VikingCCS

Viking CCS Pipeline

Environmental Statement Volume II – Chapter 15: Climate Change - Revision A (Tracked)

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15.1 Introduction

15.1.1 This chapter of the Environment Statement (ES) presents the assessment of the likely significant effects of the Viking CCS Pipeline (hereafter referred to as the Proposed Development) on the climate and the impact of climate change on the Proposed Development and surrounding environment during construction, operation and decommissioning.

15.1.2 In line with the requirements of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 15-1) (the EIA Regulations), consideration has been given to the following aspects of climate assessment:

- Lifecycle greenhouse gas (GHG) impact assessment – to identify the impact of GHG emissions arising over the lifetime of the Proposed Development on the climate;
- Climate change resilience (CCR) assessment – to understand the resilience of the Proposed Development to projected future climate change impacts, including damage to the Proposed Development caused by accidents resulting from climate change.

15.1.3 Any in-combination climate change impacts (ICCI) i.e., the combined impact of the Proposed Development and climate change on receptors in the surrounding environment, have been identified and assessed/mitigated as necessary in the individual discipline chapters. As such, a formal ICCI assessment has been scoped-out of this chapter.

15.2 Legislation, Policy, and Guidance

Introduction

15.2.1 The Legislation, Policy and Guidance section of this chapter provides an overview of the relevant legislation, planning policy and technical guidance relevant to the climate assessments.

Legislation

15.2.2 A brief overview of the policy, legislative and guidance relevant to the climate change assessments have been reviewed and summarised in **Table 15-1**.

Table 15-1: Legislation and Policy Relevant to Climate Change

Policy Reference	Policy Context
International	
United Nations Framework Convention on Climate Change Paris Agreement (UNFCCC, 2016) (Ref 15-6)	The Paris Agreement requires all signatories to strengthen their climate change mitigation efforts to keep global warming to below 2°C this century and to pursue efforts to limit global warming to 1.5°C.
National	
UK Nationally Determined Contribution (Ref 15-7)	In 2020, the UK communicated its updated Nationally Determined Contribution to the UNFCCC. Within this, the UK has committed to reducing GHG emissions by at least 68% by 2030 compared to 1990 levels.

Policy Reference	Policy Context
Climate Change Act 2008 (Ref 15-2)	The Climate Act 2008 was amended in 2019 and now commits the UK government to reducing greenhouse gas emissions by 100% of 1990 levels by 2050. This target is supported by a system of legally binding five-year 'carbon budgets' defined by a Carbon Budget Order, and an independent body, the Committee on Climate Change (CCC), to advise on budgets and monitor progress. The UK carbon budgets restrict the amount of GHG emissions the UK can legally emit in a defined five-year period. The Carbon Budgets Order 2009 defines the first 3 Carbon Budgets covering the budgetary periods 2008 – 2012, 2013 – 2017, 2018 – 2022. The Carbon Budgets Order 2011 defines the 4th Carbon Budget covers the budgetary period 2023 – 2027, and the Carbon Budgets Order 2016 defines the 5th Carbon Budget covers the budgetary period 2028 – 2032. The 6th Carbon Budget was set in the Carbon Budget Order 2021, which came into force in June 2021 (Ref 15-26) and is the first budget to reflect the amended trajectory to Net Zero by 2050.
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017) (Ref 15-1)	The EIA Regulations state that an EIA (where relevant) must include: *"a description of the likely significant effects of the development on the environment resulting from… the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change".*

National Planning Policy

15.2.3 National Planning Policy relevant to climate change is detailed in **Table 15-2**. An overview of how relevant national planning policy has been complied with is provided within the *Planning Statement (Application Document 7.1)*.

Table 15-2: National Planning Policies Relevant to Climate Change

Policy Reference	Policy Context
Overarching National Policy Statement for Energy (EN-1) and National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Ref 15-9)	National Policy Statements (NPS) EN-1 and EN-4 describe the national policy for energy infrastructure in relation to climate impacts and adaptation; adverse effects and benefits; in relation to the EU Directive and ES requirements; in relation to adaptation measures in response to climate projections; and in relation to climate projections, flood risk and the importance of relevant mitigation. EN-1 promotes Carbon Capture and Storage as an emerging technology that the Government is aiming to facilitate and encourage, including for gas-fired generating stations. Section 2.3 outlines the need for infrastructure to capture, transport, and store carbon dioxide in meeting the UK's Net Zero targets. Paragraph 2.3.3 and 2.3.4 of EN-1 states that:

Policy Reference	Policy Context
	"*Our objectives for the energy system are to ensure our supply of energy always remains secure, reliable, affordable, and consistent with meeting our target to cut GHG emissions to net zero by 2050, including through delivery of our carbon budgets and Nationally Determined Contribution. This will require a step change in the decarbonisation of our energy system.* *Meeting these objectives necessitates a significant amount of energy infrastructure, both large and small-scale. This includes the infrastructure needed to convert primary sources of energy (e.g., wind) into energy carriers (e.g., electricity or hydrogen), and to store and transport these energy carriers into and around the country. It also includes the infrastructure needed to capture, transport and store carbon dioxide. The requirement for new energy infrastructure will present opportunities for the UK and contributes towards our ambition to support jobs in the UK's clean energy industry and local supply chains."* Section 2.4 goes onto state that with the GHG emissions from the energy sectors more than halved between 2011 to 2019, mainly from the quadrupling of renewable power generation, the government is looking to incentivise the deployment of Carbon Capture, Utilisation, and Storage (CCUS) by developing a commercial framework which will enable developers to finance the construction and operation of CCUS and Industrial Carbon Capture (ICC) facilities and carbon dioxide transport and storage networks. This Policy Statement further states the benefits of having a diverse mix of power generation, including energy supply security as fossil-fuel generation that can be brought online quickly to meet demand and can complement baseload supply from nuclear and renewables. However, these fossil-fuel power generators will need CCS to be low carbon. Within the NPS Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) introduction, paragraph 1.1.3 states that "*natural gas will also continue to be used in conjunction with carbon capture use and storage (CCUS) infrastructure to produce low carbon electricity and as a feedstock for clean hydrogen production"*. In addition, paragraph 1.6.2 states that "*information in this NPS may be useful in identifying impacts to be considered in applications for pipelines intended to transport other substances*". The NPS EN-4 applies to the climate change assessment, in particular Section 2.3 which sets out considerations to ensure that new energy infrastructure is resilient to climate change.
The National Planning Policy Framework (Ministry of	The revised National Planning Policy Framework (NPPF) sets out the Government's planning policies for England. While the NPPF does not set specific policies for Nationally Significant Infrastructure Projects (NSIP), its policies may be of relevance to decision making.

Policy Reference	Policy Context
Housing, Communities and Local Government (MHCLG), 2023) (Ref 15-10)	Those policies of relevance to climate change and sustainability assessment include those achieving sustainable development and meeting the challenge of moving to a low carbon economy, climate change, flooding and coastal change. Paragraph 152 of the NPPF states that: *"the planning system should support the transition to a low carbon future in a changing climate (…) It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."* Paragraph 154 states that: *"New development should be planned for in ways that (…) can help to reduce greenhouse gas emissions, such as through its location, orientation and design."* Paragraph 155 states that: *"To help increase the use and supply of renewable and low carbon energy and heat, plans should:* *a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);* *b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and 53 In line with the objectives and provisions of the Climate Change Act 2008.* *c) identify opportunities for development to draw its energy supply from decentralised, renewable, or low carbon energy supply systems and for collocating potential heat customers and suppliers."*
National Planning Practice Guidance on Climate Change (MHCLG, 2019) (Ref 15-11)	This guidance describes how to identify suitable mitigation and climate adaptation measures to incorporate into the planning process, stating that: *"Effective spatial planning is an important part of a successful response to climate change as it can influence the emission of greenhouse gases… Planning can also help increase resilience to climate change impact through the location, mix and design of development."*
Net Zero Strategy (Department for Business, Energy & Industrial Strategy (BEIS), 2021) (Ref 15-12)	This strategy sets out policies and proposals for decarbonising all sectors of the UK economy to meet a net zero target by 2050. The strategy includes an ambition to deliver four carbon capture, usage and storage (CCUS) clusters, capturing 20-30 $MtCO_2$/year across the economy, including 6 $MtCO_2$/year of industrial emissions, per year by 2030. Teesside and the Humber, Merseyside and North Wales are identified among potential carbon capture cluster locations.

Local Planning Policies

15.2.4 Local Planning Policies relevant to climate change are detailed in **Table 15-3**. An overview of how relevant local planning policy has been complied with is provided within the *Planning Statement (Application Document 7.1)*.

Table 15-3~~15-3~~: Local Planning Policies Relevant to Climate Change

Policy Reference	Policy Context
North Lincolnshire Council Local Development Framework (North Lincolnshire Council, 2011) (Ref 15-21)	Sets out the North Lincolnshire Council's spatial vision, strategy and policies to deliver the strategy up to 2026. The Core Strategy covers several policies related to climate change, including the following, which will be considered in the assessment: • Policy CS16 North Lincolnshire Landscape, Greenspace and Waterscape; • Policy CS17 Biodiversity; • Policy CS18 Sustainable Resource Use and Climate Change; • Policy CS19 Flood Risk; and • Policy CS20 Sustainable Waste Management.
North Lincolnshire Carbon Management Strategy (North Lincolnshire Council, 2017) (Ref 15-22)	Details the North Lincolnshire Council's plan for reducing carbon from 2017 to 2022. It states that this area is one of the top five most vulnerable coasts in the UK.
North East Lincolnshire Council Environmental Policy Statement (2016) (Ref 15-23)	Sets out North East Lincolnshire Council's priorities towards consuming resources more efficiently, eliminating waste and supporting and developing the green economy and infrastructure, including a commitment to support environmentally responsive local economic growth.
North East Lincolnshire Local Plan 2013 to 2032 (Ref 15-34)	As one of North East Lincolnshire Strategic Objectives which has been considered within the assessment, SO2 Climate Change addresses the causes and effects of climate change by promoting development that minimises natural resource and energy use; reduces waste and encourages recycling; reduces pollution; brings about opportunities for sustainable transport use; responds to increasing flood risk; and incorporates sustainable construction practices. Promote appropriate distribution of development and the role of green infrastructure in mitigating aspects of flood risk. Recognise the increased stress on habitats and species that climate change causes
Central Lincolnshire Local Plan (2023) (Ref 15-35)	The following policies considered in the assessment either aim to help facilitate a carbon net zero Central Lincolnshire, by addressing the themes of Energy, Climate, and Flooding to ensure that Central Lincolnshire adapts to climate change: - S6: Design Principles for Efficient Buildings

Policy Reference	Policy Context
	- S7: Reducing energy Consumption – Residential Buildings - S8: Reducing energy Consumption – Non-Residential Buildings - S9: Decentralised Energy Networks and Combined Heat and Power - S10: Supporting a Circular Economy - S11: Embodied Carbon - S12: Water Efficiency and Sustainable Water Management - S13: Reducing Energy Consumption in Existing Buildings - S14: Renewable Energy - S15: Protecting Renewable Energy Resources - S16: Wider Energy Infrastructure - S17: Carbon Sinks - NS18: Electric Vehicle Charging - S20: Resilient and Adaptable Design - S21: Flood Risk and Water Resources - S48: Walking and Cycling Infrastructure - S53: Design and Amenity
East Lindsey District Council Environment Policy (2020) (Ref 15-24)	The East Lindsey District Council Environment Policy Theme Two covers mitigating and adapting to climate changes, including working collaboratively to support the wider District in taking action to tackle climate change with urgency and working with local businesses to support the development of a low carbon economy.
West Lindsey District Council Sustainability, Climate Change and Environment Strategy (2021) (Ref 15-25)	West Lindsey District Council's Sustainability, Climate Change and Environment Strategy and action plan are designed to achieve the ambition of net zero carbon emissions across the district by 2050.

