

A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010041

6.3 Environmental Statement – Chapter 14 Climate

Part B

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed
Forms and Procedure) Regulations 2009

June 2020

Infrastructure Planning

Planning Act 2008

**The Infrastructure Planning
(Applications: Prescribed Forms and
Procedure) Regulations 2009**

**The A1 in Northumberland: Morpeth to Ellingham
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Environmental Statement

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14 CLIMATE

14.1 INTRODUCTION

14.1.1. This chapter presents the assessment of likely significant environmental effects as a result of Part B: Alnwick to Ellingham (Part B) on climate. This chapter presents the assessment of:

- a. The potential effects of Part B on the magnitude and mitigation of Greenhouse Gases (GHGs) emitted during construction and operation.
- b. The vulnerability of Part B to the potential impacts of climate change in particular impacts on Part B from extreme weather and long-term climate change during construction and operation.

14.1.2. The chapter also identifies, where appropriate, proposed mitigation measures to prevent, minimise or control the likely adverse climate effects arising from the construction and operation of Part B, and the subsequent residual effects.

14.1.3. This chapter should be read together with **Appendix 14.1: Vulnerability to Climate Change Baseline, Volume 8** of this Environmental Statement (ES) (**Application Document Reference: TR010041/APP/6.8**).

14.1.4. This chapter should be read together with the introductory chapters of this ES (**Chapters 1 to 4, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**)) in particular **Chapter 2: The Scheme, Volume 1** of this ES. An assessment of combined effects of Part B is set out in **Chapter 15: Assessment of Combined Effects** of this ES and combined and cumulative effects of the Scheme are set out in **Chapter 16: Assessment of Cumulative Effects, Volume 4** of this ES (**Application Document Reference: TR010041/APP/6.4**).

14.1.5. **Section 4.3 of Chapter 4: Environmental Assessment Methodology, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**) identifies any differences in the assessment methodology employed for Part A: Morpeth to Felton (Part A) and Part B. Further to this, there are other differences between the chapters for Part A and Part B. All key differences include:

- a. There are differences between Part A and Part B that relate to the scoping process, for example elements that are scoped in and out of the assessment. Refer to the **Scoping Report (Application Document Reference: TR010041/APP/6.10)** and **Scoping Opinion (Application Document Reference: TR010041/APP/6.12)** for Part A, and the **Scoping Report (Application Document Reference: TR010041/APP/6.11)** and **Scoping Opinion (Application Document Reference: TR010041/APP/6.13)** for Part B.
- b. Land use change is assessed for Part A but was scoped out of Part B. It is assessed for Part A as the proposed offline section of Part A has the potential to

lead to a change in emissions associated with the loss of agricultural grassland, whereas the extent of Part B offline works are less extensive.

- c. The terminology for sensitive receptors identified in Part A and Part B differ due to the absence of defined terminology for receptors in published guidance and to align with terms used in the **Scoping Report (Application Document Reference: TR010041/APP/6.10)** for Part A and the **Scoping Report (Application Document Reference: TR010041/APP/6.11)** for Part B. The terminology used does not affect the outcomes of the assessment.
- d. Both Part A and Part B have used Met Office published historical regional weather data to establish the current climate impacts, upon which the UKCP18 probabilistic projections are based. The future baseline projections for Part A have been supplemented by projections within a 25 km grid square. This reflects the **Scoping Report (Application Document Reference: TR010041/APP/6.10)** for Part A.
- e. Slight differences in terminology exist between Part A and Part B. For Part A repair and refurbishment is used and for Part B replacement is used. This reflects the **Scoping Report (Application Document Reference: TR010041/APP/6.10)** for Part A and the **Scoping Report (Application Document Reference: TR010041/APP/6.11)** for Part B.

14.2 COMPETENT EXPERT EVIDENCE

- 14.2.1. **Table 14-1** below demonstrates that the professionals contributing to the production of this chapter have sufficient expertise to ensure the completeness and quality of this assessment.

Table 14-1 - Relevant Experience

Name	Role	Qualifications and Professional Membership	Relevant Experience
Elizabeth Watts	Author (GHGs)	BSc (Hons) Environmental Management Institute of Environmental Management and Assessment (IEMA) Practitioner	Associate In excess of 18 years in multi-disciplinary consultancy working within a wide range of environmental and safety projects. Seven years' experience in Environmental and Social Impact Assessment (ESIA) project management and review. Lead for the following scheme: – South Wokingham Distributor Road Central and Western Section,

Name	Role	Qualifications and Professional Membership	Relevant Experience
			South Wokingham Borough Council.
Shuchita Garg	Author (Climate Vulnerability)	M.Tech in Environmental Engineering B. Tech in Civil Engineering IEMA Associate	Assistant Consultant Contributed to: <ul style="list-style-type: none"> – M4 Junction 15 upgrade Environmental Assessment Report (EAR) Climate Chapter, Redrow Homes.
Stephanie Hands	Author (Climate Vulnerability)	MEnvSci Environmental Sciences Practitioner of IEMA	Climate Resilience Consultant Over four years of experience in Environmental Impact Assessment (EIA) and climate resilience. Climate resilience topic Lead for the following schemes: <ul style="list-style-type: none"> – Shrewsbury North Western Relief Road, Shropshire Council – Norwich Western Link, Norfolk County Council – Aquind Interconnector, Aquind
James Peet	Reviewer (GHGs)	MSc Environment, Science and Society BSc (Hons) Geography Chartered Environmentalist (CEnv) Full member of Institute of Environmental Management and Assessment (MIEMA)	Principal Consultant Eight years' experience in GHG assessments. GHG Topic Lead for the following schemes: <ul style="list-style-type: none"> – Southampton International Airport – Banwell Bypass, Somerset County Council; – M4 Junction 15 improvements, Redrow Homes; and, – Drax Repower GHG expert witness.

Name	Role	Qualifications and Professional Membership	Relevant Experience
			<p>Other relevant experience includes:</p> <ul style="list-style-type: none"> – Lead author or reviewer of GHG assessments and climate chapters for multiple environmental sectors including highways, transport, power waste and water sectors. – Expert witness on climate change. – Produced planning and climate change thought leadership.
Nikki van Dijk	Reviewer (Climate Vulnerability)	<p>MSc Climate Change BA (Cantab) Geography</p> <p>Chartered member of chartered Institution of Water and Environmental Management (M.CIWEM / C.WEM)</p> <p>Chartered Environmentalist (CEnv) Society for the Environment Fellow of the Royal Geographical Society (FRGS)</p> <p>Member of the IEMA working group to produce updated EIA guidance on assessing climate resilience.</p>	<p>Associate</p> <p>Twelve years' experience</p> <p>Climate Topic Lead for the following schemes:</p> <ul style="list-style-type: none"> – A27 Arundel Bypass, Highways England; – Kurty-Kapshagi Road Improvement, (Kazakhstan), EBRD; – Banwell Bypass, Somerset County Council; and – M4 Junction 15 improvements, Redrow Homes. <p>Other recent relevant experience includes:</p> <ul style="list-style-type: none"> – Lead author or reviewer of climate chapters for multiple environmental assessments across sectors including highways, rail, energy, water and industry. <p>Member of IEMA</p>

Name	Role	Qualifications and Professional Membership	Relevant Experience
			working group to update EIA Guide to Climate Change Adaptation and Resilience.

14.3 LEGISLATIVE AND POLICY FRAMEWORK

INTERNATIONAL LEGISLATION

Directive 2014/52/EU on the Assessment of the Effects of Certain Public and Private Projects on the Environment (the EIA Directive)

- 14.3.1. Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment (the EIA Directive) (**Ref. 14.1**) provides the overarching legislative framework for assessing the significance of impacts and effects from schemes on the environment.
- 14.3.2. The Directive requires EIAs to identify, describe and assess the direct and indirect significant effects of a project on climate (Article 3). It also stipulates that the information to be included within the ES should include “*the impact of the project on climate (for example the nature and magnitude of greenhouse gas (GHG) emissions and the vulnerability of the project to climate change*” (Annex IV).
- 14.3.3. Under an amendment to the EIA Directive (2014/52) the requirement to consider a project’s effects in relation to climate has resulted from the 2014 amendment to the EIA Directive (2014/52). The Directive has been fully transposed into UK law in the Infrastructure Planning (Environmental Impact Assessment) Regulations (EIA Regulations) (**Ref. 14.2**) and came into force in the UK on the 16 May 2017. The Directive requires: “*A description of the likely significant effects of the project on climate (for example the nature and magnitude of GHG emissions) and the vulnerability of the project to climate change.*”

NATIONAL LEGISLATION

UK Climate Change Act

- 14.3.4. The Climate Change Act 2008 (**Ref. 14.3**) established a legal requirement for an 80% reduction in the GHG emissions of the UK economy by 2050 in comparison to a 1990 baseline. The Act also created the Committee on Climate Change, with a responsibility for:
 - a. Setting five-year carbon budgets, covering successive periods of emissions reduction to 2050.

- b.** Advising and scrutinising the UK Government's associated climate change adaptation programmes.
- c.** Producing a national adaptation plan for the UK Government to implement.

14.3.5. In 2019, the target was revised to achieve 100% reduction (net zero) GHG emissions by 2050. However, the UK Carbon budgets were not updated as part of this revision.

PLANNING POLICY

National policy

14.3.6. National policy relevant to climate and the significance of Part B on the policy objectives is outlined in **Table 14-2**.

Local Policy

14.3.7. Local policy relevant to climate and the significance of Part B on the policy objectives is outlined in **Table 14-3**.

Table 14-2 – National Planning Policy Relevant to Climate

Policy	Relevant Policy Objectives	Significance of Part B on Policy Objective
<p>National Policy Statement for National Networks 2014 (NPS NN) (Ref. 14.4)</p>	<p>The emissions section of Chapter 3: Wider Government Policy on National Networks identifies that the transport sector will play an important part in meeting the Government’s carbon targets. It is acknowledged that technologies, fuels and promoting lower carbon transport choices will make the biggest reductions and that (comparatively) the likely impact from road development is “<i>very small</i>.” Chapter 5: Generic Impacts paragraph 5.17 states that “<i>it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets</i>.”</p> <p>The Climate Change Adaptation section of Chapter 4: Assessment Principles sets out how the policy statement shall put policy into practice with regards to climate change mitigation and adaptation when developing and consenting infrastructure. It sets out the key considerations for infrastructure projects that are proposed on or near the coast. Developments in these areas are required to “<i>undertake an assessment of the vulnerability of the proposed development to coastal change, taking account of climate change, during the project’s operational life</i>.” With regards to the decision-making process, paragraph 5.78 of the policy states that “<i>the applicant must demonstrate that a full account has been taken of the policy on assessment and mitigation...taking account of the potential effects of climate change on these risks</i>.”</p> <p>The Flood Risk section under Chapter 4: Assessment Principles paragraph 5.90 acknowledges that climate change will likely lead to an “<i>increased flood risk in areas susceptible to flooding, and to an increased risk of flooding in some areas which are not currently thought of as being at risk</i>.” Paragraph 5.93 and 5.94 also states that an applicant’s assessment should “<i>identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account</i>” by taking “<i>the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made</i>” when preparing the flood risk assessment.</p>	<p>The design of Part B is in accordance with the objectives of the policy set out in the NPS NN. The design process has sought to avoid significant effects and identify appropriate mitigation and adaptation measures to align with the policy objectives (refer to Section 14.9 of this chapter), reducing potentially significant effects where they are anticipated to arise.</p> <p>In relation to Chapter 3 of the NPS NN, Part B does not contribute positively to government carbon targets albeit the impacts of construction and operation are not concluded to be significant and land use change results in a reduction in emissions due to an increase in forest area.</p> <p>In relation to Chapter 4 of the NPS NN, the assessment of climate resilience (including flood risk) and the identification and incorporation of adaptation measures aligns Part B with these objectives.</p> <p>In relation to Chapter 5 of the NPS NN, Part B in isolation would not affect the ability of Government to meet its carbon reduction plan targets.</p> <p>The GHG assessment identifies emissions associated with Part B (refer to Section 14.10 of this chapter).</p> <p>Mitigation and adaptation measures that have been integrated into Part B in order to improve the resilience of Part B to climate change and reduce GHG emissions are detailed in Section 14.9 of this chapter.</p> <p>The Flood Risk Assessment (FRA) (refer to Appendix 10.1, Volume 8 of this ES (Application Document Reference: TR010041/APP/6.8) and Chapter 10: Road Drainage and the Water Environment of this ES) takes into account an allowance for climate change.</p>
<p>National Planning Policy Framework (NPPF) 2019 (Ref. 14.5).</p>	<p>The National Planning Policy Framework sets out the core planning principle of “<i>moving to a low carbon economy</i>”:</p> <p>Chapter 9: Promoting Sustainable Transport, encourages the pursuit of “<i>...opportunities to promote walking, cycling and public transport...and offer a choice of genuine transportation modes</i>”</p> <p>In accordance with NPPF 2019 Chapter 14: Meeting the challenge of climate change, flooding and coastal change; the planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in GHG emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the</p>	<p>The design of Part B is in accordance with the objectives of the policy set out in the NPPF. The design process for Part B has sought to avoid significant effects and identify appropriate mitigation and adaptation measures (refer to Section 14.9 of this chapter) to reduce potentially significant impacts where they are anticipated to arise.</p>

