

Viking CCS pipeline

Preliminary Environmental Information Report Volume II

Main PEIR

Applicant: Chrysoar Production (U.K.) Limited,
a Harbour Energy Company

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Chapter 9

Geology and Hydrogeology



Table of Contents

9	Geology and Hydrogeology	9-1
9.1	Introduction	9-1
9.2	Legislation, Policy and Guidance	9-1
9.3	Scoping Opinion and Consultation	9-3
9.4	Assessment Method	9-11
9.5	Baseline Environment and Study Area	9-16
9.6	Mitigation	9-46
9.7	Preliminary Assessment of Effects	9-49
9.8	Summary and Next Steps	9-58
9.9	References	9-60

Figures

Figure 9-1:	Superficial Geology	9-20
Figure 9-2:	Bedrock Geology	9-21
Figure 9-3:	BGS Borehole Data	9-22
Figure 9-4:	Superficial Hydrogeology	9-27
Figure 9-5:	Bedrock Hydrogeology	9-28
Figure 9-6:	Source Protection Zones	9-29
Figure 9-7:	Current Potentially Contaminative Land Uses	9-37
Figure 9-8:	Historic Potentially Contaminative Land Uses	9-38
Figure 9-9:	Current and Historic Landfills	9-39
Figure 9-10:	Information from Statutory Authorities	9-45

Tables

Table 9-1:	Summary of EIA Scoping Opinion in relation to Geology and Hydrogeology	9-4
Table 9-2:	Summary of Engagement Undertaken	9-10
Table 9-3:	Criteria to Determine the Sensitivity of Potential Effect to Receptors ...	9-12
Table 9-4:	Criteria to Determine the Magnitude of Receptors	9-13
Table 9-5:	Summary of Geology from BGS 1:50,000 mapping	9-17
Table 9-6:	Summary of BGS Geo-Index Boreholes	9-23
Table 9-7:	Summary of BGS Geo-Index Borehole Geology	9-23
Table 9-8:	Sensitive Land Uses	9-24
Table 9-9:	Summary of Aquifer Classifications	9-25
Table 9-10:	Other Hydrogeological Classifications	9-30
Table 9-11:	Summary of Current and Historic Landfills	9-34
Table 9-12:	Statutory Authority Information	9-40
Table 9-13:	Preliminary Assessment of Geology and Hydrogeology for the Construction Phase	9-51
Table 9-14:	Preliminary Assessment of Geology and Hydrogeology during the Operational Phase	9-56

9 Geology and Hydrogeology

9.1 Introduction

- 9.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the findings of a preliminary assessment of the likely significant effects on Geology and Hydrogeology as a result of the Viking CCS Pipeline (hereafter 'the Project'). For more details about the Project, refer to *Chapter 3: The Viking CCS Pipeline* of this PEIR.
- 9.1.2 The chapter describes the existing ground conditions with respect to geology and hydrogeology, the identified Study Area, the assessment method which will be adopted to identify possible effects posed by the existing ground conditions and the identification of effects of the Project, and how the significance of effects will be determined.
- 9.1.3 This chapter is supported by **Figures 9-1 to 9-11** and the data included in *PEIR Volume IV Appendix 9-1* and *Appendix 9-2* showing superficial deposits, bedrock geology, British Geological Survey (BGS) boreholes, coal mining information, superficial hydrogeology, bedrock hydrogeology, source protection zones (SPZ), current and historic contaminative land uses, current and historic landfill, statutory authority information and Environment Agency (EA) abstraction information (licensed).
- 9.1.4 The effects of the Project on agricultural quality of soils are considered in *Chapter 10: Agriculture and Soils* and the effects on surface water features are considered in *Chapter 11: Water Environment*.

9.2 Legislation, Policy and Guidance

Legislative Framework

- 9.2.1 The following pieces of legislation apply specifically to the geology and hydrogeology assessment:
- The Water Framework Directive (2000/60/EC) (Ref 9-1);
 - The Groundwater Directive (2006/118/EC) (Ref 9-2);
 - Classification Labelling & Packaging (CLP) Regulation (2008/1272/EC) (Ref 9-3), replacing The Dangerous Substances Directive (67/548/EEC) in 2016 (Ref 9-4);
 - The Priority Substances Directive (2008/105/EC) (Ref 9-5);
 - Environmental Protection Act, 1990 (Ref 9-6);
 - The Environment Act, 1995 (Ref 9-7);
 - The Contaminated Land (England) Regulations 2006 (Ref 9-8);
 - Groundwater (England and Wales) Regulations 2009 (Ref 9-9);
 - Environmental Damage (Prevention and Remediation) (England) Regulations 2015 (Ref 9-10);
 - The Water Act 2003 (Ref 9-11);
 - The Water Resources Act 1991 (Ref 9-12);
 - The Land Drainage Act 1991 (Ref 9-13);