Guidance

15.2.5 The climate change assessment has been carried out in accordance with the following:

- *IEMA: Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022) (Ref 15-13);*
- *IEMA: Environmental Impact Assessment Guide to: Climate Chance Resilience and Adaptation (2020) (Ref 15-14);*
- *The GHG Protocol (World Resources Institute and World Business Council for Sustainable Development (WRI & WBCSD, 2015) (Ref 15-15; and.*
- *PAS 2080: 2023 Carbon management in buildings and infrastructure (Ref 15-16).*

15.3 Scope of Assessment and Consultation

Introduction

15.3.1 A request for an EIA Scoping Opinion was made to the Planning Inspectorate in 2022 as part of the EIA Scoping Process. The Scoping Opinion was received on 5 May 2022. The comments received in the Scoping Opinion relevant to the climate change assessment are presented in **Table 15-4**.

15.3.2 A separate ICCI assessment has been scoped out of the Climate Change assessment on the basis that any identified in-combination climate change impacts will be addressed in other relevant chapters of the ES, as described in the Scoping Report.

Scoping Report and Scoping Opinion

15.3.3 A summary of stakeholder engagement specific to climate change has been provided in **Table 15-4.**

Table 15-4: Summary of EIA Scoping Opinion in relation to Climate Change

Section Reference to Scoping Opinion	Applicant's proposed matter	Planning Inspectorate / prescribed consultee comments	Project Response
Planning Inspectorate Table 18-7 and Table 18-14	In Combination Climate change	The Inspectorate accepts the reasoning presented and agrees that an assessment of 'in combination climate change' as described in the Scoping Report (the combination of future climate conditions and the Proposed Development) can be scoped out of the ES.	No response required.
Planning Inspectorate Table 18-8	Parameters to scope into the climate change resilience review	The information provided within Table 18-8 [of the Scoping Report], in relation to the Proposed Development's vulnerability to climatological and meteorological events, should be reviewed alongside the information in Table 20-3 (Major Accidents and Disasters) [in the Scoping Report] to ensure consistency in the ES's approach where these matters overlap.	The Proposed Development's vulnerability to climatological and meteorological events has been reviewed alongside the Major Accidents and Disasters. Only wave surges have been scoped into the Major Accidents and Disasters under Natural Hazards - Climatological and Meteorological as the Proposed Development is located in an area at risk of tidal flooding. The assessment of wave surges is consistent between the Major Accidents and Disasters chapter under Natural Hazards, and the Climate chapter of the ES.
Anglian Water	Movement of water supply and recycling network	To minimise the carbon cost of the project the design and construction of the project should minimise and if possible, avoid the need to move the water supply and water recycling network. If this is not possible then Protective Provisions will be required to protect the supply of water and management of wastewater for local communities by Anglian Water.	There are Anglian Water assets that intersect with the DCO Site Boundary. These assets would be crossed in a method that will be agreed with Anglian Water. It is not thought at this time that the Proposed Development would require the water supply or recycling network to be relocated. Protective Provisions are included in the *Draft DCO (Application Document 2.1)*.

Section Reference to Scoping Opinion	Applicant's proposed matter	Planning Inspectorate / prescribed consultee comments	Project Response
Lincolnshire County Council	Methodology	The proposed methodology for climate and biodiversity related assessment are sound.	No response required

Feedback on the Preliminary Environmental Information Report

15.3.4 A summary of stakeholder engagement specific to climate change has been provided in **Table 15-5**. No additional consultation specifically relating to the climate assessment was required.

Table 15-5: Climate Change Feedback on PEIR

Stakeholder	Comment	Project Response
North Lincolnshire County Council	Having considered Chapter 15 of the PEIR, it is noted that the proposals are likely to have a positive impact in respect of climate change. Furthermore, NLC do not have any objections to the approach set out in the PEIR at this stage.	Noted

Scope of Assessment

Lifecycle GHG Impact Assessment

15.3.5 **Table 15-6** summarises the key anticipated GHG emissions sources associated with the Proposed Development, agreed as part of the scoping process described in **Table 15-4**.

Table 15-6: Potential Sources of GHG Emissions

Lifecycle Stage	Activity	Primary emission sources
Product Stage	Use of products and/or materials required to build the proposed pipeline and associated infrastructure.	Embodied GHG emissions associated with extraction of required raw materials and the manufacturing of finished materials and components.
Construction process stage	On-site construction activity including emissions from construction compounds.	GHG emissions from grid electricity use during construction. GHG emissions from fuel consumed by construction vehicles and plant.
	Land use change.	GHG impact of loss of sequestration value and carbon sinks due to removal of planting/habitats.
	Water Use.	GHG emissions from the provision and treatment of water.
	Travel of construction workers. Transportation of construction materials (where these are not included in product-stage embodied GHG emissions).	GHG emissions arising from the fuel use for vehicles transporting workers to the construction site.

Lifecycle Stage	Activity	Primary emission sources
	Disposal of waste materials generated by the construction process.	Emissions arising from the transportation and treatment of waste.
Operation stage	Operation and maintenance of the Proposed Development.	Emissions arising from fuel consumed by maintenance vehicles and plant. Embodied GHG emissions within the materials used for maintenance. Grid electricity use during operation of the development. Gains in sequestration value due to new planting and habitat creation.
Decommissioning stage	On-site decommissioning activity.	Energy (electricity, fuel, etc.) consumption from plant and vehicles, generators on site.
	Worker travel.	GHG emissions from fuel consumption for transportation of workers.
	Transportation and disposal of waste materials.	GHG emissions from transportation and final treatment (disposal or recycling) of waste.

Aspects excluded from the GHG Assessment

15.3.6 The following activities listed in **Table 15-6** have been excluded from the carbon calculations at the construction process stage as these emissions sources are not anticipated to be material to the overall emissions impact:

- ~~Land-use change; removal of hawthorn plants, soil preparation, tree planting, and wild seeding as well as other landscaping activity;~~
- Water-use in construction processes have been considered as insignificant have excluded from the GHG calculation.~~; and~~
- ~~Electricity and fuel use in construction processes;~~

15.3.7 The following activities listed in **Table 15-6** have been excluded from the carbon calculations at the operation stage:

- ~~Maintenance~~ Replacement materials/parts ~~identified in the~~ of the ~~Proposed Development~~. Guidance for module B4 Replacement impacts,~~;~~ based on the RICS Whole life carbon assessment, 2nd Edition (Ref 15-36), shows that the expected lifespan of the building elements (i.e. 30/60 years) of the Proposed Development exceeds the Proposed Development's design life of 25 years. On this basis the main building elements would not be required to be replaced during the operational design life. Mechanical, electrical, and plumbing (MEP), would be subject to maintenance during this period however the impacts of this are not anticipated to be material and have therefore been excluded~~Only limited maintenance activities are required to be undertaken during the operational lifespan of the Proposed Development, as outlined in section 3.14 of *Chapter 3: Description of the Proposed Development,* of this *ES Volume II (Application Document 6.2.3)*~~.~~

15.3.8 The following activities listed in **Table 15-6** have been excluded from the carbon calculations at the decommission stage:

- On-site decommissioning activity; it is not currently feasible to assess emissions for construction activities during decommissioning. Due to uncertainty surrounding future construction techniques and technology these emissions should be assessed closer to the decommissioning date.

Climate Change Resilience Assessment

15.3.9 **Table 15-7** details the parameters which have been scoped into the climate change resilience assessment.

Table 15-7: Parameters Scoped into the Climate Change Resilience Assessment

Parameter	Scoped In/ Out	Rationale for Scoping Conclusion
Extreme weather events	In	The Proposed Development may be vulnerable to extreme weather events such as storm damage to structures and assets.
Increased average temperatures and incidence of heatwaves	In	Extremes in temperatures may result in heat stress of materials and structures.
Increased frequency of heavy precipitation events	In	The Proposed Development may be vulnerable to changes in precipitation, for example, land subsidence and damage to structures and drainage systems during periods of heavy rainfall.
Sea level rise	In	The Proposed Development is located in an area that is susceptible to sea level rise. Specifically, approximately the first 3 km of the DCO Site Boundary (Section 1) intersects with Flood Zone 2 and 3 associated with the tidal flooding from the Humber Estuary. Additionally, the last 9km (from the crossing of the B1200 onwards) of this corridor (Section 5) lies within the tidal flood zone 2-3 from the North Sea.

15.4 Assessment Methodology

Impact Assessment Methodology

Lifecycle GHG Impact Assessment

15.4.1 The potential effects of the Proposed Development on the climate during construction, operation and decommissioning have been assessed in line with the GHG Protocol (Ref 15-15) and GHG 'hot spots' (i.e., materials and activities likely to generate the largest amount of GHG emissions) have been identified. This has enabled priority areas for mitigation to be identified. This approach is consistent with the principles set out by the Institute for Environmental Management and Assessment (IEMA) document 'Assessing Greenhouse Gas Emissions and Evaluating their Significance (Ref 15-13).

15.4.2 This lifecycle approach has considered emissions by lifecycle stages of the Proposed Development. Where activity data allows, expected GHG emissions arising from the

construction, operation and maintenance, and decommissioning activities have been quantified.

15.4.3 GHG emissions have been assessed using a calculation-based methodology as per the below equation (Ref 15-16):

Activity data x GHG emissions factor = GHG emissions value

15.4.4 The Department for Energy Security and Net Zero (DESNZ) 2023 emissions factors (Ref 15-17) and embodied carbon data from the Inventory of Carbon and Energy V3.0 (ICE) (Ref 15-18) have been used as the primary source of emissions factors for calculating GHG emissions.