Policy	Relevant Policy Objectives	Significance of Part B on Policy Objective
Highways England Climate Change Adaptation Strategy and Framework (Ref. 14.6)	<p>conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure.</p> <p>Highways England's Climate Change Adaptation Strategy and Framework (2009) has led to modifications in existing standards on the national network. In 2011, Highways England was required to complete a climate change adaptation report and submit it to UK government to inform the national adaptation plan. This report set out the risks from climate change to Highways England and adaptation measures to improve resilience. In 2015, Highways England submitted a voluntary report on progress following the climate change adaptation report.</p>	<p>Many of the risks identified are relevant to Part B.</p> <p>An assessment of the vulnerability of Part B to anticipated changes in climate has been undertaken (refer to Section 14.10 of this chapter). Mitigation and adaptation measures that have been integrated into Part B in order to improve the resilience of Part B to climate change are detailed in Section 14.9 of this chapter.</p> <p>Part B would not negatively impact upon the policy objective.</p>
Infrastructure Carbon Review (Ref. 14.7)	<p>In 2013, the UK government published the Infrastructure Carbon Review, aiming to “<i>release the value of lower carbon solutions and to make carbon reduction part of the DNA of infrastructure in the UK</i>” (page 5). Major infrastructure owners, operators and developers, including Highways England, were invited to endorse, become signatories and make commitments under the review.</p> <p>The review provided increased emphasis on ‘capital carbon’ (GHG emissions associated with raw materials, activities and transport for construction, repairs, replacement, refurbishment and de-construction of infrastructure) while acknowledging that ‘operational carbon’ (associated with energy consumption for the operation and use of infrastructure) will continue to dominate overall emission to 2050 and beyond.</p> <p>The Infrastructure Carbon Review highlighted the importance of assessing GHG emissions early in the lifecycle of an infrastructure scheme when there is the greatest carbon reduction potential. The Infrastructure Carbon Review also led to the publication of a Publicly Available Specification on infrastructure carbon management; PAS2080:2016 (Ref. 14.8).</p>	<p>The assessment identifies GHG emissions associated with the construction and operation of Part B (refer to Section 14.10 of this chapter) and outlines measures to be included within Part B design to reduce emissions where possible (refer to Section 14.9 of this chapter).</p> <p>The ‘carbon footprint’ of Part B would continue to be assessed and targeted throughout detailed design, refer to Section 14.9 of this chapter.</p>

Table 14-3 – Local Planning Policy Relevant to Climate

Policy	Relevant Policy Objectives	Significance of Part B on Policy Objective
Alnwick District Wide Local Plan (1997) (Ref. 14.9)	<p>Section 18.3 of the Local Plan considers ‘Energy Conservation and Global Warming’. Given that the Local Plan was produced in 1997, policies in relation to climate change are limited. The Local Plan includes the following policy of relevance to the assessment.</p> <p>Policy CD33</p> <p>Planning permission will not be granted for development where there is an unacceptable risk of flooding, or where the development would be likely to increase the risk of flooding elsewhere.</p>	<p>The FRA (refer to Appendix 10.1, Volume 8 of this ES (Application Document Reference: TR010041/APP/6.8)) takes into account an allowance for climate change.</p>

Policy	Relevant Policy Objectives	Significance of Part B on Policy Objective
<p>Alnwick Core Strategy (October 2007) (Ref. 14.10) (Northumberland Consolidated Planning Policy Framework, 2018) (Ref. 14.11).</p>	<p>The Alnwick Core Strategy notes the importance of considering climate change, particularly in relation to the effects of global warming resulting in sea level rise, coastal erosion and flooding. In relation to transport, the Strategy seeks to reduce the environmental impact of transport while meeting the needs of people and firms for access.</p> <p>Objective 6 of the Core Strategy sets out a goal to assist in the delivery of a sustainable integrated transport system and enhance accessibility for all.</p>	<p>The design process for Part B has sought to avoid significant effects and identify appropriate mitigation and adaptation measures to reduce potentially significant impacts where they are anticipated to arise (refer to Section 14.9 of this chapter).</p> <p>The inclusion of footways and bus stops (as described in Chapter 2: The Scheme, Volume 1 of this ES (Application Document Reference: TR010041/APP/6.1)) align Part B to sustainable and integrated transport objectives.</p>
<p>Northumberland Local Plan: Draft Plan for Consultation (January 2019) (Ref. 14.12).</p>	<p>The draft local plan includes Policy STP 4 which provides principles for how the local plan and development proposals should contribute to climate change mitigation and adaptation. The key principles of the policy relevant to Part B are summarised below:</p> <p>Development proposals should mitigate climate change and contribute to meeting targets to reduce GHG emissions through:</p> <ul style="list-style-type: none"> – Reducing the need for travel for both people and goods, and encourages sustainable modes of transport – Include the re-use of existing materials <p>Development proposals should support adaptation to climate change through:</p> <ul style="list-style-type: none"> – Incorporating design features to provide resilience to climate change – Take account of the risk for flooding – Incorporate the use of sustainable drainage systems 	<p>Mitigation and adaptation measures to reduce GHG emissions are detailed in Section 14.9 of this chapter.</p> <p>Measures that have been integrated into Part B in order to improve the resilience of Part B to climate change are also detailed in Section 14.9 of this chapter.</p>
<p>Northumberland County Council Transport Plan 2011 – 2026 (Ref. 14.13)</p>	<p>Chapter 7 of the Transport Plan sets out the strategy for reducing carbon emissions. The main goal and objective is to minimise the environmental impact of transport by reducing carbon emissions and addressing the challenge of climate change and deliver sustainable low carbon travel choices.</p> <p>The actions in place to achieve the goal and objective include:</p> <ul style="list-style-type: none"> – Continue to implement the Council’s own travel plan as an integral part of the Carbon Management Plan – Promote sustainable travel choices such as walking, cycling and public transport – Improve and enhance the traffic free rights of way network around urban areas to increase the use of sustainable transport for accessing work, schools and services 	<p>The assessment identifies GHG emissions associated with the construction and operation of Part B and outlines measures to be included within the design of Part B to reduce emissions where possible (refer to Section 14.9 of this chapter).</p> <p>The inclusion of footways and bus stops (as described in Chapter 2: The Scheme, Volume 1 of this ES (Application Document Reference: TR010041/APP/6.1)) align Part B to sustainable and integrated transport objectives.</p>

14.3.8. Compliance with planning policy is addressed further in the **Case for the Scheme (Application Document Reference: TR010041/APP/7.1)** and **NPS NN Accordance Table (Application Document Reference: TR010041/APP/7.2)**.

14.4 ASSESSMENT METHODOLOGY

EFFECT OF PART B ON CLIMATE (GHG EMISSIONS)

Scope of the Assessment

14.4.1. This section sets out the scope of the assessment which has been determined via the **Scoping Report (Application Document Reference: TR010041/APP/6.11)** and **Scoping Opinion (Application Document Reference: TR010041/APP/6.13)**.

Appendix 4.1: Scoping Opinion Response Tracker, Volume 1 of this ES (Application Document Reference: TR010041/APP/6.1) provides a summary of the **Scoping Opinion** for Part B comments received from the Planning Inspectorate, along with the responses which have informed the scope, methodology and assessment in this chapter.

14.4.2. **Table 14-4** outlines the potential GHG emissions sources scoped into the assessment.

Table 14-4 – Construction and Operation Phase GHG Emissions Sources Included in the Assessment

Lifecycle Stage	Potential Sources of GHG Emissions	Examples of GHG Emissions Generated during Construction and Operation
Construction		
Product stage; including raw material supply, transport and manufacture	Emissions from construction materials typically form the greatest proportion of a scheme's emissions. Main works include: <ul style="list-style-type: none"> – Online widening 8 km carriageway (single to dual carriageway) – A grade separated junction (Charlton Mires Junction) – A new accommodation over bridge over the A1, located at Heckley Fence 	Available information for construction materials required for Part B include: <ul style="list-style-type: none"> – Bulk materials for earthworks – Road paving materials including sub-base and asphalt – Steel – for structures, reinforcement and road safety barrier

Lifecycle Stage	Potential Sources of GHG Emissions	Examples of GHG Emissions Generated during Construction and Operation
	<ul style="list-style-type: none"> – New footway at Charlton Mires Junction – Roundabout on the B6437 (north of Rock Lodge) – Six new detention basins, six new outfalls and 15 additional or modified culverts 	<ul style="list-style-type: none"> – Concrete including pre-cast or prefabricated elements – Aggregate – Timber for fencing and formwork – Plastics for drainage pipes – Other general construction materials
<p>Construction process stage; including transport to/from works site and construction/installation processes.</p>	<p>Activities of organisations conducting construction work, including demolition activities (two existing residential dwellings, and a number of outhouses and shed buildings), removal of one bus shelter and emissions sources such as fuel or energy consumption by delivery vehicles and construction plant.</p>	<p>Transportation of materials from point of purchase to site, mode and distance.</p> <p>Fuel or electricity consumption and construction activity type and duration.</p>
<p>Operation</p>		
<p>Use of the infrastructure by the end-user</p>	<p>Change in end-user emissions from the surrounding network (increase or decrease).</p>	<p>Traffic count / speed / % Heavy Delivery Vehicle (HDV) for highway links in the network.</p>
<p>Replacement</p>	<p>Part B’s resurfacing schedule provides for renewal of surface course commencing in year 12 of Part B and in years 20, 30, 40, 45 and 57.</p>	<p>Number of replacements / repairs to assets over design life.</p>

- 14.4.3. The proposed scope of assessment for the effects of Part B on climate, are as presented in the **Scoping Report (Application Document Reference: TR010041/APP/6.11)**. Emissions sources that are scoped out of the assessment are as reported in the **Scoping Report** for Part B and are summarised below:
- a. Operation and maintenance: As detailed in **Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**) roadside technology provided for Part B would be minimal, with GHG emission impacts considered to be negligible. No lighting would be provided for Part B. End user emissions are within scope and considered in the assessment.
 - b. Replacement (duplication with replacement which is scoped in).
 - c. End of life elements: Decommissioning would happen several decades into the future and well beyond the period for which the UK Government has set agreed carbon budgets. The uncertainty about the future decommissioning process and associated emissions is sufficient to scope this lifecycle stage out of the emissions assessment.
 - d. Land use, land use change and forestry: Vegetation loss as a result of permanent land take is likely to be minimal.

Methods of Baseline Data Collection

- 14.4.4. The baseline data collected and presented in this chapter were sourced through desktop research.

Methodology

- 14.4.5. The assessment approach considers the likely magnitude of GHG emissions (or avoided GHG emissions) relative to the baseline scenario with no Part B (the 'do minimum' scenario). Comparison of GHG emissions to UK National Carbon Budget periods are also considered to aid the assessment of the magnitude of change. This is in line with paragraph 5.17 of the NPS NN (**Ref. 14.4**). The assessment considers GHG emissions throughout the lifecycle of Part B including:
- a. Construction phase e.g. embodied GHG emissions associated with materials, transportation of materials to site and waste arisings from Part B, and the construction process.
 - b. Operation e.g. GHG emissions (or avoided GHG emissions) from end-user vehicles and refurbishing.
- 14.4.6. To quantify GHG emissions for the construction and operation lifecycle stages and sub-stages (as described in **Table 14-4**) of Part B, the assessment includes the following steps:
- a. Collection of available data/information on the scale of GHG emitting activities for the baseline scenario and for Part B e.g. tonnes of concrete, litres of diesel, average daily traffic flows. For each of these items, the data collected covers the whole study period (lifecycle of the assets). The whole lifecycle of Part B is

considered to be from 2021-2082 (Construction phase of 2021-2023 and operation phase 2023-2082).

- b. Calculation of the GHG emissions using best practice approaches to quantifying GHG emissions depending on the emissions source being calculated. In simplest terms, this involves applying the most suitable emissions factor (e.g. kgCO_{2e} per tonne of concrete).

