 5 for the precise tonnage of PFA to be extracted).

The assessment also presents the GHG mitigation being proposed, which follows the principles of the GHG management hierarchy (avoid, reduce, off-set), to minimise, as far as reasonably practicable, the anticipated GHG emissions over the Proposed Development's lifecycle.

Cumulative Effects

IEMA guidance[8] makes clear that climate change is "*the largest interrelated cumulative environmental effect"* and therefore the assessment of GHG emissions which contribute to climate is intrinsically cumulative.

On this point IEMA state that "*The atmospheric concentration of GHGs and resulting effect on climate change is affected by all sources and sinks globally, anthropogenic and otherwise. As GHG emission impacts and resulting effects are global rather than affecting one localised area, the approach to cumulative effects assessment for GHGs differs from that for many EIA topics where only projects within a geographically bounded study area of, for example, 10km would be included*".

In terms of this assessment the following are therefore relevant:

- The assessment considered the effects of the Proposed Development in the context of national and local cumulative totals. Since the national totals assume that other developments will contribute GHGs, the assessment considers their implications in determining significance; and
- The geographical location of emissions has no relevance to the assessment. Therefore, the effects of the Proposed Development are independent of any local cumulative emissions.

Taking this into account, an assessment of the impacts from GHG emissions associated with cumulative developments was not required and the cumulative GHG effects are considered to be the same as those for the completed Proposed Development. This is consistent with IEMA guidance which states that "*Effects of GHG emissions from specific cumulative projects therefore in general should not be individually assessed, as there is no basis for selecting any particular (or more than one) cumulative project that has GHG emissions for assessment over any other*."

[23] EEA/EMEP (2019) Air Pollutant Emission Inventory Guidebook 2019, Part 1.A.4 Non-Road mobile machinery.

15.6.2 Assessment of the likely significant effects

For GHG emissions there are no recognised significance criteria and thresholds that relate to the quantum of GHG emissions released.

The approach to classifying and defining likely significant effects relies on IEMA Guidance[8] and applying expert judgment on the significance of the Proposed Development's lifecycle GHG emissions taking into account their context, compliance with policy, and mitigation measures.

The IEMA Guidance defines five distinct levels of significance (see **Table 15-2** later in this section) which are not solely based on whether a project emits GHG emissions alone, but the degree to which the project's GHG emissions are consistent with science-based 1.5°C aligned emission trajectories towards net zero. For the UK, these trajectories are effectively defined by carbon budgets, including any sectoral pathways that are designed to achieve the UK's 2050 net zero target.

IEMA established three underlying principles, which informed its approach to significance, as follows:

- The GHG emissions from all projects will contribute to climate change, the largest interrelated cumulative environmental effect.
- The consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive – e.g., population, fauna, and soil; and
- GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant.

Based on these principles, IEMA conclude that:

- When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should be based on its net impact, which may be positive, negative, or negligible.
- Where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project's residual emissions at all stages.
- Where GHG emissions remain significant, but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered.

In advising on the significance of any net change in GHG emission resulting from a development, IEMA identify that to limit the adverse effects from climate change global temperature change needs to be limited to well below 2°C, aiming for 1.5°C. The implication of this objective is that global emissions need to fall to net zero by 2050.

The UK's response to limiting climate change is enshrined in law through the Climate Change Act which requires the UK economy to be net zero by 2050 following a trajectory set through 5 yearly carbon budgets. The 2050 target (and interim budgets set to date) are, according to the CCC, compatible with the required magnitude and rate of GHG emissions reductions required in the UK to meet the global goal of limiting climate change to less than 2°C, aiming for 1.5°C, thereby limiting severe adverse effects.

It follows that the significance of any net change of GHG resulting from a development is not so much whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions consistent with a trajectory towards net zero by 2050.

To establish the significance of the GHG emissions from the Proposed Development judgements were made on:

- the Proposed Development's consistency with policy requirements, since these are specified to ensure the economy decarbonises in line with the UK's net zero target; and
- the degree to which the Proposed Development has sought to mitigate its emissions.

Examining each of these dimensions allows the assessment to make professional judgement on the likely significance of effects based on a set of significance criteria established in the IEMA guidance, summarised in **Table 15-2** below.

Table 15-2: GHG Significance Criteria (based on IEMA Guidence[8])

Significance Rating	Description	Criteria to determine significance of net GHG emissions
Major Adverse	A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero	The project's net 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 policy for projects of this type.
Moderate adverse	A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.	The project's net 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 policy goals for projects of this type.
Minor Adverse	A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.	The project's net GHG impacts are: • fully consistent with applicable existing and emerging policy requirements; and • in line with good practice design standards for projects of this type.
Negligible	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.	The project's net GHG impacts are: • reduced through measures that go well beyond existing and emerging policy; and • better than good practice design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050.
Beneficial	A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.	The project's net GHG impacts: • are below zero; and • cause a reduction in atmospheric GHG concentrations, whether directly or indirectly, compared to the without-project baseline.

IEMA Guidance[8] advises that Major adverse, moderate adverse and beneficial effects should be considered significant in the context of EIA. Consequently, negligible, and minor adverse are considered not significant.