15.4.5 In line with applicable guidelines from the World Business Council for Sustainable Development (WBCSD) / World Resources Institute (WRI) Greenhouse Gas Protocol initiative (Ref 15-15), the GHG emissions study will be reported as tonnes of carbon dioxide equivalent (tCO_2e) and consider the seven Kyoto Protocol gases:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6); and
- Nitrogen Trifluoride (NF_3).

15.4.6 These GHGs are broadly referred to in this chapter under an encompassing definition of ‘GHG emissions’.

15.4.7 Where data are not available, and a source of GHG emissions is material to the overall footprint, a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA guidance on assessing GHG emissions in EIA (Ref 15-13).

Climate Change Resilience Assessment

15.4.8 The EIA Regulations (Ref 15-1) require the inclusion of information on the vulnerability of the Proposed Development to climate change. Consequently, an assessment of climate change resilience for the Proposed Development has been undertaken which identifies potential climate change impacts in accordance with IEMA Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation (Ref 15-14).

15.4.9 The assessment has included all infrastructure and assets associated with the Proposed Development. It covers resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events as per the UKCP18 projections (Ref 15-13).

Likelihood Magnitude

15.4.10 Once potential climate risks have been identified, the likelihood of their occurrence during the project phase is categorised. Likelihood is categorised into five levels depending on the probability of the hazard occurring. **Table 15-8** presents the likelihood levels and definitions used. This is in line with the definitions presented in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (Ref 15-30).

Table 15-8: Description of likelihood for climate change hazard/impact will occur

Likelihood Category	Description (probability of occurrence)

Very likely	90-100% probability that the hazard/impact will occur.
Likely	66-90% probability that the hazard/impact will occur.
Possible, about as likely as not	33-66% probability that the hazard/impact will occur.
Unlikely	>10-33% probability that the hazard/impact will occur
Very unlikely	0-10% probability that the hazard/impact will occur

15.4.11 The consequence of an impact has been assessed using the criteria detailed in **Table 15-9**. The assessment of consequence has considered mitigation measures which will be secured via the Draft Construction Environmental Management Plan (CEMP) *(ES Volume IV: Appendix 3.1, Application Document 6.4.3.1))*, which contains Mitigation Registers for the construction phase, and which would be relevant to the decommissioning phases. A preliminary mitigation register for the operational phase is included within *ES Volume IV, Appendix 3.6 (Application Document 6.4.3.6).*

Table 15-9: Level of consequence for Climate Change Risk

Consequence of Impact	Measure of Consequence for Climate Change Resilience
Very high	Permanent damage to structures/assets; complete loss of operation/service; complete/partial renewal of infrastructure; serious health effects, possible loss of life; extreme financial impact; and exceptional environmental damage.
High	Extensive infrastructure damage and complete loss of service; Some infrastructure renewal; major health impacts; major financial loss; and considerable environmental impacts.
Medium	Partial infrastructure damage and some loss of service; moderate financial impact; adverse effects on health; and adverse impact on the environment.
Low	Localised infrastructure disruption and minor loss of service; no permanent damage, minor restoration work required; and small financial losses and/or slight adverse health or environmental effects.
Very low	No damage to infrastructure; no impacts on health or the environment; and no adverse financial impact.

Significance Criteria

Lifecycle GHG Assessment

15.4.12 The global climate has been identified as the receptor for the purposes of the GHG assessment. The sensitivity of the climate to GHGs is considered to be high.

15.4.13 As per IEMA guidance, any GHG emissions or reductions from a project might be considered to be significant, as all emissions contribute to climate change. The rationale for classification is as follows:

- Any additional GHG impacts could compromise the UK's ability to reduce its GHGs and therefore the ability to meet its carbon budgets;
- The extreme importance of limiting global warming to below 2°C this century, as broadly asserted within the Paris Agreement, national legislation and community support.

Additionally, a recent report by the IPCC highlighted the importance of limiting global warming below 1.5°C (Ref 15-30); and

- A disruption to global climate is already having diverse and wide-ranging impacts to the environment, society, economy and natural resources. Known effects of climate change include increased frequency and duration of extreme weather events, temperature changes, rainfall and flooding, and sea level rise and ocean acidification. These effects are largely accepted to be negative, profound, global, likely, long-term to permanent, and are transboundary and cumulative from many global actions (Ref 15-31).

15.4.14 The environmental impact associated with GHG emissions is a national and global issue. Consequently, the potential significance of the Proposed Development's lifecycle GHG emissions has been assessed by comparing the estimated GHG emissions from the Proposed Development against the reduction targets defined in the Climate Change Act 2008 (Ref 15-2) and associated five-year, legally binding carbon budgets.

15.4.15 The significance level of project-related emissions has been determined using IEMA's (2022) five levels of significance. The significance criteria are not solely based on whether a development emits GHG emissions alone but on how it makes a relative contribution towards achieving the UK Government's target of net zero. The definitions for IEMA's levels of significance are provided in **Table 15-10.**

Table 15-10: Significance Levels as per IEMA Guidance

Effects	Significance level	Description
Significant	**Major adverse**	The Proposed Development's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make meaningful contribution to the UK's trajectory towards net zero.
	Moderate adverse	The Proposed Development's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
Not significant	**Minor adverse**	The Proposed Development's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.
	Negligible	The Proposed Development's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of

Effects	Significance level	Description
		the curve' for the trajectory towards net zero and has minimal residual emissions.
Beneficial	**Beneficial**	The Proposed Development's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

15.4.16 IEMA guidance states that it is challenging to identify fixed numerical thresholds against which to identify the significance of a proposed project regarding the net change in GHG emissions. Therefore, the GHG assessment should present context for the GHG emissions, and it is down to the practitioner's professional judgement on how best to contextualise a project's GHG impact. To determine if the Proposed Development makes a relative contribution towards achieving the UK Government's target of net zero the impact of the Proposed Development's GHG emissions will therefore be put into context of the UK's carbon budgets.

15.4.17 The Climate Change Act 2008 established a system of five yearly carbon budgets. Each carbon budget represents the total amount of GHG emissions that may be emitted by the UK during each 5-year period, measured in $MtCO_2e$. The carbon budgets are consistent with furthering the achievement of the UK climate objective and include all GHG emissions. Based on advice from the Climate Change Committee UK parliament has legislated for the first six carbon budgets. The 6th carbon budget covering the period 2032 to 2037 is the first budget to align with the trajectory required for the UK to meet its net zero by 2050 carbon target.

15.4.18 The CCC have proposed figures for carbon budgets beyond the 6th carbon budget based on achieving net zero, and that these proposals are included in **Table 15-11** for context, but they are not yet approved or legislated for.

15.4.19 **Table 15-11** shows the current, future and proposed UK carbon budgets up to 2050. An assessment of the impact of GHG emissions from the Proposed Development on the global climate has been carried out. This assessment involved a comparison of overall emissions from the Proposed Development with the UK's national carbon budgets and is summarised in Section 15.7 below.

Table 15-11: UK Carbon Budgets

Carbon Budget period	National Carbon budget ($MtCO_2e$)
3rd (2018-2022)	2,544
4th (2023-2027)	1,950
5th (2028-2032)	1,765
6th (2033-2037)	965
7th (2038-2042)[1]	526
8th (2043-2047)	195

[1] National Carbon Budget values for the 7th, 8th and 9th budget periods have not been formally adopted by the UK Parliament; they are based on annual values in the net-zero balanced pathway as published by the CCC, and are consistent with earlier carbon budget totals.

9th (2048-2050)	17

15.4.20 Consideration has been given to the emissions which are expected to be avoided as a result of the delivery of the wider Viking CCS Project, noting that the emission reductions should not be double counted.

Climate Change Resilience Assessment

15.4.21 The CCR Assessment is qualitative and provides commentary on how the Proposed Development will be resilient to climate change within the context of current and predicted future climate conditions.

15.4.22 Following identification of climate hazards, the likelihood and consequences have been assessed according to **Table 15-8** and **Table 15-9** respectively.

15.4.23 The ES presents embedded adaptation measures to demonstrate how the Proposed Development will be adapted to future climate conditions.

15.4.24 The CCR Assessment has identified the significance of effects by evaluating the combination of the likelihood of the climate-related impact occurring, and the consequence, as per the risk assessment matrix in **Table 15-12** where any risk rated medium or above is considered significant, and any risk rated as low is considered insignificant. The assessment has taken into account mitigation and enhancement measures.

Table 15-12: Significance of Effect Matrix

Likelihood	Magnitude of consequence				
	Very Low	Low	Medium	High	Very High
Rare	Negligible	Negligible	Minor	Moderate	Major
Unlikely	Negligible	Negligible	Minor	Minor/ Moderate	Major
Possible	Negligible	Minor	Minor/Moderate	Major	Major
Likely	Minor	Minor/Moderate	Moderate	Major	Major
Very Likely	Moderate	Moderate	Moderate/Major	Major	Major

Assumptions and Limitations

Lifecycle GHG Impact Assessment

15.4.25 To assess the magnitude of the impact of the Proposed Development on the climate as a result of GHG emissions associated with construction of the Proposed Development, the GHG emissions that would be associated with the Proposed Development activities are calculated based on the assumptions listed below.

- As stated in *ES Volume II Chapter 3: Description of the Proposed Development (Application Document 6.2.3)* for the purposes of this assessment, the main construction phase is currently anticipated to ~~cover approximately a~~last just over 1-year~~, period~~ and construction of the Proposed Development will be completed in 2027. The main construction period is estimated to ~~be~~last ~~12 hours daily, Monday to Saturday, for~~ 15 months;
- Estimated plant activity was provided by the project engineers and converted to carbon emissions using emission factors from DESNZ 2023 Emission Factors (Ref 15-17);

- ~~A bill of quantities was provided, with the exception of small bore piping and cabling which are not likely to be material to the carbon study, by the project engineers and converted to carbon emissions using emission factors from the ICE database V3 (Ref 15-18) and BEIS~~ DESNZ 2023~~2~~ Emission Factors (Ref 15-17);

- The process to calculate the carbon impacts of land-use change is taken from EU Guidance (Ref 15-37) ~~It is reasonable to assume that the construction workers will be based in nearby accommodation and will travel an average distance of 25 km (one way) to the construction site. It has been assumed that all transport will take place in a diesel Light Goods Vehicle. Worker transport was calculated on a project wide basis and the emissions total divided across the three project categories;~~

- Construction workers are assumed to travel to site in worker vans, containing 10 individuals, for all workdays in the year. The round trip is assumed to be 50km. Worker transport was calculated on a project wide basis.