Emissions Calculations

- 14.4.7. Construction and replacement emissions calculations have been completed using Highways England's (the Applicant's) carbon tool (**Ref. 14.14**) which is an industry recognised carbon calculation tool that quantifies carbon emissions for operational, construction and maintenance activities (throughout a project lifecycle) from highways' schemes. The tool uses design information in the form of materials' quantities and scheme assets. It utilises carbon emissions and conversion factors and material density factors to determine the associated emissions. This tool has been used as it is specifically designed for assessing highways' schemes and is therefore the most appropriate.
- 14.4.8. The material and waste types and quantities have been obtained from **Chapter 13: Material Resources** of this ES from data provided by the Buildability Advisor including estimated distances to the likely source of materials and location of waste sites. Values have been reported as tonnes of carbon dioxide equivalents (tCO_{2e}). Professional judgement based on similar road schemes has been applied when completing the carbon calculation tool in relation to the assigning of material types (where not already known).
- 14.4.9. The total operational phase end-user GHG emissions from traffic have been modelled using traffic data for Part B. Emissions were quantified using WebTAG data tables (**Ref. 14.15**) and data from the Department for Transport (**Ref. 14.16**). This takes into account the proportions of the vehicle types, fuel type, forecast fuel consumption parameters and emission factors over Part B's reference lifespan. An operational period of 60 years has been assumed for the assessment of GHG emissions. From this, emissions were quantified for each year over a 60 year lifetime of Part B (up to 2082). This quantitative assessment forms the basis of the assessment of this emissions source by providing emissions magnitude. This then enables the significance of emissions to be determined and is considered to be a suitable approach to identify and assess likely significant effects from Part B.
- 14.4.10. All GHG emissions have been reported as tonnes of carbon dioxide equivalents (tCO_{2e}).

Significance of Effects

- 14.4.11. In line with the NPS NN (2014) (**Ref. 14.4**), significance of effects has been assessed by comparing estimated GHG emissions arising from Part B with UK carbon budgets, and the associated reduction targets.

- 14.4.12. The NPS NN (2014) (**Ref. 14.4**) also sets out that “it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets” (paragraph 5.17, page 50, NPS NN). As such it is unlikely that Part B would constitute a significant portion of the UK carbon budgets.
- 14.4.13. There are currently no agreed thresholds for what level of GHG emissions is considered significant in an EIA. As such the significance of emissions is assessed with reference to:
- a. The magnitude of GHG emissions anticipated to be generated by Part B.
 - b. Comparison of the anticipated Part B emissions in relation to their regional and national context.
 - c. Comparison of the anticipated Part B emissions with the UK carbon budgets.
 - d. Guidance from IEMA (IEMA EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (**Ref. 14.17**)).
 - e. Comparisons to GHG emissions of schemes of a similar size and nature.
- 14.4.14. Based on the above criteria and in the absence of agreed thresholds, significance is determined using professional judgement, based upon schemes of a similar size and nature, where it is deemed that increases in GHG emissions would have a material impact.

Sensitive Receptors

- 14.4.15. The local, regional, national and global environment within which GHG emissions are emitted is considered the sensitive receptor within the assessment.

Data sources

- 14.4.16. The Part B traffic model has been used to calculate total operational phase end-user GHG emissions.
- 14.4.17. Material and waste types and quantities have been obtained from **Chapter 13: Material Resources** of this ES and the Buildability Advisor.

Consultation

- 14.4.18. No consultation has been undertaken for the completion of this chapter, as it was not required in order obtain the necessary data and information for this assessment

Guidance

- 14.4.19. The following guidance documents have been used to inform the methodology for this assessment:
- a. IEMA EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance (IEMA, 2017) (**Ref. 14.17**).
 - b. NPS NN (2014) (**Ref. 14.4**).
 - c. TAG Unit A3 Environmental Impact Appraisal, Chapter 4 Greenhouse Gases (**Ref. 14.15**).
 - d. PAS 2080:2016 Carbon Management in Infrastructure (**Ref. 14.8**).

VULNERABILITY OF PART B TO CLIMATE CHANGE

Scope of the Assessment

- 14.4.20. This section sets out the scope of the assessment which has been determined within the **Scoping Report (Application Document Reference: TR010041/APP/6.11)** and **Scoping Opinion (Application Document Reference: TR010041/APP/6.13)**. **Appendix 4.1: Scoping Opinion Response Tracker, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**) provides a summary of the Scoping Opinion for Part B comments received from the Planning Inspectorate, along with the responses which have informed the scope, methodology and assessment in this chapter.
- 14.4.21. The scope of the vulnerability assessment covers the construction and operational phases of Part B as detailed within the **Scoping Report (Application Document Reference: TR010041/APP/6.11)**. The decommissioning phase was previously scoped out and therefore is not assessed in this chapter.
- 14.4.22. Drainage aspects (such as: surface water drainage systems; cross-culverts; road-edge drainage; attenuation; outfalls; and drainage ditches) are not assessed within this chapter but have been assessed in **Chapter 10: Road Drainage and the Water Environment** of this ES.
- 14.4.23. This ES uses data from the UK Climate Projections (2018) (UKCP18), which was released after the publication of the **Scoping Report (Application Document Reference: TR010041/APP/6.11)**.
- 14.4.24. Incident management does not form part of the climate vulnerability assessment. Major accidents are dealt with separately within **Chapter 4: Environmental Assessment Methodology, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**). The management of other incidents, such as breakdowns, road use incidents / accidents and third party incidents are referred to in the **Construction Traffic Management Plan (Application Document Reference: TR010041/APP/7.4)**.
- 14.4.25. **Table 14-5** lists the climate variables, including extreme weather events, which have considered in this assessment (indicated with a tick in the table). Blank cells indicate variables that have not been considered further in this assessment due to geography and/or the context of Part B. Australian guidance (Standards Australia (2013) Climate Change Adaptation for settlements and infrastructure – a risk-based approach (**Ref. 14.18**)) is used in lieu of any UK guidance to assess the vulnerability of the elements of Part B, along with professional judgement.
- 14.4.26. Part B is not in a coastal or estuarine location. Variables associated with sea level rise including salinity do not require further inclusion in this chapter.
- 14.4.27. Evaporation is not expected to have a direct effect on the road, bridge or pedestrian and cycle way elements of Part B. Bridges are not considered to be highly sensitive

to long term changes in average precipitation, however they are expected to be sensitive to extreme rainfall, which is included in the assessment. The bridge elements are not considered to be sensitive to changes in soil runoff.

Table 14-5 - Climate Variables and Climate Related Hazards

Elements of Part B	Climate Variables and Hazards																		
	Sea				Precipitation				Temperature			Wind		Relative Humidity		Water Quality and Soils			
	Sea level rise	Storm surge and tide	Surface temperature	Currents and waves	Changes in seasonal average	Drought	Extreme precipitation events	Snow	Changes in seasonal average	Extreme temperature events	Solar radiation	Gales and extreme wind event	Storms (lightning, hail)	Changes in annual average	Evaporation	Soil moisture	Salinity/pH	Runoff	Soil stability
Road					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
Bridges						✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓
Pedestrian and cycle					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓

Methods of Baseline Data Collection

14.4.28. The baseline data collected and presented in this chapter were sourced through desktop research.

Methodology

14.4.29. The climate vulnerability assessment focusses on identifying the impacts and effects of climate change, including extreme weather events on receptors. The steps below have been followed:

- a. **Step 1** – Identify receptors (refer to **paragraph 14.4.35** below).
- b. **Step 2** – Identify potential impacts of changes in scoped in climate variables on receptors (refer to **Table 14-5**). **Table 14-6** shows typical climate change impacts affecting road schemes.
- c. **Step 3** – Identify the significance of effects on receptors by considering the likelihood and consequence of their occurrence, taking into account embedded mitigation measures incorporated in the design of Part B which contribute to the resilience of the development to changes in climate and the reduction of GHG emissions.

14.4.30. In **Step 1**, receptors for each of the broad elements of Part B considered at the scoping stage (road, bridge, pedestrian and cycle) are identified. These are the receptors that could be affected by the potential impacts of climate change.

14.4.31. In **Step 2**, for each of the receptors, potential hazards associated with changes in the climate variables scoped in for assessment are identified. **Table 14-6** shows typical climate change impacts affecting a road scheme.

Table 14-6 - Climate Variables and Potential Impacts

Climate Variable	Potential Impacts
Average (air) temperature change (annual, seasonal, monthly)	Prolonged warm periods, drought, change in growing season, sea level rise (plus local land movements), storm surge/tide Reduction in ice and snow
Extreme (air) temperature (frequency and magnitude)	Heatwaves, water availability / drought
Average precipitation (annual, seasonal, monthly)	Water availability / drought, flooding (pluvial and fluvial), soil moisture deficit, erosion, snow, ice and hail
Extreme rainfall (frequency and magnitude)	Flooding (fluvial and pluvial), subsidence and reduced ground stability, erosion

Climate Variable	Potential Impacts
Average wind speed change (annual, seasonal, monthly)	Increased wind loading on structures, erosion
Gales and extreme winds (frequency and magnitude)	Storms, lightning strike
Humidity	Fog
Solar radiation	Increased UV radiation

14.4.32. In **Step 3**, the significance of effects depends on the likelihood of potential impacts occurring and the consequence if they do occur. The assessment of likelihood and consequence includes consideration of mitigation identified in **Section 14.9**.

Assessment Criteria

14.4.33. The significance of the effects of climate change on receptors is determined by combining the likelihood and consequence ratings, as shown in **Table 14-9**. Consequence and Likelihood have been qualitatively assessed using the descriptions in **Table 14-7** and **Table 14-8**, based on professional judgement and emerging best practice as identified in **Section 14.3**. Likelihood takes account of the rate of climate change (and is informed by information on current and projected climate). Consequence considers both the potential extent and severity of disruption associated with the identified risks.

14.4.34. Mitigation measures are identified for 'significant' climate impacts using expert opinion.

Table 14-7 - Qualitative Description of Consequence

Consequence of Impact	Description
Negligible	Disruption to an isolated section of a strategic route lasting less than one day.
Minor adverse	Regional level disruption to strategic route(s) lasting less than one day.
Moderate adverse	Regional level disruption to strategic route(s) lasting more than one day but less than one week.
Large adverse	National level disruption to strategic route(s) lasting more than one day but less than one week OR regional level disruption to strategic route(s) lasting more than one week.

Consequence of Impact	Description
Very large adverse	National level (or greater) disruption to strategic route(s) lasting more than one week.

Table 14-8 - Qualitative Description of Likelihood

Likelihood Category	Description (Probability and Frequency of Occurrence)
Very high	The event occurs multiple times during the lifetime of a scheme (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of a scheme (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of a scheme (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of a scheme (60 years) e.g. once in 60 years.
Very low	The event may occur once during the lifetime of a scheme (60 years).

Table 14-9 - Significance Rating Matrix

Likelihood	Consequence				
	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

Likelihood	Consequence				
	Negligible	Minor adverse	Moderate adverse	Large adverse	Very large adverse
Very low	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Sensitive Receptors

14.4.35. The sensitive receptors in relation to the Part B assets identified in **Table 14-5** (road, bridges and Walkers, Cyclists and Horse riders (WCH)) have been detailed into the following components and been considered within the assessment:

a. Construction

- i. Site compounds.
- ii. Machinery and plant.
- iii. Materials, including topsoil which has been stripped and stored.
- iv. Staff.

b. Operation

- i. Built structures (including over and under bridges).
- ii. Geotechnics (including earthworks, embankments and foundations).
- iii. Hard surfaces (including pavements and the road surface).
- iv. Roadside infrastructure (including signs and traffic signals).
- v. Soft estate (including vegetation).
- vi. Scheme users (operators and customers).

Data Sources

14.4.36. The following data sources have been used in this assessment:

- a. UK Climate Projections 2018 (UKCP18) (**Ref. 14.19**) – UK climate change projections used to define the future baseline against which vulnerability of Part B to climate change is assessed.
- b. UK Climate Projections 2009 (UKCP09) (**Ref. 14.20**) – previous UK climate projections used where data from UKCP18 is unavailable.
- c. Centre for Environmental Data Analysis (CEDA) (**Ref. 14.21**) – for observed climate data.
- d. Met Office regional climate profile for the North East of England – for observed climate data (**Ref. 14.22**).

Consultation

14.4.37. No consultation has been undertaken for the completion of this chapter, as it was not required in order to obtain the necessary data and information for this assessment.