IEMA also advise that context is important to inform the decision maker about the relative severity of environmental effects such that they can be weighed in a planning balance. Therefore, it is essential to provide context for the magnitude of GHG emissions reported in the EIA in way that aids evaluation of these effects by the decision maker. IEMA advise that context can be provided through comparison of the whole life GHG emissions resulting from the Development with national, local and sectoral totals, as well as carbon budgets.

Therefore, the assessment of significance is established over two steps as follows:

Step 1: Establish Context of GHG Emissions

Context for decision making is provided by comparing the net change in the GHG emissions resulting from the Proposed Development with local and national GHG emissions totals, and carbon budgets.

Step 2: Determine Significance of Effects

Significance of effects is established through applying the criteria detailed in Table 15-2 based on professional judgement that considers:

- Step 2a: The consistency of the Proposed Development with national and local policies designed to limit GHG emissions and meet the UK's net zero target; and
- Step 2b: The robustness, timeliness and efficacy of mitigation measures proposed to avoid, reduce and compensate GHG emissions.

In terms of mitigation, IEMA recommends that mitigation should in the first instance seek to avoid GHG emissions. Where GHG emissions cannot be avoided, the Proposed Development should aim to reduce the residual significance of its emissions at all stages. Where additional GHG emissions remain but cannot be further reduced at source, approaches should be considered that compensate for the Proposed Development's remaining emissions, for example through offsetting.

15.6.3 Sensitivity of Receptor

The assessment of climate change does not include identification of sensitive receptors, as GHG emissions do not directly affect specific locations, but lead to indirect effects by contributing to climate change.

15.6.4 Assessment Limitations

It is necessary to make a number of assumptions when carrying out a GHG assessment, although where these are required, these have been taken to ensure a reasonable worst case. Key assumptions made in carrying out this assessment include:

- the production phase would commence in 2024 and over a number of phases (see **Chapter 5, Site Description**) would excavate circa 6.5 million tonnes of PFA;
- PFA would be exported in 30 tonnes articulated tanker-type vehicles;
- PFA would be exported on average 50 miles (85 km) for use as a cement alternative;
- Imported materials (e.g., natural gas, diesel and restoration clay) would be imported from an average distance of 50 miles (85 km);
- PFA would be exported, and other materials are imported in fully laden vehicles which then make an unladen return journey;
- employees are assumed to live within a radius of 15 miles (75% of employees) and 30 miles (25% of employees) of the Site;
- all employees are assumed to travel to and from the Proposed Development by car;
- site plant would operate 90% of the time during site operating hours (7 am to 7 pm Monday-Friday and 7 am to 1 pm Saturday) and would operate at an average engine load of 50%;
- PFA drying would use highly efficient natural gas CHP plant, with a natural gas consumption efficiency of 47 kWh per tonne of PFA dried;
- decarbonisation of road transport through the lifetime of the Proposed Development has been assumed in line with Government data;
- no decarbonisation is assumed for natural gas or diesel consumption through the lifetime of the Proposed Development;

- the assessment of lifetime GHG benefits from use of the PFA as a replacement of Portland Cement has not assumed any future decarbonisation of the cement industry. Whilst use of PFA provides a mechanism for decarbonisation itself, programmes and trajectories for other decarbonisation such as implementation of carbon capture or other technologies are not well defined;
- it has been assumed that 95% of the extracted PFA will be used as a Portland Cement replacement in cementitious applications. The application aspires that 100% of the PFA will be used for cementitious applications;
- a small number of emission sources are scoped out as detailed in **Section 15.4.3**, although these are all minor and would not affect the conclusions of the assessment;
- embodied carbon from construction materials have been estimated based on currently available data on the dimensions of buildings and structures, and the mass and materials of key assets;
- to account for uncertainty and to provide a conservative estimate, the calculated embodied carbon emissions have been uplifted by 25%;
- HGVs during the construction phase, associated with delivery of materials to the Site, are assumed to originate locally (within 50 km) or nationally (within 300 km). A 50:50 split of local and national HGV trips has been assumed;
- Construction site staff are assumed to travel over the same distances as the operational phase employees; and
- all construction site staff are assumed to travel by car.

15.7 BASELINE CONDITIONS

As described in **Section 15.5**, the baseline and future baseline GHG emissions for the existing Site are taken to be zero.

However, an alternative baseline scenario has been considered which calculates the emissions associated with the extraction and production of Portland Cement, which the PFA produced by the Proposed Development would replace.

The Applicant has advised that at least 95% of the extracted PFA would be used to replace Portland Cement due to its high-grade qualities (equivalent to 292,102 tonnes per annum based on annual average PFA extraction of 307,476 tonnes[24]). The remaining 5% (15,374 tonnes) is assumed to be used for non-cementitious applications which would have a lower carbon benefit so is not included in the baseline calculation. This assumption is designed to be conservative as the aim of the Proposed Development is to use 100% of the PFA as a replacement for Portland Cement.

Based on an average 292,102 tonnes of PFA per annum being used as Portland Cement replacement and using a carbon intensity factor of 0.812 tCO_2e/tonne for Portland Cement from a recently validated EPD for UK Portland Cement[25], the total annual baseline GHG emissions would be 237,275 tonnes CO_2e. Over the lifetime of the Proposed Development (as detailed in Chapter 5), where circa 6.5 million tonnes of PFA are extracted (assuming no decarbonisation of cement production and 95% is used to replace Portland Cement), this equates to circa 4.8 million tonnes CO_2e. This would increase to upwards of 5 million tonnes CO_2e if 100% of the PFA could be used as replacement of Portland cement.