- The Environmental Permitting (England and Wales) Regulations 2016 (Ref 9-14);
- The Water Environment (Water Framework Directive) Regulations 2017 (Ref 9-15); and
- Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations 2010 (Ref 9-16).

Policy

9.2.2 The following local and national policies are relevant to the geology and hydrogeology assessment:

- Overarching National Policy Statement for Energy (EN-1) (2011) (Ref 9-23);
- Draft Overarching National Policy Statement for Energy (EN-1) (2021) (Ref 9-22);
- National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (2011) (Ref 9-24);
- Draft National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (2009) (Ref 9-25);
- North Lincolnshire Council Local Plan (2021) (Ref 9-17);
- North East Lincolnshire Council Plan (2018) (Ref 9-18);
- East Lindsey Local Plan (2018) (Ref 9-19);
- Central Lincolnshire Council Plan (2017) (Ref 9-20);
- National Planning Policy Framework (2021) (Ref 9-21);

Guidance

9.2.3 The following UK guidance has been adopted for the geology and hydrogeology assessment:

- Planning Practice Guidance for the Natural Environment (PPGNE) 2019 (Ref 9-26);
- Natural England (2012) Technical Information Note 049 (TIN049): Agricultural Land Classification: Protecting the Best and Most Versatile agricultural land (Ref 9-27);
- Department for the Environment, Food and Rural Affairs (DEFRA): Construction Code of Practice for the Sustainable Use of Soil on Development Site (2009) (Ref 9-28);
- Ministry of Agriculture, Fisheries and Food (MAFF) Agricultural Land Classification of England and Wales Revised guidelines and criteria for grading the quality of agricultural land (Ref 9-29);
- Environment Agency (2021) Guidance for Pollution Prevention: Vehicle Washing and Cleaning GPP 13 (Ref 9-31);
- Environment Agency (2020) Land Contamination Risk Management (LCRM) (Ref 9-32);
- Highways England (2019) Design Manual for Roads and Bridges (DMRB), LA 109: Geology and Soils (Ref 9-33);
- Highways England (2020) Design Manual for Roads and Bridges (DMRB), LA 113 Road drainage and the Water Environment (Ref 9-34);
- British Standard (2015) BS 5930:2015 Code of Practice for Ground Investigations (A1:2020) (Ref 9-35);

- British Standard (2011) BS10175:2011 A2: 2017 Investigation of potentially contaminated sites – code of practice (Ref 9-36); and
- Environment Agency (2018) The Environment Agency’s approach to groundwater protection (Ref 9-37).

9.3 Scoping Opinion and Consultation

- 9.3.1 A scoping exercise was undertaken in early 2022 to establish the content of the geological and hydrogeological assessment and the approach and methods to be followed.
- 9.3.2 The Scoping Report (Ref 9-38) records the findings of the scoping exercise and details the technical guidance, standards, best practice and criteria to be applied in the assessment to identify and evaluate the likely significant effects of the Project on geological and hydrogeological receptors.
- 9.3.3 Following receipt of the Scoping Opinion (*PEIR Volume IV Appendix 5-2*), some requirements have been identified by the Planning Inspectorate which will be taken account of as part of the ongoing geology and hydrogeology assessment. These requirements are detailed in **Table 9-1**, along with comments raised by other stakeholders in the Scoping Opinion and an indication of whether the requirements / comments have been addressed now or will be as part of the subsequent Environmental Statement chapter.