Guidance

- 14.4.38. The following guidance documents have been used to inform the methodology for this assessment:
- a. IEMA EIA Guide to Climate Change Resilience and Adaptation (IEMA, 2015) (**Ref. 14.23**).
 - b. European Commission (2013) Guidance on Integrating Climate Change and Biodiversity into EIA (**Ref. 14.24**).
 - c. European Commission (2016) Climate change and major projects (**Ref. 14.25**).
 - d. European Commission Non-Paper Guidelines for Project Managers: Making vulnerable investments climate resilient (2013) (**Ref. 14.26**).
 - e. Highways England (2016) Climate adaptation risk assessment progress update (**Ref. 14.27**)
 - f. Australian guidance (Standards Australia (2013) Climate Change Adaptation for settlements and infrastructure – a risk-based approach (**Ref. 14.18**))

UPDATED DMRB GUIDANCE

- 14.4.39. This section applies to both effects of Part B on climate change (GHG Emissions) and vulnerability of Part B to climate change.
- 14.4.40. Since the initial preparations of this ES, a new DMRB guidance document for Climate has been published – DMRB LA 114 Climate (**Ref. 14.28**).
- 14.4.41. In order to determine the implications of the updated guidance to the conclusions of the ES, a sensitivity test has been undertaken to identify key changes in the assessment methodology and determine whether there would be changes to the significant effects reported in this ES if the updated guidance had been used for the assessment.
- 14.4.42. The findings of the sensitivity test are presented in **Appendix 4.5: DMRB Sensitivity Test, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**) and are summarised in **Section 14.10** below.

14.5 ASSESSMENT ASSUMPTIONS AND LIMITATIONS

EFFECT OF PART B ON CLIMATE (GHG EMISSIONS)

- 14.5.1. The assumptions and limitations which apply to this assessment are outlined in **Table 14-10**. For each assumption or limitation, an explanation of the possible effect of the assumption has been provided as well as a description of any corrective actions that have been taken to adjust for any limitations. These assumptions are considered reasonable and are not likely to impact on the outcome of the assessment.

Table 14-10 – GHG Assessment Assumptions and Limitations

Assumption or Limitation	Effect	Solution
<p>There is currently no specific guidance or carbon emissions threshold, which, if exceeded, is considered significant.</p>	<p>The assessment has not been undertaken in line with specific guidelines or standards.</p>	<p>Professional judgement based on experience and knowledge of similar schemes and current guidance as identified in Section 14.3 have been used to make the assessment.</p>
<p>Type and quantities of material and waste provided at this stage are indicative and would be refined as the design of Part B progresses.</p>	<p>Data has been provided by the Buildability Advisor, based on the current design for Part B.</p>	<p>The data included the anticipated source of construction materials, anticipated waste generated and their waste disposal method and anticipated waste management facilities. The data also included an estimation of fuel usage. The data comprises estimates of bulk quantities of anticipated construction materials.</p>
<p>Data on the anticipated transportation distance for materials brought to site and wastes taken from site have been provided by the Buildability Advisor (as outlined in Chapter 13: Material Resources of this ES), based on the current design for Part B and anticipated location of material resources and waste disposal sites.</p>	<p>The transportation distances have been used to complete the Highways England Carbon Tool to calculate construction phase GHG emissions.</p>	<p>The transportation distances are considered reasonable based on the Buildability Advisor’s professional judgement. Any changes to the distances are not considered to materially affect the chapter outcomes.</p>
<p>Highways England Carbon Tool (Ref. 14.14) required units different to those provided by the main contractor.</p>	<p>Errors in calculations within the Carbon Tool</p>	<p>The Waste and Resources Action Programme (WRAP) conversion factors have been applied (Ref. 14.29) to convert volumes to weight based on density of typical construction materials. Professional judgement</p>

Assumption or Limitation	Effect	Solution
		<p>based on similar road infrastructure schemes has been applied when completing the Highways England carbon tool (Ref. 14.14). Alterations to the conversion factors are not considered to materially affect the chapter outcomes.</p>
<p>Method for traffic data modelling for end-user traffic emissions</p>	<p>Ensuring consistency across end-user traffic data calculations</p>	<p>The change in vehicle km has been determined using data from demand forecasting modelling. This modelling predicted future use of Part B and thereby a modal shift of road users as derived from a number of factors. Emissions were quantified using the WebTAG book and data from the Department for Transport. This takes account the proportions of the vehicle types, fuel type, forecast fuel consumption parameters and emission factors – and how they change over time.</p>
<p>Calculation of linear metres of materials used in Part B when tonnes have been provided</p>	<p>Errors in calculations within the Carbon Tool</p>	<p>Professional judgement has been used to complete the carbon tool, and assumptions have been made. For example, 150 tonnes of precast concrete drainage products (manholes – 191 chambers and 44 gullies) was included in the bill of quantities. To convert linear metres to tonnes of this material for inclusion into the carbon tool, an assumption was made that each chamber or gully was estimated at 1 m each in length. In addition,</p>

Assumption or Limitation	Effect	Solution
		when considering road resurfacing, it has been assumed that only the asphalt would be replaced.
An operational period of 60 years has been assumed for the assessment of GHG emissions		

VULNERABILITY OF PART B TO CLIMATE CHANGE

- 14.5.2. The assumptions and limitations which apply to this assessment are outlined in **Table 14-11**. For each assumption or limitation, an explanation of the possible effect of the assumption has been provided as well as a description of any corrective actions that have been taken to adjust for any limitations. These assumptions are considered reasonable and are not likely to impact on the outcome of the assessment.

Table 14-11 – Climate Vulnerability Assessment Assumptions and Limitations

Assumption or Limitation	Effect	Solution
The assessment undertaken provides a broad indication of the potential impacts of climate change on Part B.	The assessment is based on a qualitative assessment and professional judgement.	An approach has been developed and applied in this assessment based on existing best practice.
There is currently no agreed methodology that should be applied for assessing the vulnerability of major schemes, including road infrastructure, under the EIA regulations.	The assessment has not been undertaken in line with specific standards.	An approach has been developed and applied in this assessment based on existing best practice as identified in Section 14.4 .
The UKCP18 projections have been used to infer future changes in a range of climate variables that may affect the vulnerability of Part B to climate change. At the time of writing, these	There are inherent uncertainties associated with climate projections and they are not predictions of the future. It is possible that future climate will differ from the baseline climate	A high emissions scenario (Representative Concentration Pathways (RCP) 8.5) using the 2080s timeslice (2070-2099 – the longest temporal scale available through UKCP18) has been used to develop

Assumption or Limitation	Effect	Solution
represent the most up-to-date representation of future climate in the UK.	against which the resilience of Part B has been assessed depending on global emissions over the next century.	the baseline against which resilience has been assessed. This is consistent with the precautionary principle (i.e. 'worst case' scenario).
Analysis of climate projections is based on selected observational data	The results of climate model ensembles and a selected range of existing climate change research and literature available at the time of assessment.	Any future decision-making based on this analysis should consider the range of literature, evidence and research available at that time and any changes to this.
The determination of resilience has been undertaken under the assumption that industry design standards will be adhered to where detailed information is unavailable.	Industry design standards may not have been updated to account for climate resilience.	To be applied, as applicable, as the design, construction and operation of Part B develops.

14.6 STUDY AREA

EFFECT OF PART B ON CLIMATE (GHG EMISSIONS)

14.6.1. The GHG emissions assessment is not restricted by geographical area but instead includes any increase or decrease in emissions as a result of Part B.

14.6.2. The Study Area therefore comprises:

a. Primary:

- i. Emissions relating to onsite construction activities (such as plant use on site).
- ii. Operational emissions from site maintenance activities related to replacement (such as plant use on site).

b. Secondary:

- i. Operational end user traffic – a comparison has been made between GHG emissions between the do-minimum (Without Part B) and do-something (With Part B) scenarios provided by a GHG assessment based on data from the traffic model for Part B, and Transport Analysis Guidance: Unit A3 Environmental Impact Appraisal.

c. Tertiary:

- i. Construction emissions relating to the manufacturing, transport and disposal of materials, which may be some distance from the location of Part B (for example, emissions associated with the manufacture of cement and steel).
- ii. Operational emissions from the manufacturing, transport and disposal of replacement materials, which may be some distance from the location of Part B (for example, emissions associated with the manufacture of cement and steel).

VULNERABILITY OF PART B TO CLIMATE CHANGE

14.6.3. The Study Area for the climate change vulnerability assessment is related to the impact of climate on Part B (rather than the impact of Part B on the environment). The climate vulnerability assessment has used Met Office published historical regional weather data to establish the current climate impacts on the Study Area for which the UKCP18 probabilistic projections are based.

14.6.4. The projections that are used to define the future baseline (against which resilience of Part B is assessed) are UKCP18 projections for the 2080s for the North East England region for a high emissions scenario (Representative Concentration Pathway (RCP) 8.5), refer to **Figure 14.1** below.



Figure 14.1 - Location of North East of England Region

14.7 BASELINE CONDITIONS

EFFECTS OF PART B ON CLIMATE (GHG EMISSIONS)

- 14.7.1. The baseline conditions set out in this section describe the current likely emissions sources from within the Order Limits, which includes the Part B Main Scheme Area (including Charlton Mires construction compound) and the Lionheart Enterprise Park Compound (eastern site and western site). The Main Compound, which would be located within Part A, is also considered in the assessment. This section describes how this baseline would be likely to change in a 'do-minimum' scenario (without Part B).
- 14.7.2. In the baseline scenario, GHG emissions occur constantly and widely as a result of human and natural activity including energy consumption (fuel, power), industrial processes, land use and land use change. The GHG assessment only considers where Part B results in additional or avoided emissions in comparison to the baseline scenario and its assumed evolution.
- 14.7.3. No construction works are anticipated to take place in the 'do minimum' scenario, and as such no construction emissions are included within the baseline.
- 14.7.4. The operation and management of the existing A1 assets likely requires a small number or volume of specialist components (for example, signage) as well as some bulk material (cement, concrete, sand and gravel) for minor maintenance and refurbishment works and repairs of the highway and ancillary infrastructure. This use of materials in the baseline scenario would have embodied emissions associated with them. However, due to the small quantities of materials required, emissions are considered to be minimal and as such have been excluded from further assessment.
- 14.7.5. The do-minimum option would be unlikely to change the emission sources generated by the current consumption of materials within the Order Limits.
- 14.7.6. In terms of end-user emissions from road traffic, the existing A1 has a large number of junctions and private accesses which result in traffic delays. Slow-moving traffic is also caused by a high proportion of heavy goods vehicles, agricultural vehicles and lack of overtaking opportunities.
- 14.7.7. The total end-user GHG emissions from traffic flows in the 'do minimum' (baseline) scenario are presented in **Table 14-12** below. The total end-user traffic GHG emissions has been based on a 60-year operational life of Part B (2023 to 2082). This exceeds the pavement design life of 40 years and covers half of the standard bridge design life (120 year). It is not considered proportionate to model GHG emissions beyond a 60-year timeframe for Part B due to a lack of certainty in GHG emissions beyond this timeframe. The average annual GHG emissions for the 60 year period is also provided.
- 14.7.8. In the 'do-minimum' (baseline) scenario, total CO₂ emissions are expected to decrease after 2023 (opening year) by 5% until the future year 2038 (15 years after

opening) as shown in **Table 14-12**. This is due to the effects of, for example, vehicle types, fuel type, forecast fuel consumption and vehicle emission factors.

Table 14-12 - Baseline GHG Emissions Data for End User Traffic in the Region of Part B

Scenario	Total GHG emissions for all traffic in the traffic model area (thousand tonnes of carbon dioxide equivalent; kTCO _{2e})			
	2023	2038	Average per year (2023 – 2082)	Total (2023-2082)
Baseline (do minimum)	117	111	112	6,725

14.7.9. In addition to the baseline traffic emissions presented above, emissions during 2016 within North East and nationally (**Ref. 14.30**) are presented in **Table 14-13** for context.

Table 14-13 – GHG Emissions, Northeast and National, 2016

Source	Northeast (kTCO _{2e})	National (kTCO _{2e})
A. Industry and Commercial Electricity	2,049.3	51,531.7
B. Industry and Commercial Gas	1,766.0	35,973.1
C. Large Industrial Installations	3,622.3	32,465.9
D. Industrial and Commercial Other Fuels	512.7	17,657.9
E. Agriculture	176.6	5,381.6
Industry and Commercial Total	8,126.9	143,010.3
F. Domestic Electricity	1,141.1	31,441.6
G. Domestic Gas	2,870.7	60,202.5
H. Domestic 'Other Fuels'	273.6	10,788.0
Domestic Total	4,285.4	102,432.0
I. Road Transport (A roads)	2,349.8	54,350.7
J. Road Transport (Motorways)	285.5	28,031.8

Source	Northeast (kTCO_{2e})	National (kTCO_{2e})
K. Road Transport (Minor roads)	1,727.3	41,483.3
L. Diesel Railways	97.5	2,150.7
M. Transport Other	34.7	2,036.2
Transport Total	4,494.9	128,052.7
N. LULUCF Net Emissions	-1,437.8	-16,025.6
Grand Total	15,469.4	357,469.5
Population ('000s, mid-year estimate)	2,636.6	65,648.1
Per Capita Emissions (t)	5.9	5.4

VULNERABILITY OF PART B TO CLIMATE CHANGE

- 14.7.10. **Appendix 14.1: Vulnerability to Climate Change Baseline, Volume 8** of this ES (Application Document Reference: TR010041/APP/6.8) provides details of current climate and projected climate for the Study Area.
- 14.7.11. Data on current and projected climate is presented at the scale of the North East of England region and as such, there are no anticipated differences in baseline climate conditions between the Part B Main Scheme Area (including Charlton Mires construction compound), the Lionheart Enterprise Park Compound (eastern site and western site and the Main Compound).
- 14.7.12. In summary, the northeast of England region has a temperate climate, although rainfall is significant, even in the driest month (typically February). Current mean temperatures in the northeast of England region are, relative to elsewhere in England, generally cool throughout the year.