15.8 DEVELOPMENT DESIGN MITIGATION

Measures to avoid or reduce potential effects from GHG emissions have been incorporated into the design of the Proposed Development ('embedded mitigation'). This includes 'mitigation by design' whereby aspects of the Proposed Development have been re-

[24] Calculated based on data set out in Chapter 5, Table 5.1
[25] EPD (2022) Environmental Performance Declaration. UK Average Portland Cement for Mineral Products Association (Valid April 2022 to April 2027).

designed to avoid or reduce effects. Embedded mitigation is taken into consideration when undertaking the assessment of significant effects. If significant effects are predicted further mitigation is detailed.

15.8.1 Mitigation by Design

The key mitigation measures embedded into the design of the Proposed Development would be developed within three deliverables, secured by suitable planning conditions, that would aim (among other environmental controls) to reduce GHG emissions:

- A Construction Traffic Management Plan to minimise construction traffic movements and emissions;
- Staff Travel Plan to reduce the number of employees travelling to the Site by single occupancy car; and
- Outline Construction Environment Management Plan to minimise construction waste and limit emissions from site plant.

In addition, the drying plant specified for the Proposed Development to dry the PFA prior to export is an innovative low energy design, that uses air rather than large amounts of heat to dry material. The system is designed to consume 75%-80% less natural gas than conventional thermal drying systems, therefore saving comparable amounts of carbon.

15.9 ASSESSMENT OF LIKELY EFFECTS

The assessment of likely effects considers the whole life GHG emissions over the construction and operational phase. These are summed to provide the whole life GHG for the Proposed Development and compared the whole life GHG emissions of the alternative baseline.

15.9.1 Quantification of Whole Life GHG Emissions from the Proposed Development

Construction – Embodied in materials

The embodied GHG emissions associated with the Proposed Development are estimated to be 7,136 tonnes CO_2e. These are assumed to be associated with the initial construction period of the processing areas that would occur over approximately 1-year, which equates to 7,136 tonnes CO_2e per annum. The detailed embodied GHG calculations are presented in **Volume 3, Appendix 15.1**.

Construction – Transport

In addition to embodied carbon in the materials used for construction, GHG emissions would be created by transportation of materials to the Site. The calculation of construction transport related GHG emissions for the Proposed Development is detailed in **Volume 3, Appendix 15.1.**

The total GHG from construction traffic is calculated as 856 tonnes CO_2e and based on a 1-year construction period, this equates to 856 tonnes CO_2e / annum.

Operation – Site Maintenance and Restoration

The GHG emission from site maintenance and restoration over its lifetime have been estimated to be 7,354 tonnes CO_2e which is equal to 350 tonnes CO_2e per annum over the lifetime of the Proposed Development.

Operation – Employee Travel

GHG emissions from employee travel are those associated with fuel consumption in vehicles used by employees to travel to and from the Proposed Development. Detailed calculations of emissions from employee travel are presented in **Volume 3, Appendix 15.1**.

GHG emissions from employee travel are calculated to be 48 tonnes CO_2e in the opening year and 714 tonnes CO_2e over the lifetime of the Proposed Development.

Operation – Material Transport

GHG emissions from material transport including both the export of PFA from the Proposed Development for use as cement replacement, and the import of materials to the Site is related to the consumption of diesel by HGVs used to transport the materials. Detailed calculations of emissions from materials are presented in **Volume 3, Appendix 15.1.**

GHG emissions from Material Transport are calculated to be 2,493 tonnes CO_2e in the opening year and 43,220 tonnes CO_2e over the lifetime of the Proposed Development.

Operation – Natural Gas Consumption

GHG emissions from natural gas consumption are associated with the use of gas-fired CHP plant used to provide heat to the on-site PFA drying process. Detailed calculations of emissions from natural gas consumption are presented in **Volume 3, Appendix 15.1.**

GHG emissions from natural gas consumption are calculated to be 2,745 tonnes CO_2e in the opening year and 57,653 tonnes CO_2e over the lifetime of the Proposed Development.

It should be noted that the low energy drying plant selected for the Proposed Development offers a natural gas saving of around 75-80% compared to conventional high temperature CHP drying systems. This equates to a saving of around 8,000 TCO_2e per annum.

Operation – Site Plant Diesel Consumption

GHG emissions from non-road mobile machinery operating on the Proposed Development are associated with diesel fuel consumption. These plant include excavators used to extract the PFA, tipper vehicles used to transport the PFA between excavation sites and pre-processing pads or main processing site, and loaders used for moving material inside the processing building. Detailed calculations of emissions from diesel consumption by site plant are presented in **Volume 3, Appendix 15.1.**

GHG emissions from diesel consumption by site plant are calculated to be 3,014 tonnes CO_2e in the opening year and 63,299 tonnes CO_2e over the lifetime of the Proposed Development.

Total GHG Emission Footprint

Table 15-3 summarises the GHG emissions for the Proposed Development in the assessment year for each footprint element and over the Proposed Development's lifetime. The GHG emissions from the construction phase are annualised assuming a 1-year construction period for the processing sites. Annualising the construction GHG emissions allows them to be compared on a like-for-like basis to the operational GHG emissions which are reported on a per annum and lifetime basis.