Table 9-1: Summary of EIA Scoping Opinion in relation to Geology and Hydrogeology

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
Planning Inspectorate Section 9.6	Assessment of radiation	The Inspectorate accepts that, based on the nature of the Proposed Development, significant effects from radiation emissions are unlikely and agrees that this can be scoped out of the ES.	No response required.
Planning Inspectorate Section 11.6, Table 11-13	Potential effects	In addition to the identified matters Proposed to be assessed, the ES should include an assessment of the likely significant effects of artesian groundwater conditions, and the presence of unique groundwater features (e.g., blow wells, chalk streams and springs), where these could occur.	The assessment of effects to groundwater, including unique groundwater features, will be covered within the Environmental Statement (ES) chapter "Geology and Hydrogeology". Where these groundwater features may result in a significant effect to surface water features these will be addressed within the Water Environment chapter of the ES. Based on a preliminary review of BGS borehole records, surface water features near the coast may be fed by, or in hydraulic connectivity with groundwater.
Planning Inspectorate Paragraph 9.2.12	Water Framework Directive (WFD) groundwater bodies	The Scoping Report identifies two WFD groundwater bodies. The ES should address any potential for impacts on these features to impact on surface water receptors, and the implications for the requirements of the WFD. Cross reference to the proposed Water Environment chapter of the ES and any separate WFD assessment produced should be provided where necessary.	A preliminary review indicates that the status of the quantitative dependent surface water body for the North Lincolnshire Chalk Unit is classified as 'poor' and the status for the South Lincolnshire Chalk Unit is classified as 'good'. The effects on each groundwater body will be assessed as part of the ES chapter and any secondary impacts on surface waters will be assessed and reported in the Water Environment Chapter.

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
Planning Inspectorate Table 9-5	Location of brownfield sites	Table 9-5 states that "According to North Lincolnshire Council data there are no brownfield sites within 500m of the Scoping Boundary". It is not clear what definition is used to define Brownfield sites. In the case that this specifically refers to sites designated under part II(a) of the Environmental Protection Act 1990, the Inspectorate considers that the potential exists for non-designated brownfield sites, or other areas subject to contamination of land or controlled waters, to exist within the study area. The ES should consider the potential effects to and from all possible sources of contamination identified within the baseline data.	Noted, this will be undertaken as part of the ES chapter. Groundsure environmental data have been obtained to determine current and historical industrial potentially contaminative land uses, with these primarily identified around Immingham at the start of the draft order limits. Information requests have been submitted to all relevant local councils on 10 August 2022.
Planning Inspectorate Paragraph 9.5.3	Effects on foundations and the main pipeline construction	<p>Bullet points 2, 3 and 4 of section 9.5.2 relate to the potential effects on soil quality including substructure damage, compaction and waterlogging. Bullet point 8 relates to the possibility of encountering Unexploded Ordnance (UXO).</p> <p>The Inspectorate considers that overlap exists for these matters with other environmental aspect assessments, namely Agriculture and Soils, Water Environment, and Major Accidents and Disasters. The ES should explain the matters to be addressed in each of these chapters and clearly set out where these matters interact.</p>	Noted, the geology and hydrogeology assessment will consider the chemical effects on foundations and the main pipeline construction only, which will be undertaken as part of the ES chapter. The potential effects of substructure damage and compaction will be assessed in <i>Chapter 10: Agriculture and Soils</i> . The potential effects of waterlogging will be assessed in <i>Chapter 11: Water Environment</i> . The potential effects of encountering UXO will be assessed in <i>Chapter 20: Major Accidents and Disasters</i> .
Planning Inspectorate Paragraph 9.5.4	Decommissioning effects	It is noted that the specific decommissioning methodology is not known at this stage, including whether or not the pipeline could be removed. Given this, the Inspectorate considers that the identified potential effects from the construction phase	Noted, the identified potential effects from the construction phase could all be relevant to the decommissioning phase and the

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
		<p>could all be relevant to the decommissioning phase considering the likelihood that working methods would be similar.</p> <p>The ES should assess all possible likely significant effects during the decommissioning phase.</p>	<p>effects will be assessed as such as part of the ES chapter.</p>
Anglian Water	Mitigation discussions relating to abstractions	<p>At page 136, 9.5.2 the report refers to groundwater and disturbance and pathways to sensitive surface and groundwater receptors including aquifers and abstractions. Anglian Water requests that where investigation work (9.5.7) identify risks through surface water and groundwater to water sources including abstractions that we are included in design and mitigation discussions with the Environment Agency. The report advises (9.7.2) that there are a number of Source Protection Zones within the site. We note that the summary (9.7.3) advises that during construction there are potential limited effects on human health and infrastructure.</p>	<p>Noted, please note we have included this request for mitigation measures in section 9.6</p>
East Lindsay District Council	Aquifers and private borehole water supplies.	<p>The EIA should assess the location and potential impact on the District's aquifers and private borehole water supplies.</p>	<p>Noted, location details have been requested from all relevant local councils on 10 August 2022 as detailed in Table 9-2. This information will be incorporated into the full assessment and presented in the ES chapter.</p>
Environment Agency	Errors in Hydrogeological Classifications	<p>Groundwater Quality & Resource Protection Table 9-4 Other Hydrogeological Classifications contains several errors, which need to be corrected as follows:</p> <ul style="list-style-type: none"> • Section A: SPZ1 reference to Aylesbury is incorrect – this 	<p>Sections now renamed as Sections 1 to 5; the section breaks have also been amended since the Scoping Report. Table 9-10 Other Hydrogeological Classifications has been</p>