FUTURE BASELINE

- 14.7.13. UKCP18 suggests that the region will become wetter in winter and drier in summer, with more extreme rainfall events. Projections for the region in the 2080s under a high emissions scenario (RCP8.5) are as follows:
- a. Mean winter precipitation is projected to increase by up to 22% (50th percentile).
 - b. Mean summer precipitation is projected to decrease by around 23% (50th percentile).
- 14.7.14. In terms of temperature, UKCP18 suggests that the region will experience hotter summers and warmer winters, with more extreme temperature events (heatwaves).

Projections for the region in the 2080s under a high emissions scenario (RCP8.5) are as follows:

- a. Mean winter temperature is projected to increase by approximately 3°C (50th percentile).
- b. Mean summer temperature is projected to increase by approximately 4°C (50th percentile).

- 14.7.15. UKCP18 projections 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 impacts of wind are experienced. This is accompanied by an increase in frequency of winter storms.
- 14.7.16. The vulnerability of Part B to climate change depends on the level of exposure of the receptors to changes in different climate variables. Due to the lag in the climate system and given past emissions of GHGs some degree of climate change is inevitable in the near-term (<20-30 years). In the short-term, natural variability will dominate the weather-related risks that are experienced, including extreme events (such as storms and heatwaves).
- 14.7.17. Over the long term, the climate we experience will be influenced by levels of GHG emissions. To model and predict future climate it is necessary to make assumptions about the economic, social and physical changes to our environment that will influence climate change. RCPs are a method for capturing those assumptions within a set of scenarios. RCPs specify the concentration of GHG in the atmosphere which will result in target amounts of radiative forcing at the top of the atmosphere by 2100, relative to pre-industrial levels. Four RCPs are modelled in UKCP18 (RCP2.6, RCP4.5, RCP6.0 and RCP8.5), representing four different climate outcomes; RCP8.5 is the highest emissions scenario.
- 14.7.18. In combination, climate change and extreme weather events will bring challenges for the UK's infrastructure over time, including in the short- (2020s), medium- (2050s) and long-term (2080s). The design life of Part B (as detailed in **Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**)) has been used to identify the temporal boundary for the climate vulnerability assessment (a pavement design life of 40 years and a standard bridge design life of 120 years). UKCP18 data does not extend beyond the 2080s timescales. In light of the above, the assessment presented here considers the 2020s, 2050s and 2080s timescales under RCP8.5, where appropriate.
- 14.7.19. The projections provided by UKCP18 (**Ref. 14.19**) are probabilistic, which means that rather than a single 'best-guess' of the impact of climate change they provide a range of outcomes based on an 'ensemble' of multiple climate model runs. This better represents the uncertainty of climate prediction science. To help demonstrate consideration of uncertainty inherent within climate modelling, projections for the 10th, 50th (central) and 90th percentiles are stated, where possible. The 10th

percentile describes the value at which 10% of the model runs fall at or below; the 50th percentile is the value at which half the climate scenarios fall below the figure and half fall above it; and the 90th percentile described the value at which 90% of the model runs fall at or below.

14.7.20. The elements of Part B have been broadly classified as 'road' 'bridges' and 'pedestrian and cycle' as presented in **Table 14-5**. Specific receptors within the classifications may be summarised as:

- a. Road:** comprising the hard surfaces such as pavements and road surface, roadside infrastructure, soft estate, earthworks, embankments and foundations.
- b. Bridges:** Built structures including over and under bridges and earthworks, embankments and foundations.
- c. Pedestrian and cycle:** Pedestrian and cycle provision.

14.8 POTENTIAL IMPACTS

EFFECT OF PART B ON CLIMATE (GHG EMISSIONS)

- 14.8.1. The impacts of GHG emissions relate to their contribution to global warming and climate change. These impacts are global and cumulative in nature, with every tonne of GHG contributing to adverse effects upon natural and human systems.
- 14.8.2. GHGs are natural and man-made gases occurring in the atmosphere, which absorb and emit infrared radiation, thereby retaining the Sun's energy within the Earth's atmosphere. There is an overwhelming scientific consensus that the major increase in the concentration of GHGs from man-made sources is contributing to global warming and climate change (**Ref. 14.31**).
- 14.8.3. The seven main GHGs defined by the Kyoto Protocol are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride. In combination, these GHG emissions are commonly expressed in terms of carbon dioxide equivalents according to their relative global warming potential. For this reason, the shorthand 'carbon' may be used to refer to GHG.
- 14.8.4. GHG emissions result in the same impacts wherever and whenever they occur, and as such it is not possible to link specific Part B emissions, with specific environmental outcomes beyond their contribution to climate change at large.
- 14.8.5. GHG emissions would occur as a result of human activities with or without Part B. The baseline data shows that, in the absence of Part B, end-user traffic emissions would decrease after 2023 (opening year) by 5% until the future year 2038.
- 14.8.6. Any increase in emissions and the corresponding concentrations of GHG present in the atmosphere will contribute to climate change, and as such emissions of GHG due to Part B would contribute to climate change.

Construction

- 14.8.7. Part B would result in increases in GHG emissions associated with construction activities (such as manufacturing of materials and construction processes).

Operation

- 14.8.8. Part B would result in changes to end-user traffic emissions throughout its operational life, which could be an increase or decrease depending on the effect on traffic flows and speeds. In addition, the road is anticipated to be resurfaced in years 12, 20, 30, 40, 45 and 57, which would also increase GHG emissions for Part B.

VULNERABILITY OF PART B TO CLIMATE CHANGE

- 14.8.9. **Table 14-14** describes the potential climate and weather related impacts on Part B receptors during the construction phase. The potential impacts identified apply to the Lionheart Enterprise Park Compound, the Charlton Mires construction compound and the Main Compound which is located within the Order Limits of Part A and would be shared by Part B.
- 14.8.10. Additional activities associated with Part B at the Main Compound are set out in **Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**). It is not considered that these additional activities would change the nature or significance of the potential impacts as they would be exposed to the same climate variables and the mitigation measures described in **Table 14-14** would apply to Part B activities. As such, further assessment of Part B activities is scoped out. The tables which follow describe potential impacts, mitigation and significance of climate change effects during construction on the Lionheart Enterprise Park Compound, the Charlton Mires construction compound and the Main Compound.
- 14.8.11. **Table 14-15** describes the potential impacts during the operation phase.

Table 14-14 – Potential Climate Impacts (Construction) on Receptors

Climate Variable		Projected Change	Construction Compounds	Machinery and Plant	Materials	Staff
Precipitation	Annual average rainfall	Increase in winter rainfall	<ul style="list-style-type: none"> – Flooding of construction works and compound – Waterlogging of excavations – Increased runoff and silt 	Water and flood damage	Excessive moisture in materials	Unsafe working conditions (e.g. exposure to contaminated flood water, electrical hazards, slips, trips and falls); lost productivity through disruption of operations and loss of access
		Decrease in summer rainfall	<ul style="list-style-type: none"> – Increase in dust – Soil erosion 	Dust damage; risk of fire damage	Enhanced reactions when cement stabilising and drying of concrete	Unsafe working conditions (eye and lung irritation)
	Extreme rainfall	Increase in magnitude and frequency of extreme rainfall events	<ul style="list-style-type: none"> – Flooding of construction works and compounds – Waterlogging of excavations – Overwhelming of drains – Soil erosion and sedimentation 	Water and flood damage	Destabilisation of material, including topsoil and spoil heaps	Unsafe working conditions (e.g. exposure to contaminated flood water, electrical hazards); lost productivity through loss of access to site
	Drought	Increased risk of drought	<ul style="list-style-type: none"> – Increase in dust – Soil erosion – Fire 	Dust damage; risk of fire damage	Enhanced reactions when cement stabilising and drying of concrete	Unsafe working conditions (eye and lung irritation; fire hazard)
Temperature	Annual average temperature	Increase in annual and seasonal average temperature	Increased vegetation growth	Overheating of machinery	Deformation of materials (e.g. melting of road surfaces)	Unsafe working conditions (heatstroke)
	Extreme temperature	Increase in magnitude of extreme temperature	Fire	Overheating of machinery	Deformation of materials (e.g. melting of road surfaces)	Unsafe working conditions (heatstroke)
	Solar radiation	Increase in solar radiation	N/A	Overheating of machinery	Deterioration of materials (e.g. brittleness)	Unsafe working conditions (high ultraviolet (UV) levels)
Wind	Gales	Increase in mean wind speed and more frequent gusts; increased wind loading	Increase in dust	Dust damage; damage due to collision with storm debris and downed trees	Loss of materials	Unsafe working conditions (working at height, increased dust, reduced visibility)
	Storms	Increase in frequency of storms	Flooding of construction works and compounds	Water and flood damage; collision with storm debris and downed trees; risk of lightning strike	Destabilisation of material, including topsoil and spoil heaps	Unsafe working conditions, particularly for working at height; lost productivity through disruption of operations and loss of access

Climate Variable		Projected Change	Construction Compounds	Machinery and Plant	Materials	Staff
Humidity	Annual average	Decrease in summer humidity, increase in winter humidity	N/A	Fog in winter may affect operation of plant	Deterioration of materials (e.g. increased rusting in high humidity)	Unsafe working conditions (low visibility due to fog)
	Soil moisture	Decrease in soil moisture in summer; increase in winter	<ul style="list-style-type: none"> - Soil erosion and sedimentation - Increase in dust - Waterlogging of site 	Dust damage; unstable ground conditions leading to unsafe driving conditions	Loss of materials	Unsafe working conditions (increased dust, reduced visibility)
	Soil stability	Decrease in soil stability	Subsidence	Unsafe driving conditions; collapse of buildings and other structures	Collapse of spoil heaps	Unsafe working conditions

Table 14-15 – Potential Climate Impacts (Operation) on Receptors

Climate Variable		Projected Change	Built Structures	Geotechnics	Road Infrastructure	Hard Surfaces	Soft Estate	Part B Users
Precipitation	Annual average rainfall	Increase in winter rainfall	Flooding of structures	Destabilisation of embankments	Flooding of infrastructure and associated control equipment	<ul style="list-style-type: none"> - Flooding of paved surfaces - Damage to paved surfaces 	Mobilisation of pollutants in the soil	Delays and disruption Increase risk of slips, trips and falls (operators) Unsafe driving conditions due to slippery and flooded surfaces
		Decrease in summer rainfall	Drying out and cracking of substrate	Drying out and cracking of soils leading to destabilisation	Increase in dust	Drying out and cracking of substrate leading to pavement damage	Drying out of vegetation leading to soil erosion	Unfavourable environment for users - Increase in dust Unsafe driving conditions due to poor visibility
	Extreme rainfall	Increase in magnitude and frequency of extreme rainfall events	Surface water flooding	Destabilisation of embankments	Surface water flooding	Surface water flooding Damage to paved surfaces Drainage overwhelmed	Flooding of unpaved shoulders Mobilisation of pollutants in soil / ground	Delays, disruption and unsafe driving conditions due to flooding Increase risk of slips, trips and falls (operators) Difficult driving conditions

Climate Variable		Projected Change	Built Structures	Geotechnics	Road Infrastructure	Hard Surfaces	Soft Estate	Part B Users
	Drought	Increased risk of drought	Drying out and cracking of substrate	Drying out and cracking of soils leading to destabilisation	Increase in dust	Drying out and cracking of substrate leading to pavement damage	Drying out of vegetation leading to soil erosion Fire	Unfavourable environment for users - Increase in dust Unsafe driving conditions due to poor visibility
Temperature	Annual average temperature	Increase in annual and seasonal average temperature	Increased thermal expansion of bridge joints	Drying out and cracking of soils leading to destabilisation	N/A	Drying out and cracking of substrate leading to pavement damage	Longer growing season – more vigorous vegetation growth	Unfavourable environment for users
	Extreme temperature	Increase in magnitude of extreme temperature	Increased thermal expansion of bridge joints	Drying out and cracking of soils leading to destabilisation	Overheating of electronic and control equipment; melting of road surfaces and increased rutting	Deformation of paved surfaces (melting and rutting)	Loss of vegetation	Uncomfortable travelling conditions (overheating vehicles) Unsafe working conditions for staff (heatstroke)
	Solar radiation	Increase in solar radiation	Deterioration in materials e.g. fading, brittleness	N/A	Deterioration in materials e.g. fading, brittleness	Deterioration in materials e.g. fading, brittleness	Increased plant growth	Unsafe working conditions for staff (high levels of UV)
Wind	Gales	Increase in mean wind speed and more frequent gusts; increased wind loading	Increased wind loading on structures	N/A	Wind driven rain infiltration into materials causing more rapid deterioration Damage to signage	N/A	Downed trees	Difficult driving conditions; delay and disruption (e.g. due to downed trees, accidents) Unsafe working conditions
	Storms	Increase in frequency of storms	Water and flood damage; collision with storm debris and downed trees; risk of lightning strike	N/A	Increased risk of lightning strike affecting control equipment Damage to signage Loss of power	N/A	Downed trees	Difficult and unsafe driving conditions
Humidity	Annual average	Decrease in summer humidity, increase in winter humidity	Deterioration of materials (e.g. increased rusting in high humidity)	N/A	Increased mould growth during winter leading repainting/ greater maintenance requirements	Increased mould growth during winter leading repainting/ greater maintenance requirements	N/A	Difficult and unsafe driving conditions (low visibility due to fog)
Soils	Soil moisture	Decrease in soil moisture in summer; increase in winter	N/A	Drying out and cracking of soils	N/A	Drying out and cracking of substrate leading to pavement damage	N/A	Disruption to WCH journey amenity due to increased dust in