Table 15-3: GHG Footprint for the Development

Development Phase	Footprint Element	Tonnes of CO_2e		% of lifetime total
		Assessment Year Emissions[26]	Lifetime Emissions[27]	
Construction	Embodied	7,136	7,136	4.0
	Transport	856	856	0.5
	TOTAL Construction	***7,992***	***7,992***	***4.4***
Operation	Site Maintenance and Restoration	350	7,354	4.1
	Employee Travel	48	714	0.4
	Materials Transport	2,493	43,220	24.0
	Natural Gas Consumption	2,745	57,653	32.0
	Site Plant Diesel Consumption	3,014	63,299	35.1
	Total Operation	***8,651***	***172,241***	***95.6***
Whole Life Total		**16,644**	**180,233**	**100.0**

Table 15-3 shows that the net change in GHG emissions (taking into account both operational and construction related GHG emissions) is calculated as 16,644 tonnes CO_2e in the assessment year and 180,233 tonnes CO_2e over the lifetime of the Proposed Development.

Operational emissions amount to 95.6% of lifetime emissions and the construction phase 4.4% of lifetime emissions. The most substantial contributions to the lifetime GHG footprint are natural gas and diesel consumed for the extraction and drying of PFA, and materials transport.

By comparison, the emissions associated with the alternative baseline of extraction and processing of Portland Cement would be 237,275 tonnes CO_2e in the assessment year and circa 4.8 million tonnes CO_2e over the lifetime of the Proposed Development (see Section 15.7). This means the Proposed Development would have potential to save up to circa 4.8 million tonnes CO_2e over its lifetime compared to use of conventional Portland Cement.

The assessment shows that the Proposed Development has potential to release substantially fewer GHGs over its entire lifetime than the production of an equal annual quantum of Portland Cement (95% of the extracted PFA) would in only a single year.

A sensitivity assessment has also been carried out to examine the lifetime benefit if 100% of the PFA could be used as replacement of Portland Cement (See **Volume 3, Appendix 15.1**). In this scenario the lifetime benefit would increase to upwards of 5 million tonnes CO_2e.

[26] Taken to be the sum of operational emissions in 2024 and construction in 2023 to ensure worst case assessment
[27] Lifetime emissions reflect the phasing plan set out in Chapter 5, Table 5.1

15.9.2 Assessment of Significance of Effect

Step 1: Establish Context

The GHG emissions from the Proposed Development are compared to national and local CO_2e totals to establish context.

National

The UK has recently legislated a 2050 net zero target following recommendations and analysis completed by the CCC[11]. To meet this target the CCC sets carbon budgets to define a pathway to net zero.

The assessment year emissions for the Proposed Development coincide with the 4th carbon budget covering the period 2023 to 2027. The 4th carbon budget has been set as 1,950 MT CO_2e, or an average annual budget of 390 MT CO2e.

As the construction and operational emissions would generally not occur in the same year, the construction emissions and operational emissions have been compared to the budget separately. It is however acknowledged that there is some potential for a degree of construction and operation happening concurrently.

Comparing the Proposed Development's annual construction phase GHG emissions (7,992 tonnes CO_2e,) to the national carbon budget shows that it is 0.002% of the carbon budget and therefore a very small contributor.

Comparing the Proposed Development's annual operational phase GHG emissions (8,651 tonnes CO2e,) to the national carbon budget shows that it is 0.002% of the carbon budget and therefore a very small contributor.

Local

Government-published GHG emissions by local authority[28] show the CO_2 emissions for Nottinghamshire in 2019 (the latest published year) were 4,547,700 tonnes CO_2.

On this basis comparing the Proposed Development's operational assessment year emissions shows that they would represent 0.19% of this total. This is a conservative comparison as a portion of the Proposed Development's transport emissions would occur outside the County.

The Proposed Development's GHG emissions represent a small contribution to local GHG emissions and budgets in the opening year. The Proposed Development is due to be decommissioned in the mid-2040s, and the majority of the Proposed Development's operational GHG emissions are from fuel consumption and materials transport, which have the ability to decarbonise in line with UK Government strategies and initiatives to achieve net zero 2050.

In addition, the use of the extracted PFA to replace Portland Cement in concrete manufacture has the potential to save up to 220,631 tonnes of CO_2e per annum, thus contributing to the UK's efforts to achieve net zero carbon. Overall, the Proposed Development would therefore firmly be in line with local and national commitments to net zero carbon.

Step 2: Determine Significance

Step 2a: Consistency of the Development with National and Local Policies

National

In terms of future emissions, the CCC[12] has established a "balanced net zero pathway" which considers feasible and cost-effective policy and technology interventions to ensure the UK can meet its new net zero target.

[28] BEIS (2021) UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019

For power generation under this scenario, the CCC consider that 100% of power generation by 2050 will be low carbon and for ground transport it forecasts that all ground transportation (apart from small number of HGVs) will be electrically powered. The CCC therefore forecast that power and ground transportation sectors are largely decarbonised by 2050 with any residual emissions removed through technical and or natural means.

The Proposed Development uses natural gas and diesel for site operations and although no specific plans or methods to decarbonise these emissions on-site is developed at this stage, it is expected that the Proposed Development would be able to adopt technologies in line with UK decarbonisation where relevant to reduce emissions from these fuels. Such measures might include (for example) site plant replacement or natural gas to hydrogen conversion for drier heating. In any case the Proposed Development is expected to be decommissioned prior to 2050 following extraction of all available PFA from the Site. It therefore would not conflict with the Government's efforts to decarbonise the economy by 2050. However, in providing a replacement for Portland Cement in UK concrete manufacture which is demonstrated to result in substantial reductions in lifecycle GHG emissions, it would actively support the UK's transition to net zero carbon by 2050.