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
		<p>should be Aylesby.</p> <ul style="list-style-type: none"> • Section B: safeguard zone GWSGZ0283 is also present in this section. • Section C and D: SPZ 2 Outer Protection Zone represents Tetney and Fulstow, not North Thoresby. • Section D: Total Catchment SPZ – doesn't represent Covenham St Bartholomew but merged GW public water supply abstractions in the area. • Sections A-C: NVZ of relevance to hydrogeology is the groundwater NVZ not surface water – G80 (Lincs Chalk). This has not been referenced. 	<p>updated to reflect the required changes as part of this assessment.</p>
	<p>Protection designations</p>	<p>Although protection designations have been identified in Table 9-4, there is no discussion as to how these will be used to target mitigation measures; we presume this will become more evident in the full EIA.</p>	<p>Yes, this will be included in the EIA and reported in the ES.</p>
	<p>Dewatering scheme</p>	<p>Section 9.5.8 states that more detailed hydrogeological risk assessments are to be undertaken for trenchless crossings or where dewatering is required. A dewatering scheme will be developed prior to construction in consultation with the Environment Agency. We welcome the confirmation that we will be consulted on all hydrogeological risk assessments, as suggested, particularly for trenchless crossings; every care should be taken to avoid reaching the underlying principal chalk aquifer bedrock to mitigate against potential impacts and issues with water resources, for example artesian flow.</p>	<p>Noted, the EA will be consulted regarding further assessments.</p>
	<p>Guidance</p>	<p>There is no reference made to the 'Environment Agency's approach to groundwater protection' or relevant Groundwater</p>	<p>Noted, guidance updated within this preliminary assessment in section 9.2 and</p>

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
		Protection Position Statements, in particular section C. We recommend that this guidance should be followed.	included in mitigation measures in section 9.6.
	Guidance	Land Affected by contamination There is little reference made to our Land Contamination: Technical Guidance. We recommend that this guidance should be followed. Reference should also be made to British Standards BS 5930:1999 A2:2010 code of practice for site investigations and BS10175:2011 A1: 2013 Investigation of potentially contaminated sites – code of practice.	Noted, guidance updated within section 9.2 and throughout the preliminary assessment.
	Consultation	We welcome the confirmation that we will be consulted prior to any remedial strategy being put into place.	Noted, the EA will be consulted regarding further assessments.
	Contaminated sites	Several potentially contaminated sites have been identified, and there is the potential for heterogeneity in ground conditions. As such we would suggest that if, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the local planning authority) shall be carried out until the developer has submitted a remediation strategy (to the local planning authority) detailing how this unsuspected contamination shall be dealt with. We will ask for this to be made a Requirement within the Development Consent Order and to be a consultee to its discharge.	Noted. Groundsure environmental data has been obtained to determine current and historical industrial potentially contaminative land uses, and information requests have been submitted to all relevant local councils on 10 August 2022. An inspection and discovery strategy has been included within the proposed mitigation measures.
Lincolnshire County Council	Information from LCC	At paragraph 9.2.10 states that no mineral safeguarding information is available from the County Council. This is not the case and contact should be made with the County	Noted, Minerals and Waste plan reviewed and information updated as per section 9.5.18.