Climate Variable	Projected Change	Built Structures	Geotechnics	Road Infrastructure	Hard Surfaces	Soft Estate	Part B Users
			leading to destabilisation				summer and muddiness in winter
Soil stability	Decrease in soil stability	Subsidence and destabilisation of bridge foundations	Subsidence and destabilisation	Subsidence and destabilisation of road foundations	Destabilisation of soils leading to pavement damage	N/A	Disruption to WCH journey amenity

14.9 DESIGN, MITIGATION AND ENHANCEMENT MEASURES

EFFECTS OF PART B ON CLIMATE (GHG EMISSIONS)

- 14.9.1. The effects on climate from the construction of Part B are inherently linked to the consumption of material resources, the generation and disposal of waste and transport of these items to, within and from the site.
- 14.9.2. Measures within the design of Part B are identified below and included within the **Outline Construction Environmental Management Plan (Outline CEMP) (Application Document Reference: TR010041/APP/7.3)**.

Design Measures

- 14.9.3. The following principles, as identified in **Section 2.5 of Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**), have been adopted within the design of the road surfacing to ensure sustainability:
- a. Re-use of materials to minimise resource consumption, waste disposal and emissions resulting from material haulage.
 - b. Whole-lifecycle design, including that which maximises the residual life of existing surfacing components.
 - c. Recycling of end-of-life materials.
 - d. Innovative and best practice design to ensure environmental protection and minimise construction periods and traffic disruption.
- 14.9.4. In addition, the following measures are included within the design of Part B and included within the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**:
- a. Where possible, existing structures would be retained, such as footpaths and culverts, as set out in **Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**).
 - b. The selection of structural elements (each bridge and culvert) has been completed using a matrix examination of the various potential structural forms. Sustainability considerations are one of the main areas through which the options were assessed. Wherever possible, the most appropriate low carbon solution has been chosen for Part B.
 - c. During detailed design, the most appropriate low carbon solution would be selected for Part B, in line with good practice.
 - d. Use of pre-fabricated elements and off-site construction to optimise efficiency, such as the girders and bracing for the deck works and culvert elements as set out in **Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**).
 - e. Design initiatives would be realised through working with the Pavement Efficiency Group to ensure that emerging or improved practices are adopted wherever possible. The design aspects would be confirmed as detailed design progresses; however, this may include specialist road recycling through cold reconstruction processes which reduces

waste to landfill and energy reduction, mobile batching plant which would reduce vehicle movements, and warm mix asphalt, manufactured at lower temperatures reducing the carbon footprint and using less fuel in the manufacturing process.

- f. As far as possible, incorporating material resource efficiency and waste minimisation best practice into design, in particular improving the cut and fill balance of Part B.
- g. Select and engage with material suppliers and the main contractor taking into account their policies and commitments to reduction of GHG emissions, including embodied emission in materials.
- h. Minimise energy consumption would include fuel usage by, for example, reducing the requirement for earth movements to/from and within the construction site.

Mitigation Measures

Construction

- 14.9.5. As detailed in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**, a Site Waste Management Plan (SWMP) and Materials Management Plan (MMP) would be developed by the main contractor (as outlined in **Chapter 13: Material Resources** of this ES) to ensure waste minimisation and re-use of materials on site. The Outline CEMP would be developed into a detailed full CEMP by the main contractor and secured through **Requirement 4** of the **draft DCO (Application Document Reference: TR010041/APP/3.1)**.
- 14.9.6. As described in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**, measures to reduce GHG emissions include:
- a. The re-use of site arisings (earthworks, road planings, concrete (through crushing and use on haul roads)) and vegetation (through mulching) (as outlined in **Chapter 13: Material Resources** of this ES). Earthworks and topsoil fill may be sourced from the surplus fill from Part A. Refer to **Chapter 15: Assessment of Combined Effects** of this ES for further information.
 - b. Minimise transportation of materials and waste through local sourcing of materials, use of local waste facilities and backhauling. **Chapter 13: Material Resources** of this ES identifies that materials would be sourced from the North East in the first instance and then nationally depending on the availability of construction materials.
 - c. Collection of rainwater on-site to minimise transportation of freshwater for bowsers.
 - d. Use of vehicles fitted with telematics and start – stop technology on construction plant to minimise fuel use.

Operation

- 14.9.7. There are no operation measures in relation to the effects of Part B on climate.

Enhancement Measures

- 14.9.8. No enhancement measures are proposed for the construction and operation of Part B. The mitigation measures described above are sufficient in reducing potential GHG emissions as far as reasonably possible.

VULNERABILITY OF PART B TO CLIMATE CHANGE

Construction

- 14.9.9. **Table 14-16** outlines the embedded mitigation measures that have been integrated into the design and construction methodology of Part B in order to improve the resilience of Part B to the potential impacts identified in **Table 14-14** and **Table 14-15**. These measures and how they have been secured are detailed in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**.

Table 14-16 - Embedded Mitigation Measures

Climate variable	Potential Impacts	Embedded Mitigation Measure(s)
Precipitation	<p>Extreme rainfall events, Wetter winters (including flooding and/or repeated wet cycles)</p> <ul style="list-style-type: none"> - Surface water flooding - Destabilisation of embankments - Damage to paved surfaces - Overwhelming of drainage - Water accumulation causing disruption to construction and operation - Delays and disruption to the construction process and when Part B is operational - Difficult driving and working conditions - Slip, trips and falls 	<p>Design Measures</p> <p>Structures</p> <ul style="list-style-type: none"> - The detailed design would ensure that the culvert spans are compatible with predicted flow rates during periods of high rainfall (during operation), particularly for extreme rainfall events with regard to surrounding topography and other watercourses. <p>Drainage</p> <ul style="list-style-type: none"> - The drainage design includes Sustainable Drainage System (SuDS) to limit the effect of the new works by attenuating the runoff during operation. - An allowance has been made for increased intensity of rainfall. An increase of 20% has been used in line with DMRB. <p>Flood Risk</p> <ul style="list-style-type: none"> - 300 – 600 mm freeboard allowance in culvert design. <p>Buildability</p> <ul style="list-style-type: none"> - Landscape planting on embankments to improve stability during operation. - Embankment slopes would be 3:1. - Embankment slopes to be constructed from earthworks cut with appropriate planting. - Design drainage such that maintenance (during operation) is more accessible and easier to undertake. - Design drainage for minimal maintenance during operation. - Provide self-cleansing systems in drainage to remove silting. - Agree higher discharge levels with Environment Agency to remove excess stored water from drainage system quicker during operation. - Provide more effective seals to equipment such as the weather station, Automatic Number Plate Recognition, Technology cabinets, Electricity Interface cabinets to minimize water ingress and subsequent equipment failure during operation. <p>Construction Mitigation Measures</p> <p>Buildability</p> <ul style="list-style-type: none"> - Avoid earthworks during winter months of construction phase. - Provide appropriate temporary measures for maintaining site free from flood waters during construction phase. - Controlled methods for construction of embankments.
	<p>Drought</p> <ul style="list-style-type: none"> - Destabilisation of embankments - Cracking of substrate leading to pavement damage - Loss of vegetation leading to greater erosion risk - Risk of fire - Increase in dust 	<p>Design Measures</p> <p>Structures</p> <ul style="list-style-type: none"> - Structures would be designed for temperature effects and to current standards. <p>Buildability</p> <ul style="list-style-type: none"> - Proposed hedgerows would be supported by linear belts of woodland block planting, to enable successful plant establishment and reduce the loss of vegetation. For further information on the planting, refer to the Chapter 7: Landscape and Visual of this ES.

Climate variable	Potential Impacts	Embedded Mitigation Measure(s)
	<p>Drier summers</p> <ul style="list-style-type: none"> – Destabilisation of embankments – Cracking of substrate leading to pavement damage – Loss of vegetation leading to greater erosion – Increase in dust 	<p>Construction Mitigation Measures</p> <p>Structures</p> <ul style="list-style-type: none"> – Recommend the use of admixtures to maintain water-to-cement ratio during construction, thus enabling increase in consistency. In particular: <ul style="list-style-type: none"> • Increase volume of a lignosulfonate-based plasticiser to use as a set retarder; • Admixture combinations to ensure consistent retention of concrete; and • Use of super plasticiser to reduce the total cement content. – The use of CEM 1 (concrete mix) could be considered during construction to increase the rate and heat of hydration and reduce curing time. Careful consideration and testing must be given to reduction in concrete strength, but under certain situations this may be an applicable approach. – Concreting during periods of day when temperature is not at maximum/cooler (during construction). <p>Buildability</p> <ul style="list-style-type: none"> – Dust suppression during construction. – Construction working hours to be amended to avoid concreting in middle of day.
<p>Temperature</p>	<p>Extreme temperature events</p> <ul style="list-style-type: none"> – Overheating of equipment – Reduced working periods – Uncomfortable travelling conditions – Difficult working conditions – Increased thermal expansion of bridge joints – Deformation of paved surfaces – Loss of vegetation 	<p>Design Measures</p> <p>Structures</p> <ul style="list-style-type: none"> – Fires are less of a concern for highways structures, provided inappropriate materials are not stored nearby during construction and operation. – Risk during construction of reduced working periods and delays from extreme temperature events is deemed to be very low, with no legal maximum temperature in the UK. HSE guidance offers no specific guidance regarding when it is too hot to work. – Structures are designed for temperature effects to current standards. <p>Buildability</p> <ul style="list-style-type: none"> – Design structures with expansion joints of greater capacity. – Consider materials for surface course that would withstand higher temperatures before skid resistance is affected during design. <p>Construction Mitigation Measures</p> <p>Buildability</p> <ul style="list-style-type: none"> – Provide protection to all UV resistant materials during construction. – Provide appropriate curing methods for concrete during construction. – Change site working hours to avoid working in hotter times of day during construction.
	<p>Solar radiation</p> <ul style="list-style-type: none"> – Faster rate of deterioration of materials – Unsafe working conditions 	<p>Construction Mitigation Measures</p> <p>Buildability</p> <ul style="list-style-type: none"> – Provide protection to all UV resistant materials during construction – Change site working hours to avoid working in hotter times of day during construction.

Climate variable	Potential Impacts	Embedded Mitigation Measure(s)
Wind	Gales and extreme wind events <ul style="list-style-type: none"> – Increased wind loading – Wind driven rain infiltration into materials – Damage to signage – Difficult working and driving conditions 	Design Measures Structures <ul style="list-style-type: none"> – Structures designed to current standards for wind loading. Construction Mitigation Measures Buildability <ul style="list-style-type: none"> – Monitor winds during construction and avoid working at heights, craneage, etc. during these times.
	Storms <ul style="list-style-type: none"> – Lightning strike – Damage to signage 	Construction Mitigation Measures Buildability <ul style="list-style-type: none"> – Monitor winds during construction and avoid working at heights, craneage, etc. during these times.
Relative humidity	Humidity <ul style="list-style-type: none"> – Excessive condensation and water accumulation Uncomfortable driving / working conditions 	Design Measures Structures <ul style="list-style-type: none"> – Relative humidity can lead to excessive condensation and water accumulation, particularly on steel surfaces. This would need to be collected/managed during operation with suitable drip details and water collection/drainage. Buildability <ul style="list-style-type: none"> – Ensure site testing of materials carried out during construction to optimise moisture content and therefore ensure stability of any structures or embankments, etc.
Soil moisture and stability	Decreased soil stability <ul style="list-style-type: none"> – Subsidence and destabilisation of bridge foundations and earthworks – Destabilisation of soils leading to pavement damage 	Design Measures Buildability <ul style="list-style-type: none"> – Landscape planting on embankments to improve stability during operation. – Embankment slopes to be 3:1. – Embankment slopes to be constructed from earthworks cut with appropriate planting.