In terms of the NPPF[5], paragraph 154 b) states that "*developments should be planned for in ways that can help reduce GHG emissions such as through its location, orientation and design"*. The Proposed Development has adopted a low energy drying plant for the PFA, and the PFA would replace high carbon Portland cement resulting in a significant lifetime benefit and would therefore be consistent with the NPPF.

Local

The relevant local polices are Policy ST50 from the emerging Bassetlaw Local Plan, and SP3 from the Nottingham Minerals Local Plan. Each is summarised further below, with an assessment of the Proposed Development's performance with the policy. Only relevant elements of each policy are presented for simplicity.

Bassetlaw Local Plan

Policy ST50: Reducing carbon emissions, climate change mitigation and adaptation.

All proposals, including the change of use of existing buildings and spaces, should seek to reduce carbon and energy impacts in their design and construction in accordance with Policy ST35. Proposals should incorporate measures that address issues of climate change mitigation through:

a) ensuring no adverse impact on local air quality;

b) directing development towards locations that minimise the need to travel and maximise the ability to make trips by sustainable modes of transport;

c) incorporating passive and energy efficient materials and/or technologies where appropriate;

d) requiring compliance with relevant national building standards such as meeting BREEAM very good-excellent standards;

e) promoting the retrofitting of existing buildings, including incorporating measures to reduce energy consumption;

f) providing for electric vehicle charging capability and charging infrastructure in new development, and/or providing infrastructure that supports car-free living, particularly in town centres;

g) ensuring that major development makes an appropriate financial contribution to the Bassetlaw carbon offsetting fund;

h) making best use of available opportunities to reduce the impact of climate change on biodiversity and the natural environment by providing space for habitats and species to move through the landscape and for the operation of natural processes;

i) minimising the use of natural resources over the development's lifetime, such as minerals and consumable products, by reuse or recycling of materials in construction, and by making the best use of existing buildings and infrastructure;

Policy ST50 also sets out requirements relevant to climate change adaptation. These are considered in Part B of this assessment.

The Proposed Development would be compliant with policy ST50 by:

- Producing on average circa 300,000 tonnes per annum of PFA for use as a replacement for Portland cement in concrete manufacture, which would result in substantial reductions in lifecycle GHG emissions compared to the use of conventional Portland Cement;
- Specification of a low energy PFA drying plant. The system is designed to consume 75%-80% less natural gas than conventional thermal drying systems, resulting in a GHG emissions saving of approximately 8,000 TCO_2e per annum;
- A Construction Traffic Management Plan to minimise construction traffic movements and emissions;
- Staff Travel Plan to reduce the number of employees travelling to the Site by single occupancy car; and
- Outline Construction Environment Management Plan to minimise construction waste and limit emissions from site plant.

Nottingham Minerals Local Plan

Policy SP3- Climate Change

All minerals development, including site preparation, operational practices and restoration proposals should minimise impacts on the causes of climate change for the lifetime of the development by being located, designed and operated to help reduce greenhouse gas emissions, and move towards a low-carbon economy.

Policy SP3 also sets out requirements relevant to climate change adaptation. These are considered in Part B of this assessment.

The Proposed Development would be compliant with Policy SP3 by providing a replacement to conventional Portland Cement in concrete manufacture capable of returning substantial lifecycle GHG savings.

Step 2b: Robustness, timeliness and efficacy of mitigation

The principles of the IEMA Guidance are that where GHG emissions cannot be avoided, mitigation should be provided to minimise GHGs. Mitigation measures adopted by the Proposed Development are described for each element of the GHG footprint.

Construction

Mitigation measures adopted by the Proposed Development to minimise GHG emissions from the construction phase are set out through the Outline Construction Environment Management Plan.

Operation

Transport

Mitigation measures adopted by the Proposed Development to minimise GHG emissions from transport include:

- A Construction Traffic Management Plan to minimise construction traffic movements and emissions; and
- Staff Travel Plan to reduce the number of employees travelling to the Site by single occupancy car.

Both of these deliverables would be secured through suitable planning conditions.

Energy and Fuel Consumption

Measures to avoid and reduce GHG emissions from on-site fuel and energy consumption include:

- Use of low energy drying process; and
- Installation of an electric conveyor to transport PFA from the extraction site (Area A) to the processing site (Area C) and avoid higher emissions associated with the use of diesel site plant.