- Whilst the actual supplier for the pipe has yet to be confirmed, for the purposes of this assessment, it is assumed that the steel used in the pipeline will be sourced from a steel foundry from overseas and will be transported to site by Cargo Ship and Heavy Goods Vehicle (HGV);

- ~~For the purpose of the assessment, all other equipment at the Immingham, Theddlethorpe and Block Valve Sites would be manufactured in the United Kingdom and transported to site by HGV travelling 300 km;~~

- ~~The provided Bill of Quantities was used to determine the material wastage quantities. A 5% wastage rate was applied to~~for all materials in the provided bill of quantities. ~~steel used for the pipeline. No wastage rate was applied for all other equipment, assuming all metal products will be manufactured offsite specifically for the Proposed Development; and~~

- It ~~As a worst-case scenario, it i~~was assumed that 1~~0~~0% ~~of~~ wastage material would be sent to landfill (Ref 18-19) according to the adopted waste strategy for the Proposed Development. The other 90% is assumed to be sent for closed-loop recycling. Although, as the primary material~~it~~ is steel, it is likely that reuse options will be explored for steel elements before being recycled. DESNZ 2023 emission factors were used to determine carbon values for wastage. In reality, it is also worth noting that the Proposed Development has set a target of 90% recovery for non-hazardous construction waste.

15.4.26 To assess the magnitude of impacts as a result of GHG emissions associated with the operation of the Proposed Development, GHG emissions associated with the project activities are calculated based on the assumptions and listed below.

- As stated by *ES Volume II Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*, the anticipated design life of the pipeline will be for an initial 25 years; however, this could be extended through appropriate maintenance;

- The electricity consumed through the operation of the Proposed Development was estimated by the project engineers;

- Grid decarbonisation during the operation of the Proposed Development was estimated based off emission factors by the HM Treasury Green Book (Ref 15-31); and

- Worker commuting was excluded from the GHG Assessment due to the number of operational staff on site being negligible.
- Maintenance and repair emissions were calculated based on the methodology outlined in RICS Whole life carbon assessment for the built environment, 2nd Edition, 2023 (Ref 15-36).

15.4.27 In order to assess the magnitude of the climate change impacts as a result of GHG emissions associated with decommissioning of the Proposed Development, the GHG emissions that would be associated with the Proposed Development activities are calculated based on the assumptions and listed below:

- The pipeline will remain in-situ and will not be disposed of at the end of its operational life;
- All other equipment at the Immingham, Theddlethorpe and Block Valve Sites will be decommissioned and removed from site for disposal, as a worst-case scenario. However, it is likely that reuse options will be explored before being recycled;
- DESNZ 2023 Emission Factors were applied to the material quantities to generate emission values for the waste disposal. It was assumed that 100% of material will be sent to landfill. This is a reasonable worst-case scenario. A separate waste management strategy will be produced for the decommissioning phase of the Proposed Development;
- It is assumed that the equipment will be transported a distance of 100km to the waste disposal site and HGV's will be used. This is a reasonable worst-case scenario. The DESNZ 2023 Emission Factor for an HGV were applied to provide an estimate of the likely GHG impact in the absence of readily available future emissions factors for HGV transport that might apply at the time of decommissioning; and
- It has been estimated that the decommissioning phase of the Proposed Development will require 50% of the manpower required for the construction phase. All vehicles used to transport decommissioning workers were all EV powered van's (up to 3.5 tonnes). This was used in place of LGVs as emission factors are unavailable for EV LGVs.

Climate Change Resilience Assessment

15.4.28 The CCR Assessment will analyse the significance of potential climate change events given their likelihood and measure of consequence, under the assumption that specified adaptation and resilience measures have been taken.

15.5 Baseline Conditions and Study Area

Study Area

Study Area for Lifecycle GHG Impact Assessment

15.5.1 The Study Area for the lifecycle GHG impact assessment considers all GHG emissions arising over the lifecycle of the Proposed Development. This includes direct GHG emissions arising from activities within the DCO Site Boundary and indirect emissions from activities outside the DCO Site Boundary (for example, the transportation of materials to the DCO Site Boundary and embodied carbon within construction materials).

15.5.2 The Study Area also includes activities that may be avoided or displaced as a result of the Proposed Development, including consideration of the emissions that are expected to be avoided as a result of the delivery of the wider Viking CCS Project.

Study Area for Climate Change Resilience Assessment

15.5.3 The Study Area for the CCR Assessment is the DCO Site Boundary i.e., it covers all land, assets and infrastructure which constitute the Proposed Development, during construction, operation, and decommissioning.

Baseline Conditions

Baseline for Lifecycle GHG Impact Assessment

15.5.4 Current land use within the DCO Site Boundary is predominantly arable with managed hedgerows and trees. Trees are present individually in some areas, as well as in rows and within small woodland areas. The abundance of vegetation within the DCO Site Boundary suggests a relatively high carbon sink potential. Also, current land use within the DCO Site Boundary has minor levels of associated GHG emissions as the land use is largely agricultural. Baseline agricultural GHG emissions are dependent on soil and vegetation types present, and fuel use for the operation of vehicles and machinery.

15.5.5 The lifecycle GHG impact assessment for the Proposed Development comprises of the Viking CCS pipeline and associated infrastructure within the DCO Site Boundary and is included in the impact assessment sections of this chapter below.

15.5.6 For the GHG Assessment, the baseline is the 'do nothing' scenario where the Proposed Development is not constructed, operated, and decommissioned. The baseline typically consists of the GHG emissions from the existing carbon stock within the soil and the above- and below-ground vegetation with the DCO Site Boundary.

15.5.7 While the current land use within the DCO Site Boundary will have minor levels of associated GHG emissions, it is anticipated that these emissions will not be material in the context of the Proposed Development. Therefore, for the purposes of the lifecycle GHG impact assessment, a net GHG emissions baseline of zero is applied.

Baseline for Climate Change Resilience Assessment

15.5.8 The current baseline for the assessment of the climate change risks to the Proposed Development (the CCR assessment) will be based on historic climate data obtained from the Met Office (Ref 15-3) recorded by the closest meteorological station (Cleethorpes, approximately 21 kilometres from the Proposed Development) for the period 1991-2020. This data is listed in **Table 15-13** below.

Table 15-13: Historic Climate Data 1991-2020

Climatic Variable	Month (if applicable)	Value
Mean annual maximum daily temperature (°C)	n/a	14.05
Mean summer maximum daily temperature (°C)	n/a	20.24
Mean winter minimum daily temperature (°C)	n/a	2.13
Number of days of air frost per annum	n/a	25.05
Warmest Month on Average (°C)	July/August	21.08
Coldest Month on Average (°C)	January	1.99

Climatic Variable	Month (if applicable)	Value
Mean annual rainfall (mm)	n/a	600.71
Mean summer rainfall (mm)	n/a	166.1
Mean winter rainfall (mm)	n/a	142.27
Wettest month on average (mm)	November	63.4
Driest month on average (mm)	March	34.47

15.5.9 The Met Office historic 10-year averages for the 'England and North East England' region identify gradual warming (although not uniformly so) between 1969 and 2018, with increased rainfall also. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in **Table 15-14**.

Table 15-14: Historic 10-year Averages for Temperature and Rainfall for the England Southeast and Central South Region

Climate Period	Climate Variable	
	Mean maximum annual temperatures (°C)	Mean annual rainfall (mm)
1971-1980	12.0	710
1981-1990	12.2	732.1
1991-2000	12.6	750.8
2001-2010	13.1	801.5
2011-2020	13.3	803.5

Future Baseline

15.5.10 The future climatic baseline will be determined through the UK Climate Impacts Programme UK Climate Projections 2018 (UKCP18) (Ref 15-4) detailed in **Table 15-15**. As the design life of the Proposed Development is expected to be an initial 25 years, the vulnerability assessment has considered a scenario that reflects a high level of greenhouse gas emissions at the 10%, 50% and 90% probability levels up to the 2070s' time period and to assess the impact of climate change over the whole lifetime of the Proposed Development where possible.

15.5.11 For the purpose of the assessment, UKCP18 probabilistic projections for pre-defined 30-year periods for the following average climate variables have been obtained and will be further analysed:

- Mean Sea Level Rise;
- Mean annual temperature;
- Mean summer temperature;
- Mean winter temperature;
- Maximum summer temperature;
- Minimum winter temperature;
- Mean annual precipitation;

- Mean summer precipitation; and
- Mean winter precipitation:

15.5.12 Projected temperature and precipitation variables are presented in **Table 15-15**. UKCP18 probabilistic projections have been analysed for the 25 km grid square in which the Proposed Development is located. These figures are expressed as temperature/precipitation anomalies in relation to the 1981-2010 baseline.

15.5.13 UKCP18 uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform differing future emission trends. These RCPs "*… specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels."* RCP8.5 has been used for the purposes of this assessment as a worst-case scenario.

15.5.14 As the design life of the Proposed Development is expected to be at least an initial 25 years, the CCR assessment has considered a scenario that reflects a high level of GHG emissions at the 10%, 50%, and 90% probability levels up to 2069 to assess the impact of climate change over the lifetime of the Proposed Development. The projections were updated on 26 May 2023. The methodology was updated to improve:

- consistency between maximum, minimum and mean temperature;
- consistency in the downscaling;
- statistical treatment of precipitation particularly at the wet and dry extremes; representation of annual and decadal variability; and
- adjustment of data in 1981-2010 baseline period to ensure anomalies average to zero.

15.5.15 The combination of the improvements means that all variables are modified to some degree.

15.5.16 **Table 15-15** shows projected changes in temperature (expected to increase), precipitation (expected to increase in winter and decrease in summer) and sea level rise (expected to increase). The climate projections do not take account of the Proposed Development.