Operation

- 14.9.10. There are no operation measures in relation to the vulnerability of Part B to climate change.

Enhancement Measures

- 14.9.11. No enhancement measures are proposed for the construction and operation of Part B. The mitigation measures described above are sufficient in reducing the vulnerability of Part B to climate change as far as reasonably possible.

14.10 ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

EFFECTS OF PART B ON CLIMATE (GHG EMISSIONS)

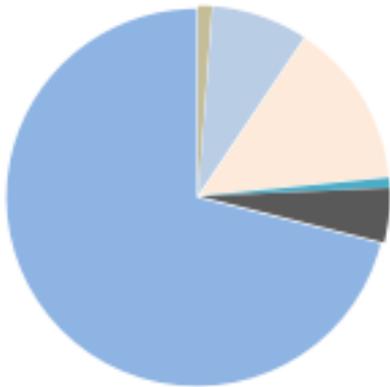
- 14.10.1. This assessment takes account of the following design, mitigation and enhancement measures (**Section 14.9**), that have been incorporated within the design of Part B:
- a. Retention of existing structures where possible and selection of low carbon structural elements – this is expected to provide a carbon saving for Part B. The anticipated material quantities for Part B have been incorporated into the assessment, based on the current design. It has not however been possible to obtain data to calculate the carbon reduction without the retention of existing structures and selection of low carbon elements as developing specification data for such aspects is not considered proportional to the benefits of the assessment.
 - b. All other mitigation measures noted in **Section 14.9** are not quantifiable, in terms of inputting into the Highways England Carbon Tool, at this stage of the design. This would be confirmed during the detailed design of Part B, and also during the construction phase.

Construction Phase Estimated GHG Emissions

- 14.10.2. During construction, the main source of emissions is anticipated to be embedded carbon in construction materials including those associated with the pavement for road widening and the new dual carriageway and junctions (i.e. asphalt and aggregate); and the new structures such as Charlton Mires Junction and the Heckley Fence Accommodation Overbridge over the A1 and the extended or renewed culverts (i.e. structural and reinforced steel and concrete). Refer to **Chapter 13: Material Resources** of this ES for further details on construction materials. Another important source of GHG emissions during construction is the transport of materials to/from site and the use of construction plant.
- 14.10.3. The total GHG emissions (tonnes of carbon dioxide equivalent) arising from the consumption of material supply, the manufacturing of materials, waste generation and disposal and transportation of materials to and from site for the construction of Part B (based on data available at the time of writing) are presented in **Figure 14.2** below.
- 14.10.4. **Figure 14.2** also shows a breakdown of the GHG emissions ‘hot spots’ from materials, as the main source of emissions from construction of Part B. These are the outputs from the Highways England Carbon Tool covering the construction phase. This does not include operational phase emissions.

Materials

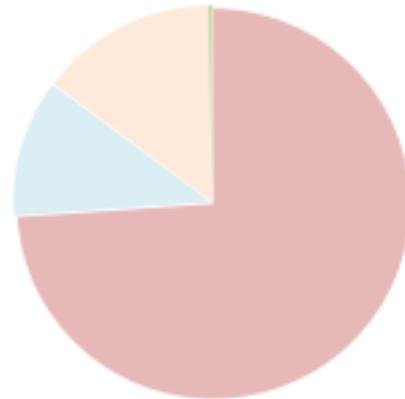
The table and pie chart displayed below show the total CO₂e emissions associated with materials purchased for the contract.



Category	CO ₂ e Emissions
Fencing / RRS / barriers	212.725
Drainage	1,479.344
Earthworks	2,550.000
Pavements	151.520
Street furniture	0.000
Civil Structures	539.549
Bulk Materials	12,552.900
Total	18,086.041

Materials, Transport, Energy and Waste Emissions

This table and pie chart show the total CO₂e emissions associated with materials compared to materials transport, energy use, business and employee transport and waste



Category	CO ₂ e Emissions
Materials Total	15,056.041
Materials Transport	2,753.609
Energy Use	3,565.200
Business and Employee transport	0.000
Waste	39.199
Total	24,477.149

Figure 14.2 - Total GHG Emissions (Tonnes of Carbon Dioxide Equivalent) Breakdown Associated with Materials

14.10.5. The majority (73.9%) of GHG emissions are associated with materials (product stage ‘cradle to gate’¹ or ‘embodied’ emissions), 14.6% from diesel consumption from construction vehicles (energy use), 11.4% from transport of materials and wastes to and from the site and 0.2% from waste generation and disposal.

¹ This is a measure of emissions incurred between resource extraction and the point at which a completed product leaves the factory (C. Cao (2017) *Sustainability and life assessment of high strength natural fibre composites in construction*, Woodhead Publishing)

14.10.6. Of the emissions for materials, the majority (71.1%) relate to bulk materials required for Part B which comprise asphalt, aggregate, reinforcement steel and ready-mixed concrete. Other significant contributions relate to earthworks (14.1%) drainage (8.2%) such as pre-cast concrete and plastics and structures (4.6%) (concrete and steel for the new bridges over the A1) and fencing (1.2%) (timber fencing).

Operation Phase Estimated GHG Emissions

14.10.7. During operation, the main GHG emissions source would be from end-users (traffic). Another lesser source of GHG emissions is those associated with the replacement of specific assets of Part B over its operational lifecycle.

14.10.8. Total end user GHG emissions are presented in **Table 14-17** for the year 2023 (the first year of operation for Part B) and the year 2038 (the future modelled year). In addition, the average annual and total GHG emissions based on a 60-year operational period of 2023 to 2082 are presented. The baseline figures (do minimum) are included for comparison.

Table 14-17 - End User GHG Emissions Data for Traffic in the Region

Scenario	Total GHG Emissions for all Traffic in the Traffic Model Area (thousand tonnes of carbon dioxide equivalent; ktCO _{2e})			
	2023 (operational year)	2038 (future year)	Average per year (2023 – 2082)	Total (2023-2082)
Baseline (do minimum)	117	111	112	6,725
Scheme (do something)	128	122	123	7,355

14.10.9. The total regional traffic GHG emissions for the operational lifespan of Part B (2023-2082) is 629 ktCO_{2e} higher (approximately +9%) than the 'do minimum' scenario.

14.10.10. When considering road resurfacing (operational phase replacement), the primary GHG emissions would be from the replacement of asphalt materials. The resurfacing schedule provides for renewal of surface course commencing in year 12 of Part B and in years 20, 30, 40, 45 and 57. Material quantity data provided by the Buildability Advisor indicated that 218,400 tonnes of asphalt would be required, which equates to 12.7 ktCO_{2e}. Of that, 95.3% relates to the asphalt, and 4.7% is for transport of the material.

Total Estimated GHG Emissions

14.10.11. The total estimated GHG emissions arising from Part B have been calculated using the Highways England Carbon Tool (**Ref. 14.14**) and modelling based on Part B traffic data, quantified using WebTAG data tables (**Ref. 14.15**) and data from the Department of

Transport, and are presented in **Table 14-18** below. They are presented for the construction phase (2021-2023), the operation phase (2023-2082) and the overall total for the whole lifecycle (2021-2082).

- 14.10.12. GHG emissions are presented and compared in percentage terms to UK National Carbon Budget periods to aid the assessment of the magnitude of change. This is in line with Paragraph 5.17 of the NPS NN (**Ref. 14.4**). The Third Carbon Budget covering 2018 to 2022 is 2,544 million tCO_{2e}. The Fourth Carbon Budget covering 2023 to 2027 is 1,950 million tCO_{2e}. The Fifth Carbon Budget covering 2028 to 2032 is 1,725 million tCO_{2e} (the latest Carbon Budget agreed by the Government).
- 14.10.13. An annual average of the total GHG emissions arising from Part B is also presented in comparison with the 2016 road CO_{2e} emissions for the North East in 2016 (**Ref.14.27**).

Table 14-18 – Part B Impacts on Carbon Budgets

Stage / Timing	Total GHG emissions (thousand tonnes of carbon dioxide equivalent; kTCO_{2e})
Scheme GHG Emissions	
Construction (2021/23)	24
Operation (2023-2082)	642 (11 per year)
Total for lifecycle (2021-2082)	667
Comparison of Part B GHG Emissions against Carbon Budget	
Total during third Carbon Budget period* (2018-2022) <i>[% of budget]</i>	16 (0.00064%)
Total during fourth Carbon Budget 4 period (2023-2027) <i>[% of budget]</i>	62 (0.00318%)
Total during fifth Carbon Budget period (2028-2032) <i>[% of budget]</i>	53 (0.00308%)
Comparison of 1 Year Operational Part B GHG Emissions against North East Total Road CO_{2e} Emissions for 2016	
One year's emission's during the operational phase as a % of North East Total Road CO _{2e} emission estimate in 2016	0.25%

* Only considering construction emissions as asset would not be operational until 2023.

- 14.10.14. GHG emissions result in the same global climate change effects wherever and whenever they occur and therefore the sensitivity of different human and natural receptors is not considered.
- 14.10.15. In line with Paragraph 5.17 of the NPS NN (**Ref. 14.4**), and in the absence of agreed thresholds for what level of GHG emissions is considered significant in an EIA, professional judgement, based on schemes of a similar size and nature, has been used to assess the significance of effects. As shown in **Table 14-18** the impact of Part B against the National Carbon Budgets is less than 0.003%.
- 14.10.16. The GHG emissions from the construction of Part B is likely to have an adverse impact. The magnitude of change in GHG emissions is considered to be **minor adverse**.
- 14.10.17. The GHG emissions from the operation of Part B is likely to have an adverse impact. The magnitude of change in GHG emissions is predicted to be **minor adverse**.
- 14.10.18. Part B is therefore expected to have a **slight adverse** effect on climate. IEMA guidance (**Ref. 14.17**) suggests that all GHG emissions are significant in the absence of any significance criteria or defined threshold. However, given the embedded mitigation measures, the magnitude of GHG emissions and the context of Part B, using professional judgement, it is considered that the slight adverse effect of Part B is **not significant** for the purpose of the assessment detailed in this ES.
- 14.10.19. The NPS NN states that it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plans. This is the case not only for Part B but for the Scheme as a whole.
- 14.10.20. Furthermore, as presented in **Table 14-18**, the GHG impacts of Part B would not have a material impact on the Government meeting its carbon reduction targets.

VULNERABILITY OF PART B TO CLIMATE CHANGE

- 14.10.21. The significance of climate impacts depends on the likelihood of them occurring and the consequence if they do occur. **Table 14-19** shows the outcome of the significance assessment (taking account of the incorporated mitigation measures described in **Table 14-16**) for the construction phase. **Table 14-20** shows the outcome of the significance assessment (taking account of the incorporated mitigation measures described in **Table 14-16**) for the operation phase.
- 14.10.22. With the mitigation measures described in **Table 14-16**, it is considered that climate change would have no significant impacts on Part B.