Summary of GHG Assessment

The assessment of significance has followed a 2-step process consistent with IEMA Guidance and is summarised below in **Table 15-4.**

Table 15-4: Assessment of Significance

Step	Description	Assessment	Applicable IEMA rating
Step 1	Context	The Development's gross emissions are a small component of local (0.19 %) and national carbon budgets (0.002% operational and 0.002% construction). The Proposed Development's net emissions would be below zero. The Proposed Development would indirectly reduce GHG emissions in concrete manufacture through replacement of Portland Cement.	Net GHG emissions would be below zero and would indirectly reduce GHG emissions.
Step 2	Consistency with National and Local policy	The Proposed Development would provide a PFA product resulting in substantial lifecycle GHG emissions compared to use of conventional Portland Cement. The Proposed Development would include primary design measures and further operational measures that would be consistent with national and local policies to decarbonise energy and transport emissions to net zero.	The net GHG impacts would be reduced beyond those in policy and contribute to the transition to net zero.
	Robustness, timeliness and efficacy of mitigation	The Proposed Development would adopt good practice measures to avoid and minimise GHG emissions during the construction phase and over the lifetime of its operation. The majority of the measures to avoid and reduce GHGs would be designed in and would therefore be delivered from the occupation of the Proposed Development onwards.	The Proposed Development would be *"in line with good practice design standards for projects of this type."*

Based on **Table 15-4** and with reference to IEMA's significance criteria (see **Table 15-2**) the assessment therefore finds that the effects would be significant **beneficial**. This is primarily based on the substantial saving in GHG emissions resulting from use of the PFA as a replacement for Portland Cement.

15.10 MITIGATION AND RESIDUAL EFFECTS

No additional measures are proposed and therefore the residual effects would remain as **significant beneficial**.

15.11 CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects are not assessed for the reasons set out in Section 15.6.1.

15.12 SUMMARY OF EFFECTS

Table 15-5 provides a summary of effects detailed within this chapter. The effects are established based on the Proposed Development's whole life GHG emissions and are therefore not distinguishable between the construction and operational phases.

Table 15-5: Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Whole Life: Construction and Operational Phase				
Global atmosphere	Whole life GHG emissions	Beneficial, Significant	None proposed	Beneficial, Significant

15.13 STATEMENT OF SIGNIFICANCE

Beneficial significant effects in terms of the EIA Regulations are predicted over the lifetime of the Proposed Development.

Part B: Resilience to Climate Change

15.14 LEGISLATION, POLICY AND GUIDENCE

This is provided earlier in this document, see Section 15.2

15.15 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

This part of the chapter provides a qualitative assessment of the resilience of the Proposed Development to climate change. The assessment methodology takes into account the recommendations in the IEMA EIA Guide to Climate Change Resilience and Adaptation[15] and has been adapted to ensure the assessment is proportionate to the Proposed Development.

15.15.1 Consultation

Table 15.1 sets out comments regarding the scope of the climate resilience assessment and how those are addressed through this assessment.

15.16 SCOPE OF ASSESSMENT

15.16.1 Geographical Scope

The study area for climate resilience, unlike other disciplines, focuses on the impact that climate will have on the Proposed Development (as opposed to the impact of the Proposed Development on the environment). The study area is therefore limited to the footprint of the Proposed Development, split into its constituent parts (receptors).

The geographical scope of the climate projections that are used to define the future baseline are projections from UKCP18 for East Midlands region.

15.16.2 Temporal Scope

IEMA Guidance[15] advises that UKCP18 for the 2080s be used to inform assessments, using the Representative Concentration Pathway (RCP) 8.5 projections (high emissions scenario).

As the Proposed Development lifetime ends before 2050, the 2030-2049 UKCP projections have been used. The use of the high emissions scenario RCP8.5 projections ensures the assessment is conservative.

15.17 ESTABLISHING BASELINE CONDITIONS

The assessment of resilience of the Proposed Development to the impacts of climate change was informed by regional scale information on historic and projected change in climate variables, and other studies undertaken relevant to the Proposed Development.

The future baseline conditions were defined by potential climate risks identified in the UK Climate Change Risk Assessment[29] and the Key Climate Projections: Headline Findings[30] produced by the Met Office UK. These are based on the 2018 UK climate projection dataset (UKCP18).

15.18 METHODOLOGY FOR THE ASSESSMENT OF EFFECTS

Climate change by its nature occurs over many decades and future changes, as modelled by UKCP18, consider climate change in the 2050s and beyond. The Resilience to Climate Change assessment seeks to establish the potential for significant effects of climate change on the Proposed Development in the future – when it is anticipated that changes

[29] CCC, (2017). *UK Climate Change Risk Assessment 2017 Evidence Report.*
[30] Met Office, (2019). *UK Climate Projections: Headline Findings*.

from the existing climate will have occurred – and potential risks these may pose to the operational function of the Proposed Development.

In terms of mitigation to climate change, this is principally a function of the design which needs to anticipate future risks and build in appropriate adaptation measures as required. There is, therefore, an important focus on embedded measures to address future climate change.

The assessment does not explicitly consider climate risks during the construction period, since any near-term risks associated with climate change are well established and managed through standard construction site practices.

The assessment is carried out over four-steps, as follows:

Step 1: Identify Receptors

During this stage, relevant receptors in the Proposed Development which may be affected by climate change (e.g., change in average weather conditions and extreme events) are identified.

Step 2: Identify Potential Impacts of Climate Change on Receptors and Confirm Embedded Mitigation

This stage comprises identification of potential impacts of changes in a range of climate variables on the receptors identified in Step 1. This is undertaken using professional judgement with reference to supporting literature and identifies the design measures to mitigate the impacts.

Step 3: Assess the Significance of Effects of Climate Change on Receptors

This step assesses the significance of each hazard (using definitions in **Table 15-8**) based on scoring the likely consequence and likelihood of that hazard arising, using a five-point scale described in **Table 15-6 and Table 15-7**. The assessment of significance and scoring of likelihood and consequence are based on IEMA Guidance[15].