Table 15-15: Climate Change Baseline and Projection Data (°C), 50% Probability (10% and 90% Probability in Parentheses)

Climate Variable	Baseline (1981-2010)	Climate Change Projection RCP8.5 (2020-2099)			Projected Trend	Climate Projection source
		(2010-2039)	(2040-2069)	(2070-2099)		
Temperature						
Mean annual maximum daily temperature (°C)	13.60	*0.76°C (+0.32°C to + 1.21°C)*	*1.81°C (+0.95°C to + 2.72°C)*	*3.48°C (+2.04°C to + 5.00°C)*	↑	*UKCP18 RCP8.5*
Mean summer maximum daily temperature (°C)	19.82	*0.90°C (+0.31°C to + 1.49°C)*	*2.19°C (+0.99°C to + 3.39°C)*	*4.28°C (+2.20°C to + 6.42°C)*	↑	*UKCP18 RCP8.5*
Mean winter minimum daily temperature (°C)	7.61	*0.67°C (+0.05°C to + 1.34°C)*	*1.72°C (+0.49°C to + 2.81°C)*	*3.15°C (+1.20°C to + 4.94°C)*	↑	*UKCP18 RCP8.5*
Number of days of air frost per annum	30.60	*Based on rising annual temperatures, and more relevantly rising minimum winter temperatures, the number of frost days per annum is projected to fall. Although rise in precipitation during winter season may counter this effect, ground temperatures must be below freezing for it to occur.*			↓	*UKCP18 RCP8.5*
Highest temperature for period (°C)	(August) 20.69	*0.97°C (+0.20°C to + 1.73°C)*	*2.38°C (+0.86°C to + 3.93°C)*	*4.68°C (+2.08°C to + 7.37°C)*	↑	*UKCP18 RCP8.5*
Lowest temperature for period (°C)	(January) 7.38	*0.67°C (-0.01°C to + 1.41°C)*	*1.72°C (+0.42°C to +3.14°C)*	*3.15°C (+1.06°C to + 5.55°C)*	↑	*UKCP18 RCP8.5*
Rainfall						
Mean annual rainfall (mm)	587.94	*1.55% (-4.33% to +7.36%)*	*-2.30% (-11.42% to +6.97%)*	*-1.42% (-13.04% to +10.54%)*	↑↓	*UKCP18 RCP8.5*
Mean summer rainfall (mm)	51.48	*-1.65% (-15.31% to +12.04%)*	*-14.38% (-36.45% to +7.96%)*	*-29.40% (-53.48% to +-3.69%)*	↓	*UKCP18 RCP8.5*
Mean winter rainfall (mm)	46.51	*2.98% (-5.39% to +12.34%)*	*7.58% (-4.30% to +21.10%)*	*18.21% (-0.78% to +40.00%)*	↑	*UKCP18 RCP8.5*
Wettest month on average (mm)	(November) 60.18	*Although there is no projected data available to identify the specific month, based on projected rising precipitation anomalies in the winter season along with projected falling precipitation anomalies in the summer season, it's likely that the wettest month on average will fall within the winter months.*				*UKCP18 RCP8.5*
Driest month on average (mm)	(April) 37.99	*Although there is no projected data available to identify the specific month, based on projected falling precipitation anomalies in the summer season along with projected rising precipitation anomalies in the winter season, it's likely that the driest month on average will fall within the summer months.*				*UKCP18 RCP8.5*
Other						
Time mean sea level anomaly (m) (Immingham Facility)	-	*0.13 (+0.10 to + 0.16)*	*0.33 (+0.25 to + 0.42)*	*0.60 (+0.45 to + 0.79)*	↑	*UKCP18 RCP8.5*
Time mean sea level anomaly (m) (Theddlethorpe Facility)	-	*0.14 (+0.11 to + 0.17)*	*0.34 (+0.26 to + 0.43)*	*0.62 (+0.47 to + 0.81)*	↑	*UKCP18 RCP8.5*
Droughts	*The Met Office has projected a trend towards drier summers on average, with the trend being stronger under a high GHG emission scenario compared to a low one. However, it is the distribution of rainfall throughout the seasons that will determine UK drought risk.*				↑	*UKCP18 RCP8.5*

Climate Variable	Baseline (1981-2010)	Climate Change Projection RCP8.5 (2020-2099)			Projected Trend	Climate Projection source
		(2010-2039)	(2040-2069)	(2070-2099)		
Wildfires	*The wildfire hazard is classified as medium according to the information that is currently available to the Think Hazard tool. This means that there is between a 10% and 50% chance of experiencing weather that could support a hazardous wildfire that may poses some risk of life and property loss in any given year.*				↑	*Think Hazard!*
Storms	*The UKCP18 model suggest a small contribution from storm surges, however it is unclear if the frequency and severity of future storm surges is going to change. Although, rising sea levels due to climate change are expected to worsen the impacts of storm surges*				↑↓	*UKCP18 RCP8.5*

15.6 Development Design and Embedded Mitigation

15.6.1 A Preliminary Draft Construction Environmental Management Plan (CEMP) has been prepared and can be found in PEIR Volume IV - Appendix 3.1. This includes a preliminary mitigation register which includes measures to help reduce the GHG impact of the Project. The mitigation presented in the Draft CEMP is secured through a requirement within the DCO, which requires a CEMP to be submitted to the planning authority for approval prior to commencement of development.

15.6.2 The mitigation measures comprise of:

- **M1**: Adopting the Considerate Constructors Scheme to assist in reducing pollution, including GHGs, from the Project by employing best practice measures which go beyond the statutory requirements;
- **M4**: Develop sustainability targets and monitor during construction;
- **K1**: Develop and adopt an Energy Reduction Plan which includes measures to identify and implement all cost-effective efficiency measures. This will form part of the Final CEMP;
- **K2**: A cost benefit analysis is to be undertaken to better understand whether it is more efficient to hire one or two generators (one larger for daytime use, and a second smaller generator for night-time use) for all construction activities where grid connections are not possible, including hydrotesting. This can be considered as part of the Energy Reduction Management Plan;
- **K3**: Develop a Sustainable Procurement Plan to identify the risks and opportunities of procurement against a broad range of social, environmental, and economic issues. This will form part of the Final CEMP;
- **K4**: Develop a Materials Management Plan which includes best practice measures on suitability for use, certainty of use and quantities required;
- **K5**: Develop the outline Site Waste Management Plan attached to the Draft CEMP. This will be required to include measures to ensure waste produced or held on a site is disposed of safely, efficiently and lawfully, and meets 90% total waste diverted from landfill;
- **K6**: When designing the Project in detail, ensure sufficient shading is provided where equipment/machinery is stored; and
- **K7**: Key access roads should be designed with materials that can withstand future temperature increases.

15.6.3 EIA is an iterative process which informs the development of a project's design. Where the outputs of the preliminary assessment identify likely significant effects, changes to the design can be made or mitigation measures can be built-in to the proposal to reduce these effects.

15.6.4 This type of mitigation is defined as embedded mitigation, as mitigation measures which have been identified and adopted as part of the evolution of the Project design ("embedded" into the Project design).

15.6.5 The design of the Project has been developed to reflect the findings of ongoing environmental studies, comments raised during this statutory consultation and ongoing engagement with stakeholders. As the design develops, the embedded mitigation measures will also be refined as part of an iterative process.

15.6.6 For the purposes of the climate change assessment, an initial worst-case assessment has been undertaken within which no mitigation measures are considered embedded into the design. The review of potential impacts and assessment of effects (Section 15.7) therefore does not consider any mitigation measures.

15.6.7 Proposed additional mitigation measures are discussed in Section 15.8.

15.7 Potential Impacts and Assessment of Effects

Introduction

15.7.1 This section will assess the potential carbon emissions of Proposed Development and its impact on climate. This will be split into the GHG Assessment, and the Climate Change Resilience (CCR) Assessment.

Lifecycle Greenhouse Gas Assessment

General Overview

15.7.2 This section presents the findings of the GHG impact assessment for the construction of the Proposed Development. It identifies any likely significant effects that are predicted to occur.

15.7.3 The GHG Assessment provides a breakdown of emissions throughout the Proposed Development Lifecyle given the methodology and assumptions made in Section 15.4. A breakdown of emissions is provided for construction, operation, then finally decommissioning of the Proposed Development.

Assessment of Potential Impacts: Construction Phase

Construction Emissions

15.7.4 As detailed in **Table 15-16**, using the assumptions listed in Section 15.4, the total construction related GHG emissions from the Proposed Development are calculated to be around 10784,051279 tCO_2e. Thewith a large majority of construction emissions being come fromassociated with the embodied carbon inof construction materials, mainly the pipeline and pipeline components.

15.7.5 This section breaks down construction stage carbon emissions between the above ground installations (AGI), the pipeline, and temporary construction compounds, and are assessed as follows:

- The AGIs include the Inlet Facility at Immingham, The Reception Facility at Theddlethorpe, and the Block Valve Stations.
- The pipeline is split into five sections for ease of reporting throughout the ES.
- The temporary construction compounds assessed are the North, South, and Central compounds.

15.7.6 Following the breakdown for construction stage emissions will be an assessment of alternative design options that were not taken, for transparency.

~~15.7.4~~

Table 15-16~~15-16~~: Overview of Construction Stage Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)	GHG Emissions as a proportion of total project emissions ~~generated throughout the construction~~
Earthworks~~Plant emissions and enabling works~~	887	1~~1~~%[2]
Land-use change	1,300	1%
Construction Materials~~, primarily steel pipeline~~	77,402~~,187~~	70~~92~~%
Fuel-use from plant and construction compounds	22,847	20%
Transport of Materials	4,556~~25~~	4~~5~~%
Construction Worker Commuting	58	<1~~0~~%
Construction Waste	2~~1,622~~	<1~~2~~%
Total GHG emissions over construction period (tCO2e)	107~~84~~,052~~279~~	96%

~~15.7.5~~15.7.7 The following tables break down the construction phase carbon emissions in **Table 15-16** into three categories: Immingham and Theddlethorpe Facilities; Pipeline Route; and Block Valve Stations:

- *Immingham and Theddlethorpe Facilities, Block Valve Stations:* **Table 15-17** shows the emissions break down for the Immingham facility including the Cathodic Protection. ~~and~~ **Table 15-18** ~~detail~~ shows the carbon emissions ~~attributed to the construction of the Immingham and~~breakdown for the Theddlethorpe Facility~~ie~~ including the Dune Valve. **Table 15-19** shows the emissions breakdown of the combined Block Valve station~~s~~;
- *The Pipeline Route:* **Table 15-20** to **Table 15-24~~Table 15-24~~** ~~detail~~ show the carbon emissions attributed to the ~~construction of the~~ pipeline and pipeline route components, ~~per~~ broken down by pipeline section as defined in *ES Volume II: Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*; and
- ~~*Block Valve Stations*~~*Temporary Construction compounds*: **Table 15-25** d~~**Table 15-25** to **Table 15-27** d~~etail the carbon emissions attributed to the Block Valve Stations.

Immingham and Theddlethorpe Facilities, and Block Valve Stations

~~15.7.6~~15.7.8 **Table 15-17** and **Table 15-18** identify the construction phase emissions attributed to the Immingham and Theddlethorpe Facility Option1. ~~, including Option 1 and Option 2 for the Theddlethorpe Facility.~~ This excludes any construction work attributed to the pipeline route components which is reported in the following section. Both sites are anticipated to be built on brownfield sites and therefore no land-use change impact is anticipated.