Table 14-19 – Significance Assessment for the Vulnerability to Climate Change (Construction)

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance
Precipitation	Annual average rainfall	Increase in winter rainfall	Construction compounds	Flooding of construction works and compounds	Low	Moderate adverse	Not Significant
				Waterlogging of excavations	Low	Moderate adverse	Not Significant
				Increased runoff and silt	Low	Minor adverse	Not Significant
		Materials	Excessive moisture in materials	Low	Minor adverse	Not Significant	
		Decrease in summer rainfall	Construction compound	Increase in dust	Medium	Negligible	Not Significant
				Soil erosion	Low	Minor adverse	Not Significant
	Materials		Enhanced reactions when cement stabilising and drying of concrete	Medium	Negligible	Not Significant	
	Extreme rainfall	Increase in magnitude and frequency of extreme rainfall events	Construction compound	Flooding of construction works and compound	Low	Moderate adverse	Not Significant
				Waterlogging of excavations	Low	Moderate adverse	Not Significant
				Overwhelming of drains	Low	Minor adverse	Not Significant
				Soil erosion and sedimentation	Low	Minor adverse	Not Significant
			Materials	Destabilisation of material, including topsoil and spoil heaps	Low	Minor adverse	Not Significant
			Staff	Unsafe working conditions	Moderate	Negligible	Not Significant
	Drought	Increased risk of drought	Construction compounds	Increase in dust	Medium	Minor adverse	Not Significant
				Soil erosion	Medium	Minor adverse	Not Significant
Fire				Low	Moderate adverse	Not Significant	

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance	
			Materials	Enhanced reactions when cement stabilising and drying of concrete	Medium	Negligible	Not Significant	
Temperature	Annual average temperature	Increase in annual and seasonal average temperature	Construction compounds	Increased vegetation growth	Medium	Negligible	Not Significant	
			Staff	Unsafe working conditions (heatstroke)	Medium	Minor adverse	Not Significant	
	Extreme temperature	Increase in magnitude of extreme temperature	Construction compounds	Fire	Low	Moderate adverse	Not Significant	
			Machinery and plant	Overheating of machinery	Medium	Minor adverse	Not Significant	
			Materials	Deformation of materials	Medium	Minor adverse	Not Significant	
			Staff	Unsafe working conditions (heatstroke)	Medium	Minor adverse	Not Significant	
	Solar radiation	Increase in solar radiation	Materials	Deterioration of materials	Medium	Negligible	Not Significant	
			Staff	Unsafe working conditions (high UV levels)	Medium	Minor adverse	Not Significant	
	Wind	Gales	Increase in mean wind speed and more frequent gusts	Construction compounds	Increase in dust	Medium	Minor adverse	Not Significant
				Materials	Loss of materials	Medium	Minor adverse	Not Significant
Staff				Unsafe working conditions -working at height, increased dust, reduced visibility	Medium	Minor adverse	Not Significant	
Storms		Increase in frequency of storms	Construction compounds	Flooding of construction works and compounds	Low	Moderate adverse	Not Significant	
			Materials	Destabilisation of material, including topsoil and spoil heaps	Low	Minor adverse	Not Significant	
			Staff	Unsafe working conditions, particularly for working at height	Medium	Minor adverse	Not Significant	
Humidity	Annual average	Decrease in summer humidity, increase in winter humidity	Machinery and plant	Fog in winter may affect operation of plant	Medium	Negligible	Not Significant	
			Materials	Deterioration of materials	Medium	Minor adverse	Not Significant	

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance
			Staff	Unsafe working conditions – low visibility	Medium	Minor adverse	Not Significant
Soils	Soil moisture	Decrease in soil moisture in summer	Construction compounds	Soil erosion and sedimentation	Medium	Minor adverse	Not Significant
				Increase in dust	Medium	Minor adverse	Not Significant
				Waterlogging of site	Low	Moderate adverse	Not Significant
			Materials	Loss of materials	Medium	Minor adverse	Not Significant
			Staff	Unsafe working conditions – increased dust and reduced visibility	Medium	Minor adverse	Not Significant
	Soil stability	Decrease in soil stability	Construction compounds	Subsidence	Low	Moderate adverse	Not Significant
			Materials	Collapse of spoil heaps	Low	Minor adverse	Not Significant
			Staff	Unsafe working conditions	Medium	Minor adverse	Not Significant

Table 14-20 – Significance Assessment for the Vulnerability to Climate Change (Operation)

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance
Precipitation	Annual average rainfall	Increase in winter rainfall	Built structures	Flooding of structures	Low	Moderate adverse	Not Significant
			Geotechnics	Destabilisation of embankments	Low	Moderate adverse	Not Significant
			Road infrastructure	Flooding of infrastructure and associated control equipment	Low	Minor adverse	Not Significant
			Hard surfaces	Flooding of paved surfaces	Medium	Minor adverse	Not Significant
				Damage to paved surfaces	Low	Minor adverse	Not Significant
			Soft estate	Mobilisation of pollutants in the soil	Low	Minor adverse	Not Significant

Variable	Projected Change	Receptor	Impact	Likelihood	Consequence	Significance	
	Decrease in summer rainfall	Scheme users	Delays and disruption	Low	Moderate adverse	Not Significant	
			Increase risk of slips, trips and falls (operators)	Low	Negligible	Not Significant	
		Built structures	Drying out and cracking of substrate	Low	Minor adverse	Not Significant	
		Geotechnics	Drying out and cracking of soils leading to destabilisation	Low	Moderate adverse	Not Significant	
		Road infrastructure	Increase in dust	Medium	Negligible	Not Significant	
		Hard surfaces	Drying out and cracking of substrate leading to pavement damage	Low	Minor adverse	Not Significant	
		Soft estate	Drying out of vegetation leading to soil erosion	Low	Negligible	Not Significant	
		Scheme users	Unfavourable environment for users - Increase in dust	Low	Minor adverse	Not Significant	
	Unsafe driving conditions		Low	Moderate adverse	Not Significant		
	Extreme rainfall	Increase in magnitude and frequency of extreme rainfall events	Built structures	Surface water flooding	Medium	Minor adverse	Not Significant
			Geotechnics	Destabilisation of embankments	Low	Moderate adverse	Not Significant
			Road infrastructure	Surface water flooding	Medium	Minor adverse	Not Significant
			Hard surfaces	Surface water flooding	Medium	Minor adverse	Not Significant
				Damage to paved surfaces	Low	Minor adverse	Not Significant
Drainage overwhelmed				Medium	Minor adverse	Not Significant	

Variable	Projected Change	Receptor	Impact	Likelihood	Consequence	Significance	
		Soft estate	Flooding of unpaved shoulders	Medium	Minor adverse	Not Significant	
			Mobilisation of pollutants in soil / ground	Low	Minor adverse	Not Significant	
		Scheme users	Delays and disruption due to flooding	Medium	Minor adverse	Not Significant	
			Increase risk of slips, trips and falls (operators)	Medium	Negligible	Not Significant	
			Difficult driving conditions	Medium	Minor adverse	Not Significant	
		Drought	Increased risk of drought	Built structures	Drying out and cracking of substrate	Low	Minor adverse
	Geotechnics			Drying out and cracking of soils leading to destabilisation	Low	Moderate adverse	Not Significant
	Road infrastructure			Increase in dust	Low	Negligible	Not Significant
	Hard surfaces			Drying out and cracking of substrate leading to pavement damage	Low	Minor adverse	Not Significant
	Soft estate			Drying out of vegetation leading to soil erosion	Medium	Negligible	Not Significant
				Fire	Low	Moderate adverse	Not Significant
	Scheme users			Unsafe driving conditions	Low	Moderate adverse	Not Significant
				Unfavourable environment for users - Increase in dust	Low	Minor adverse	Not Significant
	Temperature	Annual average temperature	Increase in annual and seasonal average temperature	Built structures	Increased thermal expansion of bridge joints	Low	Moderate adverse
Geotechnics				Drying out and cracking of soils leading to destabilisation	Low	Minor adverse	Not Significant

Variable	Projected Change	Receptor	Impact	Likelihood	Consequence	Significance	
		Hard surfaces	Drying out and cracking of substrate leading to pavement damage	Low	Minor adverse	Not Significant	
		Soft estate	Longer growing season – more vigorous vegetation growth	Medium	Negligible	Not Significant	
		Scheme users	Unfavourable environment for users	Low	Minor adverse	Not Significant	
	Extreme temperature	Increase in magnitude of extreme temperature	Built structures	Increased thermal expansion of bridge joints	Low	Moderate adverse	Not Significant
			Geotechnics	Drying out and cracking of soils leading to destabilisation	Low	Minor adverse	Not Significant
			Road infrastructure	Overheating of electronic and control equipment	Medium	Minor adverse	Not Significant
			Hard surfaces	Deformation of paved surfaces	Low	Moderate adverse	Not Significant
			Soft estate	Loss of vegetation	Medium	Negligible	Not Significant
			Scheme users	Uncomfortable travelling conditions	Medium	Negligible	Not Significant
				Unsafe working conditions for staff	Medium	Minor adverse	Not Significant
	Solar radiation	Increase in solar radiation	Road infrastructure	Deterioration in materials e.g. fading, brittleness	Medium	Negligible	Not Significant
			Scheme users	Unsafe working conditions for staff (high levels of UV)	Medium	Minor adverse	Not Significant
	Wind	Gales		Built structures	Increased wind loading on structures	Low	Moderate adverse

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance	
		Increase in mean wind speed and more frequent gusts	Road infrastructure	Wind driven rain infiltration into materials causing more rapid deterioration	Low	Minor adverse	Not Significant	
			Scheme users	Difficult driving conditions	Medium	Negligible	Not Significant	
				Unsafe working conditions	Medium	Minor adverse	Not Significant	
	Storms	Increase in frequency of storms	Road infrastructure	Increased risk of lightning strike affecting control equipment	Low	Moderate adverse	Not Significant	
				Damage to signage	Medium	Negligible	Not Significant	
				Loss of power	Low	Moderate adverse	Not Significant	
			Scheme users	Difficult driving conditions	Medium	Minor adverse	Not Significant	
	Humidity	Annual average	Decrease in summer humidity, increase in winter humidity	Road infrastructure	Increased mould growth during winter leading repainting/greater maintenance requirements	Low	Negligible	Not Significant
				Scheme users	Difficult driving conditions	Medium	Minor adverse	Not Significant
	Soils	Soil moisture	Decrease in soil moisture in summer	Geotechnics	Drying out and cracking of soils leading to destabilisation	Low	Moderate adverse	Not Significant
Hard surfaces				Destabilisation of soils leading to pavement damage	Low	Minor adverse	Not Significant	
Scheme users				Disruption to WCH journey amenity	Medium	Minor adverse	Not Significant	
Soil stability		Decrease in soil stability	Built structures	Subsidence and destabilisation of bridge foundations	Low	Moderate adverse	Not Significant	
			Geotechnics	Subsidence and destabilisation	Low	Moderate adverse	Not Significant	

Variable		Projected Change	Receptor	Impact	Likelihood	Consequence	Significance
			Hard surfaces	Destabilisation of soils leading to pavement damage	Low	Moderate adverse	Not Significant
			Scheme users	Disruption to WCH journey amenity	Medium	Minor adverse	Not Significant

ASSESSMENT PARAMETERS

- 14.10.23. The Assessment Parameters are presented in **Section 2.12 of Chapter 2: The Scheme, Volume 1** of this ES (**Application Document Reference: TR010041/APP/6.1**). The parameters are not considered to alter the findings or significance of effects of the climate assessment as a result of Part B.
- 14.10.24. The Assessment Parameters may slightly alter the requirement for construction materials (as outlined in **Chapter 13: Material Resources** of this ES), and the construction phase GHG emissions. However, this is not considered likely to change the outcome of the effects of Part B on Climate Change (GHG Emissions). This is due to the potential change in volumes of material of waste not being sufficient to change to outcome of the assessment.
- 14.10.25. The Assessment Parameters are not considered to impact on the vulnerability of Part B to climate change as the assessment uses UKCP18 (**Ref. 14.19**) and UKCP09 (**Ref. 14.20**) for the North East England Region which contains Part B. As such, any effects of the Assessment Parameters are already incorporated in the assessment.

UPDATED DMRB GUIDANCE

- 14.10.26. The DMRB sensitivity test as described in **Section 14.4** has determined that the application of the updated guidance (**Ref. 14.28**) would not change the likely significance of effects. This is because the approach used for the assessment has recently evolved and been brought in close alignment with the updated guidance (DMRB LA 114) and is therefore considered to be of the same standard. Therefore, with the application of the updated guidance the conclusions of the assessment remain unchanged.

14.11 MONITORING

EFFECT OF PART B ON CLIMATE (GHG EMISSIONS)

- 14.11.1. As part of the monitoring activities detailed in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**, the Applicant's supply chain is responsible for providing monthly or quarterly carbon data returns using the Highways England Carbon Tool (**Ref. 14.14**). As such, during the construction phase, data would be collected for materials and fuel / electricity consumption, which would enable embedded GHG emissions and emissions from energy to be monitored. The actual GHG emissions of Part B (outturn data) can then be compared to the GHG emissions estimates at this ES stage (i.e. this chapter) and the Applicant can iteratively feedback into the environmental assessment process.
- 14.11.2. Any noteworthy increases in GHG emissions associated with the outturn data in comparison with the GHG emissions estimates at this ES stage would be managed and mitigated accordingly through measures outlined in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**.

VULNERABILITY OF PART B TO CLIMATE CHANGE

- 14.11.3. Adaptation and resilience to climate and weather-related risks would be considered periodically through maintenance regimes to be detailed in the CEMP to be developed by

the main contractor, as set out in the **Outline CEMP (Application Document Reference: TR010041/APP/7.3)**.

- 14.11.4. A schedule of general inspections and principal inspections of each structure should be carried out to determine condition of the structure and identify any potential maintenance requirements. Inspections would be in accordance with DMRB CS 450 (**Ref. 14.32**) and would also occur following an intense rainfall event or heatwave to monitor any damage and implement appropriate mitigation as necessary.
- 14.11.5. In addition, a list of extreme weather-related incidents (for example, road surface deformations, snow and ice, etc.) would be maintained by the Applicant to assist in identifying thresholds which, when exceeded, require maintenance.
- 14.11.6. Given the uncertainties inherent in climate science and projections, the impacts and effects identified should be monitored throughout the construction and operational phase of Part B by the Applicant. The monitoring would be undertaken to assess the appropriateness of the mitigation measures. The assessment would be revisited when new or updated information becomes available, for example when further updates to climate projections are published.

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