Table 15-6: Qualitative Description of Consequence

Measure of Consequence	Description
Negligible	No damage to the Proposed Development, minimal adverse effects on health, safety and the environment or financial loss. Little change to service and disruption lasting less than one day.
Minor Adverse	Localised disruption or loss of service. No permanent damage, minor restoration work required: disruption lasting less than one day. Small financial losses and/or slight adverse health or environmental effects.
Moderate Adverse	Limited damage and loss of service with damage recoverable by maintenance or minor repair. Disruption lasting more than one day but less than one week. Moderate financial losses. Adverse effects on health or the environment.
Large Adverse	Extensive damage and severe loss of service. Disruption lasting more than one week. Early renewal of 50-90% of the Development. Permanent physical injuries and/or fatalities. Major financial loss. Significant effect on the environment, requiring remediation.
Very Large Adverse	Permanent damage and complete loss of service. Disruption lasting more than one week. Early renewal of the Proposed Development >90%. Severe health effects or fatalities. Extreme financial loss. Very significant loss to the environment requiring remediation and restoration.

Table 15-7: Qualitative Description of Likelihood

Measure of Likelihood	Description (Assuming up to 25year Lifetime)
Very High	The event occurs multiple times during the lifetime of the Development, i.e., approximately annually.
High	The event occurs several times (approximately every 5 years) during the lifetime of the Proposed Development.
Medium	The event occurs limited times (approximately every 10 years) during the lifetime of the Proposed Development.
Low	The event occurs once during the lifetime of the Proposed Development.
Very Low	The event may occur once during the lifetime of the Proposed Development or may not occur at all.

These determinants are combined to assess the significance of effects on receptors, as shown in **Table 15-8**. The assessment is qualitative and based on expert judgment based on knowledge of similar schemes, engagement with the wider Project Team and a review of relevant literature.

The assessment of significance takes embedded mitigation into account. Embedded mitigation is identified through consultation with the Project Team.

Table 15-8: Significance Rating Matrix

Likelihood of Hazard Occurring	Consequence of Hazard Occurring				
	Negligible	Minor Adverse	Moderate Adverse	Large Adverse	Very Large Adverse
Very High	Not significant	Significant	Significant	Significant	Significant
High	Not significant	Significant	Significant	Significant	Significant
Medium	Not significant	Not significant	Significant	Significant	Significant
Low	Not significant	Not significant	Not significant	Significant	Significant
Very Low	Not significant	Not significant	Not significant	Not Significant	Not Significant

Step 4 Establish Further Adaptation Measures and Determine Residual Effects

In the fourth step, further adaptation measures for any significant effects are identified through expert opinion based on knowledge of similar schemes and consultation with the Project Team. Residual effects of climate change on the identified receptors are assessed using **Table 15-6 to Table 15-8**.

15.18.1 Assessment Limitations

This assessment provides a broad indication of the potential impacts of climate change on the Proposed Development based on a qualitative assessment and professional judgement using knowledge of similar schemes. The UKCP18 projections are the most up-to-date projections of climate change for the UK.

UKCP18 provides probabilistic projections of future climate for a range of emissions scenarios. Future GHGs emissions, and resulting pathway, is uncertain. A precautionary approach, consistent with IEMA Guidance[15] has therefore been adopted here by selecting a high emissions scenario (RCP8.5).

Any further research, analysis or decision-making should take account of the accuracies and uncertainties associated with climate projections. Any future decision-making based

on this analysis should consider the most up-to-date projections and range of literature, evidence, and research available at the time.

The embedded adaptation measures are based on information provided by the Project Team. The determination of significance has been undertaken under the assumption that industry design standards would be adhered to where detailed design information is unavailable.

15.19 BASELINE CONDITIONS

15.19.1 Existing Conditions

Table 15-9 sets out the current understanding of climate hazards within the Site, based on the assessments within relevant technical chapters.

Table 15-9: Current Climate Change Hazards

Climate Risk	Current Baseline
Fluvial Flooding	The Flood Risk Assessment (FRA) finds that the Proposed Development is classed as Less Vulnerable (as per Annex 3: Flood risk vulnerability classification: of the National Planning Policy Framework)
Surface Water Flooding	The FRA identifies that there are minor isolated areas mapped to be at risk of surface water flooding.
Groundwater Flooding	The FRA has established that the risk of groundwater flooding is negligible.
Extreme Weather Events	There are a number of extreme weather event risks that affect Nottinghamshire, such as: heatwaves; drought storms & gales; and low temperature & heavy snow.

There has been a significant human influence on the observed warming in the UK annual temperature since 1950. Statistical results from extreme value analysis suggest that the UK daily maximum and minimum temperature extremes have increased by just over 1°C since the 1950s, and that heavy seasonal and annual rainfall events have also increased.

15.20 FUTURE BASELINE

Climate modelling completed by the meteorological office (UKCP18)[33] is forecasting drier hotter summers, warmer wetter winters and more frequent extreme weather events due to climate change.

At the same time, there are upward trends in rainfall across the UK. Higher levels of winter rainfall have been experienced often in increasingly heavy rainfall events leading to more flooding and damage to buildings and infrastructure. These patterns are consistent with projections of more and heavier rainfall for the UK in a warmer global atmosphere. These changes increase health and safety risks to people and the built environment, increasing costs and disruption for repair and adaptation.