~~15.7.7~~ The design process for the Theddlethorpe facility is still in progress. Carbon emissions have only been assessed for ~~option 1 of the design~~the preferred option. Currently, there is no significant difference between Option 1 and Option 2 within the site boundary for the Theddlethorpe~~t~~ Facility. While the size of enabling works for both Option 1 and Option 2 are similar, the main difference identified is the location of the enabling works within the facility

[2] Values that show as <1 or <1% represent a number that is closer to zero than to 1.

site boundary. With the expectation that there will be no material difference in carbon emissions when comparing between the two options, it has been insignificant. **Table 15-28** shows a breakdown of Option 2. ~~The carbon assessment for the Pipeline Route Section 5 for Option 1 and Option 2 can be found in **Table 15-19** to **Table 15-24** respectively.~~

Table 15-17: Immingham Facility and Cathodic Protection Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks~~nabling works~~	1
Land-use change	0
Construction Materials (including Cathodic Protection)	87~~3~~
Transport of Materials	16~~5~~
Construction Worker Commuting	7~~6~~
Construction Waste	<1
~~Cathodic Protection~~	4
Total GHG emissions over construction period (tCO2e)	**111~~110~~**

Table 15-18: Theddlethorpe Option 1 ~~(Preferred Option~~ Construction Phase Carbon Emissions~~)~~

Project Activity/ Emission Source	GHG Emissions (tCO2e)
~~Plant emissions and enabling works~~Earthworks	1
Land-use Change	0
Construction Materials (including Dune Valve)	207~~191~~
Transport of Materials	17
Construction Worker Commuting	7~~6~~
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**233~~215~~**

15.7.10 **Table 15-19** below shows the total construction emission breakdowns of the Washingdales, Thoroughfare, and Louth Road Block Valve Stations.

Table 15-19 Total Block Valve Stations Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks	1
Land-use change	298
Construction Materials	92
Transport of Materials	17
Construction Worker Commuting	7
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**414**

Pipeline Route and Components

~~15.7.8~~15.7.11 **Table 15-20** to **Table 15-29** identify the carbon emissions attributed to the pipeline route during the construction phase. Each table reflects the pipeline route section

1 to 5 as described in *ES Volume II - Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*. Plant activity has been calculated as a whole based on the *ES Volume IV - Appendix 3-3: Indicative Plant and Equipment List~~indicative plant list~~* and apportioned to the Pipeline route proportionally across the five sections for ease of reporting. ~~Sections as they contribute the major share of upfront embodied emissions.~~ Pipeline route component are assumed to be made bespoke to the project and therefore have no waste from construction materials.

~~15.7.9~~15.7.12 **Table 15-20** above shows the emission breakdown for Pipeline Route section 1 which includes approximately 4km length of pipe from the Immingham Facility to the A180, as well as pipework components from Immingham Facility.

Table 15-20~~15-19~~: Pipeline Route Section 1 Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
~~Plant emissions and enabling works~~Earthworks	65
Fuel-use from plant activity	3,715
Construction Materials, primarily steel pipeline	5,770
Transport of Materials	328
Construction Worker Commuting	7~~6~~
Construction Waste	<1~~123~~
Total GHG emissions over construction period (tCO2e)	**9,886~~6,291~~**

Table 15-21~~15-20~~: Pipeline Route Section 2 Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e) Emission Source
Earthworks~~Plant emissions and enabling works~~	161
Fuel-use from plant activity	3,715
Construction Materials, primarily steel pipeline	13,857
Transport of Materials	812
Construction Worker Commuting	7~~10~~
Construction Waste	<1~~292~~
Total GHG emissions over construction period (tCO2e)	**18,552~~15,131~~**

~~15.7.10~~15.7.13 **Table 15-21** above shows the emission breakdown for Pipeline Route section 2 which includes approximately 10km length of pipe from the A180 to the A46, as well as pipework components from Washingdales Lane Block Valve Station.

Table 15-22~~15-21~~: Pipeline Route Section 3 Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks~~Plant emissions and enabling works~~	289
Fuel-use from plant activity	3,715
Construction Materials, primarily steel pipeline	24,904
Transport of Materials	1,461

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Construction Worker Commuting	7~~10~~
Construction Waste	1~~524~~
Total GHG emissions over construction period (tCO2e)	**30,377~~27,188~~**

~~15.7.11~~15.7.14 **Table 15-22** above shows the emission breakdown for Pipeline Route section 3 which includes approximately 18km length of pipe from the A46 to Pear Tree Lane, as well as pipework components from Thoroughfare Block Valve Station.

~~15.7.12~~15.7.15 **Table 15-23** ~~above~~ below shows the emission breakdown for Pipeline Route section 4 which includes approximately 15km length of pipe from Pear Tree Lane to Manby Middlegate, as well as pipework components from Louth Road Block Valve Station.

Table 15-23~~15-22~~: Pipeline Route Section 4 Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks~~Plant emissions and enabling works~~	241
Fuel-use from plant activity	3,715
Construction Materials, primarily steel pipeline	20,761
Transport of Materials	1,218
Construction Worker Commuting	7~~10~~
Construction Waste	<1~~437~~
Total GHG emissions over construction period (tCO2e)	**25,942~~22,666~~**

Table 15-24~~15-23~~: Pipeline Route Section 5 (Option 1) Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks~~Plant emissions and enabling works~~	129
Fuel-use from plant activity	3,715
Construction Materials, primarily steel pipeline	11,526
Transport of Materials	656
Construction Worker Commuting	76
Construction Waste	<1245
Total GHG emissions over construction period (tCO2e)	**16,034~~12,562~~**

15.7.16 **Table 15-24** above shows the emission breakdown for Pipeline Route section 5 which includes c.8km length of pipe from Manby Middlegate to the Theddlethorpe facility, as well as pipework components from Theddlethorpe AGI.

Temporary Construction Compounds

15.7.17 Table 15-25 below shows the emission breakdown for the temporary construction compounds. ~~No earthworks are anticipated for the construction compounds, and g~~Ground preparation emissions are captured within land-use change emissions. Construction worker emissions are anticipated to be zero for the construction compounds, workers emissions from commuting are captured at the appropriate work sites i.e., the pipeline sections, and above ground installations.

Table 15-25: Total Construction ~~Compouends~~Compounds Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
~~Earthworks~~	0
Land-use change	1,002
Fuel-use from on-site generators	4,271
Construction Materials,	197
Transport of Materials	30
Construction Worker Commuting	0
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**5,470501**

~~15.7.13~~

~~15.7.14 **Table 15-24** above shows the emission breakdown for Pipeline Route section 5 which includes approximately 8km length of pipe from Manby Middlegate to the Theddlethorpe facility, as well as pipework components from Theddlethorpe Facility Option 2.~~

Table 15-24: Pipeline Route Section 5 (Option 2) Construction Phase Carbon Emissions

		Project Activity/ Emission Source
		Plant emissions and enabling works
		Construction Materials, primarily steel pipeline
		Transport of Materials
		Construction Worker Commuting
		Construction Waste
		Total GHG emissions over construction period (tCO2e)

Block Valve Sites

15.7.15 **Table 15-25** to **Table 15-27** show the construction emission breakdowns for the Block Valve Stations.

Table 15-25: Washingdales Block Valve Station Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Plant emissions and enabling works	<1
Construction Materials	31
Transport of Materials	6
Construction Worker Commuting	2
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**39**

15.7.16 **Table 15-25** above details the emission breakdown of Washingdales Block Valve Station construction.

Table 15-26: Thoroughfare Block Valve Station Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Plant emissions and enabling works	<1
Construction Materials	31
Transport of Materials	6
Construction Worker Commuting	2
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**39**

15.7.17 **Table 15-26** above details the emission breakdown of Thouroughfare Block Valve Station construction.

Table 15-27: Louth Road Block Valve Station Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)

~~Plant emissions and enabling works~~	~~<1~~
~~Construction Materials~~	~~30~~
~~Transport of Materials~~	~~5~~
~~Construction Worker Commuting~~	~~2~~
~~Construction Waste~~	~~<1~~
~~*Total GHG emissions over construction period (tCO2e)*~~	~~**38**~~

~~15.7.18 **Table 15-27** above shows the emission breakdown of Louth Road Block Valve Station construction.~~

Assessment of Potential Impacts: Operational Phase

15.7.18 As detailed in **Table 15-26**, using the listed assumptions, the lifetime operational GHG emissions from the Proposed Development within the DCO Site Boundary are calculated to be approximately 2,514 tCO_2e ~~with 100% of operational emissions associated with electricity usage onsite~~, and Repair and maintenance emissions are anticipated to be 1,357 tCO2e and is calculated using the methodology set out in Whole life carbon assessment for the built environment, 2nd Edition, 2023 (Ref 15-36).~~.~~

15.7.19 ~~.~~Assuming that emission-related activities are similar during the initial 25-year development, annual emissions are expected to be approximately 332 tCO_2e in 2027 and will decrease to approximately 15 tCO_2e from 2049 onwards due to projected electricity grid decarbonisation.

Table 15-26~~15-28~~: Operational Emissions (within DCO Site Boundary)

Project Activity/ Emission Source	GHG Emissions (tCO2e)	GHG Emissions as a proportion of total project emissions ~~generated throughout Operation~~
Operational Energy Usage ~~– Immingham Facility Site~~	2,514~~880~~	2~~35~~%
~~Operational Energy Usage – Theddlethorpe Facility~~	~~1,445~~	~~57%~~
~~Operational Energy Usage – Block Valve Stations 1-3~~	~~189~~	~~8%~~
Repair, and maintenance	1,357	1%
Total GHG emissions over operational period (tCO2e)	**~~112,592~~3,871~~514~~**	**3%**

15.7.20 In addition to the operational emissions listed above in **Table 15-26,** the GHG assessment needs to consider the anticipated GHG impacts of the wider Viking CCS Project to abate carbon emissions from large industrial emitters at the Immingham Industrial Site that sit outside of the DCO Site Boundary. As stated in *ES Volume II Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*, the Proposed Development aims to transport up to 10 million tonnes of CO_2 annually by 2030. This anticipated GHG activity needs to be assessed against the significance criteria detailed in **Table 15-10**.

15.7.21 The vast majority of the overall GHG impact come from the sequestration of CO_2 emissions from the Immingham industrial site, resulting in the Proposed Development being carbon negative relative to a without-project baseline. This net impact figure does not account for any additional emissions from the CO_2 capture process at the Immingham industrial site.

15.7.22 It is important to note that the GHG emissions associated with CO_2 capture and sequestration will be considered separately for the significance assessment as these GHG emissions fall out with the Proposed Development's DCO Site Boundary.

Assessment of Potential Impacts: Decommissioning Phase

15.7.23 This section presents findings of the GHG impact assessment for the decommissioning of the Proposed Development. It identifies any likely significant effects that are predicted to occur and then highlights the mitigation and enhancement measures that are proposed to minimise any adverse significant effects.

15.7.24 As detailed in **Table 15-27**, using the listed inclusions and exclusions, the total GHG emissions from the Proposed Development are calculated to be approximately 91 tCO_2e with the majority (60%) of emissions associated with the transport of waste material from the Proposed Development site. The remaining emissions are associated with the recycling and disposal of onsite equipment.

15.7.25 As noted above, emissions from the transportation of waste materials and workers are based on the most recent vehicle emissions factors. The UK Government's Transport Decarbonisation Plan (Ref 15-32) sets out ambitions to decarbonise all aspects of road transport by 2050, so the actual transport emissions at the time of future decommissioning are likely to be significantly lower than the figures presented in **Table 15-27** below.