Section Reference to Scoping Opinion	Applicant's Proposed Matter	Planning Inspectorate / Prescribed Consultee Comments	Response
		Council to obtain this information to ensure this issue has been addressed before the ES is produced.	
Mablethorpe & Sutton Town Council	Geological disposal facility	The impact of any future proposed geological disposal facility at the same location be factored into any agreed route/scheme.	Noted this will be considered as part of the Cumulative Effects within the ES.
North Lincolnshire Council	Phase 1 report	North Lincolnshire Council agree that a Phase 1 report in respect of land contamination should be submitted with any future application and depending on the findings, a Phase 2 report may be required.	A standalone Phase 1 report will not be produced but the assessment normally undertaken in the Phase 1 report will be provided in the ES chapter. If required Phase 2 assessment would be undertaken as part of detailed design.

Consultation

9.3.4 **Table 9-2** provides a summary of the engagement undertaken to inform the assessment to date. If deemed necessary following initial responses from the below stakeholders, further consultation will be undertaken to support the ES chapter.

Table 9-2: Summary of Engagement Undertaken

Consultee	Date and method of engagement	Summary of engagement
Environment Agency	<p>Contacted via email on 29/04/2022</p> <p>Response received via email on 06/06/2022</p>	<p>Requested information relating to:</p> <ul style="list-style-type: none"> • Licensed water abstractions information; • Active discharge consents; • Details of category 3 or worse pollution incidents for water courses; and • Hydraulic head levels, boreholes, abstractions, water quality and issues concerning the groundwater for the Lincolnshire Chalk Aquifer. <p>Response provided required information for the Lincolnshire and Northamptonshire area, awaiting response to confirm whether there are data available within the buffer area surrounding the northern half of the Draft Order Limits.</p>
	<p>Contacted via email on 10/08/2022 and 29/08/2022</p>	<p>Requested information relating to:</p> <ul style="list-style-type: none"> • Records of public and private abstractions information; • Records relating to water quality, both surface and groundwater, in regard to any physical/chemical data as per the Water Framework Directive (WFD)/River Basin Management Plans (RBMP); and • Records of any historic/current monitoring locations. <p>Awaiting Response.</p>
North Lincolnshire Council	<p>Contacted via email on 10/08/2022</p> <p>Response received via email on 05/09/2022</p>	<p>Requested information relating to:</p> <ul style="list-style-type: none"> • Pollution incidents, spills, accidents or other regulatory actions; • Records of any sites which feature Part A(2) or Part B Processes regulated by the council under the Environmental Permitting Regulations 2018; • Records on previous ground investigations and or known remediation schemes (relating to soil and groundwater) that have taken place; • Records of private and public water abstractions;

Consultee	Date and method of engagement	Summary of engagement
		<ul style="list-style-type: none"> Records of regionally important geological sites (RIGS), Local Geological Sites and quarrying/mining sites; Records of Mineral safeguarding information; Records relating to water quality, both surface and groundwater, in regard to any physical/chemical data as per the Water Framework Directive (WFD)/River Basin Management Plans (RBMP); Records of any historic/current monitoring locations; Records of information relating to natural background contamination e.g., naturally occurring elevated concentrations of metals in soils, areas of known ground gas production and radon; and Any information on licenced waste operations or historic landfill sites (either operated by the Local Planning Authority (LPA) or other historical landfills). <p>Response provided required information which will be assessed as part of the ES chapter.</p>
North East Lincolnshire Council	<p>Contacted via email on 10/08/2022</p> <p>Response received via email on 08/09/2022</p>	<p>Same information requested as listed under North Lincolnshire Council.</p> <p>Response provided required information which will be assessed as part of the ES chapter.</p>
West Lindsey District Council	<p>Contacted via email on 10/08/2022</p> <p>Response received via email on 09/09/2022</p>	<p>Same information requested as listed under North Lincolnshire Council.</p> <p>Response provided required information which will be assessed as part of the ES chapter.</p>
East Lindsey District Council	<p>Contacted via email on 10/08/2022</p>	<p>Same information requested as listed under North Lincolnshire Council.</p> <p>Awaiting Response.</p>

9.4 Assessment Method

Study Area and Desk Study

9.4.1 The Study Area and Desk Study sources used to inform the geology and hydrogeology assessment are presented in section 9.5.