Four key climate risks are identified for the Proposed Development, as follows; hotter summers with extreme temperatures (heatwaves); wetter winters including extreme rainfall; drier summers including drought; and increased wind and storms, which are considered in this assessment.

Information on predicted UK climate is taken from the UK Climate Projections where available[30]. UKCP18 are the most up-to-date projections of climate change for the UK. The projections include probabilistic projections of a range of climate variables for different emissions scenarios, known as Representative Concentration Pathways (RCPs), over a range of time slices.

In this section, the central estimate (50th percentile) projections for high emissions scenario (RCP8.5) are presented. The high emissions scenario was used to adopt a 'worst-case' estimate of climate projections. These are summarised in **Table 15-10**.

Table 15-10: Climate Projections for East of England Based on UKCP18 - RCP8.5 (50th Percentile)

Climate Risk	2030 - 2049
Mean Winter Rainfall	+ 7%
Mean Summer Rainfall	- 12%
Mean Summer Temperature	+ 1.6C
Mean Winter Temperature	+ 1.3C

Extreme weather events are considered for the Proposed Development. Climate change predictions indicate increasingly erratic weather pattern that are likely to lead to extreme weather events.

Snow

According to UKCP18 projections, a decrease in both falling and lying snow across the UK relative to the 1981-2010 baseline is expected by the end of the century. In general, the decreases are largest in low-lying/coastal regions.

Wind

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 inter-annual variability.

15.21 ASSESSMENT OF LIKELY EFFECTS (CLIMATE RESILIENCE)

The assessment has followed the 4-step process identified earlier, as detailed further below.

Step 1: Identify Receptors

The key receptors identified are:

- site buildings and infrastructure; and
- site staff.

Step 2: Identify Potential Impacts of Climate Change on Receptors and Embedded Mitigation

A number of potential impacts were identified. The Project Team were consulted regarding the potential risks inherent to the Proposed Development's design. The results are detailed in **Table 15-11.**

Table 15-11: Climate Risks and Mitigation

Climate Variable	Receptor	Potential Impact	Design Measures to Mitigate Impacts
Hotter Summers Extreme Temperatures (Heatwaves)	Site buildings and infrastructure	Heat damage to road surfaces and buildings	Design standards to meet higher ambient temperatures.
	Staff	Overheating and heat stress	Operational procedures to manage staff heat stress.
Wetter Winters Extreme Rainfall	Site buildings and infrastructure	Surface water flooding	Active surface water management measures in place (see Drainage Management Plan). Extraction area set lower than the surrounding areas to the Site, therefore limiting potential for transfer of surface water offsite.
		Groundwater flooding	Preliminary sizing of the soakaways has considered the potential rainfall-runoff volumes from the active area including direct rainfall to the bench below groundwater level and potentially runoff from higher benches. Where necessary bunds would be constructed around the perimeter of the active area in order to segregate overland flows (clean water) from surrounding grassland areas from the water in the active excavation. Currently surface water would infiltrate and runoff, and the surface water scheme would look to maintain this passive drainage approach.
Drier Summers Drought	Site Buildings and infrastructure	Loss of site planting due to drought	Planting chosen to be resilient to drought.
Wind and Storms	Site buildings and infrastructure	Storm damage to roofs and facades	Roofs and facades designed to withstand storm damage.
Colder temperatures and snow	Site buildings and infrastructure	On site machinery unable to operate	Operational procedures to minimise any loss of production.
	Staff	Staff unable to access site	Operational procedures to minimise any loss of production.

Step 3: Assess the Significance of Effects of Climate Change on Receptors

Table 15-12 below details the assessment of climate risks identified in Step 2 above. This takes into account projections of future climate change in period up to 2050 and mitigation designed into the facility.

Table 15-12: Climate Resilience Assessment

Climate Variable	Receptor	Potential Impact	Likelihood	Consequence	Significance
Hotter Summers Extreme Temperatures (Heatwaves)	Site buildings and infrastructure	Heat damage to road surfaces and buildings	Medium	Minor Adverse	Not significant
	Staff	Overheating and heat stress	Medium	Minor Adverse	Not significant
Wetter Winters Extreme Rainfall	Site buildings and infrastructure	Surface water flooding	Low	Minor Adverse	Not Significant
		Groundwater flooding	Low	Minor Adverse	Not Significant
Drier Summers Drought	Site Buildings and infrastructure	Loss of site planting due to drought	Medium	Negligible	Not significant
Wind and Storms	Site buildings and infrastructure	Storm damage to roofs and facades	Medium	Minor Adverse	Not significant
Colder temperatures and snow	Site buildings and infrastructure	On site machinery unable to operate	Medium	Minor Adverse	Not significant
	Staff	Staff unable to access site	Medium	Minor Adverse	Not significant

Step 4 Establish Further Adaptation Measures and Determine Residual Effects

Table 15-12 above shows that there would be no significant effects on the Proposed Development due to future climate change and as such no additional mitigation measures are required.

15.22 MITIGATION AND RESIDUAL EFFECTS

The residual effects are not significant.

15.23 CUMULATIVE RESILIENCE EFFECTS

15.24 SUMMARY OF EFFECTS AND STATEMENT OF SIGNIFICANCE

The climate resilience measures identified and adopted by the design seek to minimise climate risks due to future climate change.

The assessment has found that the Proposed Development is resilient to likely climatic changes within its lifetime and the effects are not significant.