Table 15-27~~15-29~~: Decommissioning Phase

Project Activity/ Emission Source	GHG Emissions (tCO2e)	GHG Emissions as a proportion of emissions generated throughout Decommissioning
~~Waste Material Transport~~	~~53~~	~~58%~~
Worker Transport	29	<1~~32~~%
~~Material~~ Waste Disposal	261~~1359~~	<1~~0~~%
Total GHG emissions over Decommissioning period (tCO2e)	**289~~10591~~**	**<1%**

Assessment of Alternative Options

15.7.26 This sections provides an assessment of the construction stage emissions of alternative design options for the Theddlethorpe Facility, and the Section 5 pipeline route going into the facility.

Theddlethorpe Facility

15.7.27 **Table 15-28** below shows the emission breakdown for option 2 for the Theddlethorpe Ffacility. This option has a higher land-use impact due to it being on arable land.

Table 15-28: Theddlethorpe Alternative Option

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks	1
Land-use	457
Construction Materials	207
Transport of Materials	17
Construction Worker Commuting	7
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**670**

Pipeline Route Section 5 Alternative option

15.7.28 **Table 15-29** below shows the emission breakdown for the alternative option for Pipeline Route section 5 which includes approximately 8km length of pipe from Manby Middlegate to the Theddlethorpe facility, as well as pipework components from Theddlethorpe Facility Option 2. This option has a higher embodied carbon impact due to the need for more steel components in design compared to the preferred option.

Table 15-29: Pipeline Route Section 5 (Option 2) Construction Phase Carbon Emissions

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Earthworks	145
Fuel-use from plant activity	3,715

Project Activity/ Emission Source	GHG Emissions (tCO2e)
Construction Materials, primarily steel pipeline	13,324
Transport of Materials	683
Construction Worker Commuting	7
Construction Waste	<1
Total GHG emissions over construction period (tCO2e)	**174,875**

Climate Change Resilience Assessment

General Overview

~~15.7.26~~15.7.29 The CCR Assessment will analyse the significance of potential climate change events given their likelihood and measure of consequence, under the worst-case scenario RCP8.5, given the assumption that adaptation and resilience measures have not been taken. The Future Baseline highlights the projected trends within the region in **Table 15-15**, and the significance of effects are assessed using the likelihood criteria, consequence criteria and significance criteria presented in **Table 15-8**, **Table 15-9** and **Table 15-10** respectively. The key climate change hazards that could impact the Proposed Development during the Construction Phase, and the Operational Phase are detailed in **Table 15-30,** and **Table 15-31** respectively.

Effects during Construction

~~15.7.27~~15.7.30 During enabling works and construction, receptors such as the construction work force, construction plant, vehicles, materials and the construction programme may be vulnerable to a range of climate risks. These could include:

- Inaccessible construction sites at the permanent facilities (Theddlethorpe, Immingham, and Block Valve Stations), and temporary compounds due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
- Health and safety risks to the workforce during severe weather events;
- Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
- Damage to construction materials, plant and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, for example as a result of stormy weather.

~~15.7.28~~15.7.31 However, as seen in **Table 15-15** the projected trends of minimal change with an even likelihood to occur can be considered as **Minor/Moderate adverse** within the period of construction activities.

Effects during Operational Phase

~~15.7.29~~15.7.32 During operation, average and summer maximum temperature increases and therefore the severity and likelihood of extreme heat. This also the same for winter rainfall, and sea level rise, which increases the likelihood and severity of other extreme weather events (i.e., floods, and storms). While receptors such as permanent facilities, plant, and equipment and the surrounding areas may be vulnerable to these climate risks, the significance of the climate impact can still be considered as **Minor/Moderate adverse**.

Table 15-30 Climate Change Resilience Assessment Summary: Construction Phase

Potential climate changes	Potential impacts on the Proposed Development	Adaptation / Resilience measures	Likelihood of climate related impact occurring (2020-2049) (Probability of Occurrence based on Table 15-8)	Measure of Consequence occurring (based on Table 15-9)	Significance Level (2020-2049) (based on Table 15-12)
Increased frequency and severity of extreme weather events	Damage to construction equipment due to storm events or intense rainfall. Damage to drainage systems, gutters and downpipes due to flooding from intense rainfall. Flooding from drainage systems during intense or prolonged rainfall.	N/A	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**
Increased winter precipitation	Flooding from drainage systems during intense or prolonged rainfall. Restricted access to sites (such as heavy rain resulting in flooding of heavy roads sources of power supply or inundation of sites). Water-logged land due to prolonged rainfall which inhibits the movement of construction machinery. Flooding of the construction sites. Damage to equipment.	N/A	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**
Increased Summer Temperatures	Potential damage to access roads due to prolonged exposure to high intensity temperatures. Overheating of equipment/machinery. Increased heat stress/heat exhaustion of workers.	N/A	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**

Table 15-31 Climate Change Resilience Assessment Summary: Operation Phase

Potential climate changes	Potential impacts on the Proposed Development	Adaptation / Resilience measures	Likelihood of climate related impact occurring (2020-2049) (Probability of Occurrence based on Table 15-8)	Likelihood of climate related impact occurring (2040-2069) (Probability of Occurrence based on Table 15-8)	Measure of Consequence occurring (Table 15-9)	Significance Level (2020-2049) (based on Table 15-12)	Significance Level (2040-2069) (based on Table 15-12)
Increased frequency and severity of extreme weather events	Damage to equipment due to storm events or intense rainfall. Damage to drainage systems, gutters and downpipes due to flooding from intense rainfall. Flooding from drainage systems during intense or prolonged rainfall.	N/A	Possible, about as likely as not	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**	**Minor/Moderate Adverse**
Increased winter precipitation	Flooding from drainage systems during intense or prolonged rainfall. Restricted access to sites (such as heavy rain resulting in flooding of heavy roads sources of power supply or inundation of sites) Water-logged land due to prolonged rainfall which inhibits the movement of construction machinery. Flooding of the sites Damage to equipment	N/A	Possible, about as likely as not	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**	**Minor/Moderate Adverse**
Increased Summer Temperatures	Potential damage to equipment and infrastructure due to prolonged exposure to high intensity temperatures resulting in overheating of equipment/machinery.	N/A	Possible, about as likely as not	Possible, about as likely as not	Medium	**Minor/Moderate Adverse**	**Minor/Moderate Adverse**
Sea Level Rise	Flooding of the Theddlethorpe Facility; Damage to Infrastructure and Equipment	N/A	Unlikely	Possible, about as likely as not	Low	**Minor Adverse**	**Minor Adverse**

15.8 Additional Mitigation Measures

15.8.1 Additional climate change resilience mitigation measures, particularly in relation to flooding, which are also secured in the Preliminary Draft CEMP are outlined below. The specific flood risk impacts and associated mitigation measures are discussed in more detail in *ES Volume II Chapter 11: Water Environment (Application Document 6.2.11)*. These measures include:

- **G2**: Establish the location and condition of existing land drainage and compile a record. Subject to landowner/occupier agreement, existing drains should be restored, or new drains established to help prevent damage to soil structure, maintain work areas in a dry condition and to enable current drainage systems to continue to operate through the construction period; and
- **G11**: Following installation of the pipeline, topsoil and excavated material will be reinstated and a post-construction drainage system installed to ensure no detriment to the existing land drainage regime.

15.8.2 The assessment of residual effects (Section 15.9), assumes that these proposed mitigation measures have be successfully implemented.

15.9 Residual Effects

GHG Emissions Impact Assessment

15.9.1 As stated in Section 15.4.13, all emissions are considered to be potentially significant. To contextualise the level of significance, **Table 15-32** details the Proposed Development's emissions and compares these to the UK's 4th, 5th and 6th carbon budgets to determine if the Proposed Development aligns with the UK's Government's 2050 net zero target.

15.9.2 The Proposed Development has significantly lower emissions compared to the 4th, 5th and 6th carbon budgets. The Proposed Development's trajectory is fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type.

15.9.3 The UK Carbon budgets only include GHG emissions emitted within the UK. In the GHG assessment, it was assumed the steel used in the pipeline was sourced from overseas. These GHG emissions have been included in the Significance assessment to present a conservative worst-case scenario for the GHG Assessment.

15.9.4 It is anticipated that the majority of these residual emissions beyond 2050 will result from the operational and decommissioning phases. It is anticipated that direct operational emissions will decrease over time due to continuing grid decarbonisation, machinery, and vehicle electrification, in line with the UK's net-zero carbon emissions trajectory. For the decommissioning phase, it is anticipated that the GHG emissions will be negligible due to decarbonisation of surface transport and improvements in waste management.

Table 15-32: Contribution of the Proposed Development's GHG Emissions to the UK Carbon Budgets

Carbon budget period	Lifecycle Stage	Carbon budget (tCO_2e)	Project GHG emissions (tCO_2e)	Percentage of Carbon Budget from Project
4th (2023-2027)	Construction & Operation	1,950,000,000	8670,086650.83	0.00441358%
5th (2028-2032)	Operation	1,725,000,000	212,729092.40	0.00132007%

Carbon budget period	Lifecycle Stage	Carbon budget (tCO_2e)	Project GHG emissions (tCO_2e)	Percentage of Carbon Budget from Project
6th (2033-2037)	Operation	965,000,000	816~~476.38~~	0.000086~~%~~
Projected Carbon Budgets				
7th (2038 – 2042)	Operation	526,000,000	592~~365.63~~	0.000101~~7~~%
8th (2043 – 2047)	Operation	195,000,000	514~~175.00~~	0.000261~~2~~%
9th (2048 – 2050)	Operation	17,000,000	163~~49.79~~	0.000966~~0~~%
Decommissioning emissions of ~~187~~289tCO_2e fall outside of 9th Carbon Budget Period				

15.9.5 Based on the significance criteria laid out in **Table 15-10**, it can be determined that the Proposed Development within its DCO Site Boundary will likely result in a **Minor Adverse** effect on the climate that is **Not Significant**.

15.9.6 Beyond the DCO Site Boundary, the Proposed Development forms part of a wider Viking CCS Project to abate carbon emissions from large industrial emitters at the Immingham Industrial Site. This broader project will result in a significant reduction in carbon emissions based on projected carbon capture rates. These avoided indirect emissions will far outweigh any direct emissions resulting from the operation of the Proposed Development over its operational lifetime.

15.9.7 On this basis, the Proposed Development as part of the wider Viking CCS Project causes a reduction in atmospheric GHG concentrations compared to the 'Do Nothing' Scenario. Therefore, based on the IEMA Significance guidance in **Table 15-10**, the Proposed Development within the wider Viking CCS Project will result in a **Beneficial** effect on the climate that is **Significant**.

15.9.8 To further supplement the reporting of Significance concise summary tables have been produced (see **Table 15-33**, **Table 15-34** and **Table 15-35**).