Assessment Methodology

- 9.4.2 The baseline and potential effects have been established through the desk study and the project description (*Chapter 3: The Viking CCS Pipeline*). Utilising this information and consultation with statutory consultees undertaken to date, a combination of qualitative and quantitative risk assessment have been undertaken to preliminarily assess the potential effects of the existing ground conditions on the Project, and the potential effects of the Project on the Geology and Hydrogeology.
- 9.4.3 In relation to ground contamination, the risk assessment has been based on the source-pathway-receptor methodology outlined in Land Contamination Risk Management (LCRM) (Ref 9-32) and promoted by Defra and the EA. For there to be an identifiable risk, not only must there be contaminants present on the site (source) there must also be a receptor and a viable pathway which allows the source to impact on the receptor.
- 9.4.4 The general assessment methodology used for the PEIR is summarised in *Chapter 5: PEIR Assessment Methodology*. However, the preliminary assessment of the significance of the potential effects on geology and hydrogeology has been based on guidance in the Design Manual for Roads and Bridges (DMRB) LA 109 Geology and Soils (geology) (Ref 9-33) and LA 113 Road Drainage and the Water Environment (groundwater) (Ref 9-34) and will be for the ES chapter assessment. There is no specific guidance in relation to CO₂ transportation schemes for assessing geology and hydrogeology. Therefore, DMRB has been used as it is considered to be the most appropriate methodology for the geology and hydrology assessment of the Project because it is designed for assessing effects on linear schemes (including ‘point’ features), albeit road schemes. It is also a well-established and tested methodology, familiar to the statutory consultees.

Sensitivity

- 9.4.5 The sensitivity of the receptor reflects the quality of receptor and its ability to absorb an effect without perceptible change. Sensitivity is defined in **Table 9-3**.

Table 9-3: Criteria to Determine the Sensitivity of Potential Effect to Receptors

Sensitivity / Value	Description / Criteria	Typical Examples
High	<p><u>Geology</u> Very rare and of international importance with no potential for replacement.</p> <p><u>Hydrogeology</u> Nationally significant attribute of high importance.</p>	<p><u>Geology</u> UNESCO World Heritage Sites; SSSIs of international importance; or Global Geoparks.</p> <p><u>Contamination</u> Very high sensitivity land use (e.g. residential).</p> <p><u>Hydrogeology</u> Principal aquifer providing a regionally important resource and/ or supporting site protected under European and UK habitat legislation; SPZ 1; or Groundwater locally supports Groundwater Dependent Terrestrial Ecosystem (GWDTE).</p>
Medium	<p><u>Geology</u> Rare and of national</p>	<p><u>Geology</u> SSSIs; or</p>

Sensitivity / Value	Description / Criteria	Typical Examples
	importance with little potential for replacement. <u>Hydrogeology</u> Locally significant attribute of high importance.	National Nature Reserves. <u>Contamination</u> High sensitivity land use (e.g. public open space). <u>Hydrogeology</u> Principal aquifer providing a locally important resource or supporting a river ecosystem; SPZ 2; or Groundwater supports Groundwater Dependent Terrestrial Ecosystem (GWDTE).
Low	<u>Geology</u> Of regional importance with limited potential for replacement. <u>Hydrogeology</u> Of moderate quality and rarity.	<u>Geology</u> RIGS. <u>Contamination</u> Medium sensitivity land use (e.g. commercial). <u>Hydrogeology</u> Aquifer providing water for agricultural or industrial use with limited connection to surface water; or SPZ 3.
Very Low	<u>Geology</u> Of local importance / interest with potential for replacement or little/ no local interest. <u>Hydrogeology</u> Lower quality.	<u>Geology</u> Non-designated geological exposures, former quarries / mining sites. No geological exposures. <u>Contamination</u> Low sensitivity land use (e.g. highways and rail); or No sensitive land use proposed. <u>Hydrogeology</u> Unproductive strata.

Magnitude

9.4.6 The magnitude of a potential effect considers the scale of the predicted change to the baseline condition taking into account its duration (i.e., the magnitude may be moderated by the effects being temporary rather than permanent, short term rather than long term). Definitions for effect magnitude are described in **Table 9-4**. It is unlikely that any effects on geology and soils will be beneficial, so the examples of magnitude all relate to adverse effects.