Table 15-33: Summary of Construction Impacts

Receptor	Potential Impact	Duration	Mitigation	Significance of residual effect
Climate	Effect of GHG emissions on the global climate	Long term impacts: Impacts from Project activities whose effects will occur for longer than 2 years.	Mitigation measures are stated in Section 15.7.	Based on the significance criteria as set out in Section 15.4 the Proposed Development is **Minor Adverse** (Not Significant).

Table 15-34~~15-34~~: Summary of Operational Impacts

Receptor	Potential Impact	Duration	Mitigation	Significance of residual effect
Climate	Effect of GHG emissions on the global climate	**Long term impacts**: Impacts from the operation of the Proposed Development activities whose effects will occur for longer than 2 years.	Mitigation measures are stated in Section 15.8.	Based on the significance criteria as set out in Section 15.4 the Proposed Development within the DCO Site Boundary is **Minor Adverse** (Not Significant).
Climate	Effect of GHG emissions on the global climate	**Long term impacts**: in consideration of the impact of the transportation of CO_2 through the Proposed Development and onward storage within the overall Viking CCS Project	None required. The overall Viking CCS Project is expected to transport and store at least 10 million tonnes of CO2 per annum once operational.	Transportation and storage activities of CO_2 are considered **Beneficial** (Significant).

Table 15-35~~15-35~~ Summary of Decommissioning Impacts

Receptor	Potential Impact	Duration	Mitigation	Significance of Residual effect
Climate	Effect of GHG emissions on the global climate	**Long term impacts:** Impacts from Project activities whose effects will occur for longer than 2 years.	Mitigation measures are stated in Section 15.7.	Based on the significance criteria as set out in Section 15.4 the Proposed Development is **Minor Adverse** (Not Significant).

Climate Change Resilience Assessment

15.9.9 The CCR Assessment will analyse the significance of potential climate change events given their likelihood and measure of consequence, under the worst-case scenario RCP8.5, given that adaptation and resilience measures such as those mentioned in 15.6 and 15.8 have been taken. The Future Baseline highlights the projected trends within the region in **Table 15-15**, and the significance of effects are assessed using the likelihood criteria, consequence criteria and significance criteria presented in **Table 15-8**, **Table 15-9** and **Table 15-10** respectively.

15.9.10 The measure of consequence is expected to reduce given that the adopted mitigation measures, are adopted for this specific purpose. The key climate change hazards that could still impact the Proposed Development given the adopted mitigation measures in during the

Construction Phase, and the Operational Phase are detailed in **Table 15-36** and **Table 15-37,** respectively.

Assessment of Residual Effects: Construction Phase

15.9.11 During enabling works and construction, receptors such as the construction work force, construction plant, vehicles, materials and the construction programme may be vulnerable to a range of climate risks. These could include:

- Inaccessible construction sites at the permanent facilities (Theddlethorpe, Immingham, and Block Valve Stations), and temporary compounds due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
- Health and safety risks to the workforce during severe weather events;
- Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
- Damage to construction materials, plant and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, for example as a result of stormy weather.

15.9.12 Along with the minimal change in projected trends as seen in **Table 15-15** with an even likelihood to occur, the mitigation measures as can further reduce the climate risk from the water environment on receptors during the construction phase giving a **Minor Adverse** level of significance within the period.

Assessment of Residual Effects: Operational Phase

15.9.13 During operation, although mitigation measures do not specifically target temperature increases and extreme heat, historically the area is more prone to flooding. The added mitigation measures further reduce the significance of the climate impact on the Proposed Development and can be considered as **Minor Adverse**.

Assessment of Residual Effects: Decommissioning Phase

15.9.14 Decommissioning phase risks are considered as the same as operational risks between 2050-2069 and can be considered as **Minor Adverse**.

Table 15-36~~15-36~~: Summary of Construction Phase Residual Effects

Potential climate changes	Potential impacts on the Proposed Development	Adaptation / Resilience measures	Likelihood of climate related impact occurring (2020-2049) (Probability of Occurrence based on Table 15-8)	Measure of Consequence occurring (based on Table 15-9)	Significance Level (2020-2049) (based on Table 15-12)
Increased frequency and severity of extreme weather events	Damage to construction equipment due to storm events or intense rainfall. Damage to drainage systems, gutters and downpipes due to flooding from intense rainfall. Flooding from drainage systems during intense or prolonged rainfall.	*The Draft CEMP* contained within *ES Volume IV Appendix 3.2 (Application Document 6.4.3.1)* includes the following additional mitigation measure: • **G2:** Establish the location and condition of existing land drainage and compile a record. Subject to landowner/occupier agreement, existing drains should be restored, or new drains established to help prevent damage to soil structure, maintain work areas in a dry condition and to enable current drainage systems to continue to operate through the construction period.	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**
Increased winter precipitation	Flooding from drainage systems during intense or prolonged rainfall. Restricted access to sites (such as heavy rain resulting in flooding of heavy roads sources of power supply or inundation of sites). Water-logged land due to prolonged rainfall which inhibits the movement of construction machinery. Flooding of the construction sites. Damage to equipment.	• Establish a Flood Warning and Evacuation Plan which contains information on flood emergency response actions. • Surface water runoff from the pipeline spread will be managed to prevent discharge of silted water into any surface watercourse or drain. Details to be included in the Drainage Management Plan. • Where necessary and subject to agreement with the landowner/occupier, new field drains will be installed to aid recovery from the construction activities and ensure site work areas are appropriately drained.	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**
Increased Summer Temperatures	Potential damage to access roads due to prolonged exposure to high intensity temperatures. Overheating of equipment/machinery. Increased heat stress/heat exhaustion of workers.	• Infrastructure and equipment should be designed with materials that can withstand future temperature increases. • Provide workers with access to drinking water and sunscreen to mitigate against effects of dehydration and heat exhaustion.	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**

Table 15-37~~15-37~~: Summary of Operational Phase Residual Effects

Potential climate changes	Potential impacts on the Proposed Development	Adaptation / Resilience measures	Likelihood of climate related impact occurring (2020-2049) (Probability of Occurrence based on Table 15-8)	Likelihood of climate related impact occurring (2040-2069) (Probability of Occurrence based on Table 15-8)	Measure of Consequence occurring (Table 15-9)	Significance Level (2020-2049) (based on Table 15-12)	Significance Level (2040-2069) (based on Table 15-12)
Increased frequency and severity of extreme weather events	Damage to equipment due to storm events or intense rainfall. Damage to drainage systems, gutters and downpipes due to flooding from intense rainfall. Flooding from drainage systems during intense or prolonged rainfall.	*ES Volume IV Appendix 3.1: Draft CEMP (Application Document 6.4.3.1)* includes the following additional mitigation: • **G11:** Following installation of the pipeline, topsoil and excavated material will be reinstated, and a post-construction drainage system installed to ensure no detriment to the existing land drainage regime.	Possible, about as likely as not	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**	**Minor Adverse (Not Significant)**
Increased winter precipitation	Flooding from drainage systems during intense or prolonged rainfall. Restricted access to sites (such as heavy rain resulting in flooding of heavy roads sources of power supply or inundation of sites). Water-logged land due to prolonged rainfall which inhibits the movement of construction machinery. Flooding of the sites Damage to equipment.	• Establish a Flood Warning and Evacuation Plan which contains information on flood emergency response actions. • Surface water runoff from the pipeline spread will be managed to prevent discharge of silted water into any surface watercourse or drain. Details to be included in the Drainage Management Plan.	Possible, about as likely as not	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**	**Minor Adverse (Not Significant)**
Increased Summer Temperatures	Potential damage to equipment and infrastructure due to prolonged exposure to high intensity temperatures resulting in overheating of equipment/machinery.	• When designing the Proposed Development in detail, ensure sufficient shading is provided where equipment/machinery is stored. • Key access roads should be designed with materials that can withstand future temperature increases.	Possible, about as likely as not	Possible, about as likely as not	Low	**Minor Adverse (Not Significant)**	**Minor Adverse (Not Significant)**
Sea Level Rise	Flooding of the Theddlethorpe Facility; Damage to Infrastructure and Equipment.	*ES Volume IV Appendix 3.1: Draft CEMP (Application Document 6.4.3.1)* includes the following additional mitigation measure: • **G2**: Establish the location and condition of existing land drainage and compile a record. Subject to landowner/occupier agreement, existing drains should be restored, or new drains established to help prevent damage to soil structure, maintain work areas in a dry condition	Unlikely	Possible	Very Low	**Negligible (Not Significant)**	**Negligible (Not Significant)**

Potential climate changes	Potential impacts on the Proposed Development	Adaptation / Resilience measures	Likelihood of climate related impact occurring (2020-2049) (Probability of Occurrence based on Table 15-8)	Likelihood of climate related impact occurring (2040-2069) (Probability of Occurrence based on Table 15-8)	Measure of Consequence occurring (Table 15-9)	Significance Level (2020-2049) (based on Table 15-12)	Significance Level (2040-2069) (based on Table 15-12)
		and to enable current drainage systems to continue to operate through the construction period.					
Effect of GHG emissions on the global climate	Effect of GHG emissions on the global climate - in consideration of the impact of the transportation of CO_2 through the Proposed Development and onward storage within the overall Viking CCS Project.	None required. The overall Viking CCS Project is expected to transport and store at least 10 million tonnes of CO_2 per annum once operational.	-	-	-	**Beneficial** (**Significant**)	**Beneficial** (**Significant**)

15.10 Cumulative Effects

15.10.1 The GHG assessment provided within this chapter is considered inherently cumulative as it presents the impact of the development in the context of National carbon budgets, used to represent the key sensitive receptor, (i.e., the global climate). This includes the provision of legally binding limits of GHG emissions that can be emitted by the UK if it is to meet its net zero targets by 2050. This assessment is considered comprehensive and includes a worst case within the defined assessment parameters.

15.10.2 Therefore, no additional intra-project effects assessment is required within this chapter. The effects of climate change on different receptors in-combination with the other identified impact pathways within the EIA have already been assessed in each topic chapter of this ES through consideration of the future baseline.

Assessment of Intra-Project Effects

15.10.3 Climate change is not considered to produce any significant intra-project effects.

Assessment of Inter-Project Effects

15.10.4 Climate change is not considered to produce any significant inter-project effects.

15.11 Summary

GHG Assessment

15.11.1 The GHG assessment for the Proposed Development has considered the Proposed Development to have a '*minor* adverse' residual effect and is therefore **not considered to be significant**. The Proposed Development within the wider Viking CCS Project will result in a **Beneficial** effect that is considered **Significant**.

CCR Assessment

15.11.2 Future climate change projections have been reviewed, and the sensitivity of assets has been examined before commenting on the adequacy of the climate change resilience mitigation measures identified for the Proposed Development. As a result of the proposed resilience measures, **no significant** climate change risks during the construction and operation phases have been identified.

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