Table 9-4: Criteria to Determine the Magnitude of Receptors

Magnitude	Criteria	Typical Examples
High	<u>Geology</u> Loss of feature/ designation and/ or quality and integrity,	<u>Geology</u> Destruction of features at a protected site; i.e. SSSIs of international importance; or Global Geoparks. <u>Contamination</u>

Magnitude	Criteria	Typical Examples
	<p>severe damage to key characteristics.</p> <p><u>Hydrogeology</u> Loss of attribute and/or quality and integrity of the attribute.</p>	<p>Significant contamination identified; Contaminant concentrations significantly exceed background levels and relevant screening criteria; Potential for significant harm to human health; or Contamination heavily restricts future use of land.</p> <p><u>Hydrogeology</u> Loss of, or extensive change to, an aquifer; Loss of regionally important water supply; Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies; Reduction in water body WFD classification; or Loss or significant damage to major structures through subsidence or similar effects.</p>
Medium	<p><u>Geology</u> Partial loss of feature / designation, potentially adversely affecting integrity; partial loss of/damage to key characteristics, features or elements.</p> <p><u>Hydrogeology</u> Results in effect on integrity of attribute, or loss of part of attribute.</p>	<p><u>Geology</u> Partial loss of features at a protected site; i.e. SSSIs; National Nature Reserves.</p> <p><u>Contamination</u> Contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria; Significant contamination can be present; or Control/remediation measures are required to reduce risks to human health / make land suitable for intended use.</p> <p><u>Hydrogeology</u> Partial loss or change to an aquifer; Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies; Partial loss of the integrity of GWDTE; Contribution to reduction in water body WFD classification; or Damage to major structures through subsidence or similar effects or loss of minor structures.</p>
Low	<p><u>Geology</u> Minor measurable change in geological feature / designation</p>	<p><u>Geology</u> Minor measurable change of features at Geological sites; i.e. RIGS</p> <p><u>Contamination</u></p>

Magnitude	Criteria	Typical Examples
	<p>attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.</p> <p><u>Hydrogeology</u> Results in some measurable change in attributes, quality or vulnerability.</p>	<p>Contaminant concentrations are below relevant screening criteria; Significant contamination is unlikely with a low risk to human health; or Best practice measures can be required to minimise risks to human health.</p> <p><u>Hydrogeology</u> Minor effects on an aquifer, GWDTs, abstractions and structures.</p>
Very Low	<p><u>Geology</u> Very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature / designation. Overall integrity of resource not affected.</p> <p><u>Hydrogeology</u> Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.</p>	<p><u>Geology</u> Very minor change of features at sites of local importance, i.e. non-designated geological sites.</p> <p><u>Contamination</u> Contaminant concentrations substantially below relevant screening criteria; or No requirements for control measures to reduce risks to human health/make land suitable for intended use.</p> <p><u>Hydrogeology</u> No measurable impact upon an aquifer and/or groundwater receptors.</p>

Significance

- 9.4.7 The significance of environmental effect is typically a function of the sensitivity of a receptor and the magnitude of an impact. Effects can be beneficial, adverse or negligible and their significance Major, Moderate, Minor or Negligible.
- 9.4.8 For the purposes of this preliminary assessment, effects have been assessed to be either 'Not Significant' or 'Significant'. A more detailed consideration of the level of effect anticipated will be undertaken for and reported in the ES.

Assumptions and Limitations

- 9.4.9 To ensure transparency within the EIA process, the following limitations and assumptions have been identified:
 - The assessment will rely on available data, and reasonable endeavours will be made to ensure that the data is accurate and up to date, however the accuracy of third-party information cannot be confirmed;
 - Assessments will be limited by availability of design information, specifically in relation to below ground structures (i.e., depth of piles/foundations, pipe/ tunnel invert levels);

- It is recognised that ground contamination may be present at one of the options for the proposed Theddlethorpe Facility at TGT, but it is assumed that by the time of construction this area within the Draft Order Limits will have been fully remediated, with mitigation in place to avoid disturbing remedial works;
- If remedial works are required at the proposed Immingham Facility, it is assumed remediation will have occurred prior to construction; and
- Assumed a ground investigation will be undertaken to inform the detailed design stage.

9.5 Baseline Environment and Study Area

Study Area

- 9.5.1 The Study Area for the PEIR of the geology and hydrogeology assessment is 250m either side of the Draft Order Limits. Interaction between the Project and receptors or sources of contamination beyond 250m would generally not occur as a result of the ground conditions present in and around the Project, as a viable pathway between source and receptor is less likely to be present over this distance.
- 9.5.2 The receptors and sources of contamination have been identified within the Draft Order Limits. Where relevant for specific subtopics, such as groundwater SPZs, the Study Area extends to 500m either side of the Draft Order Limits.

Desk Study

- 9.5.3 Baseline conditions of the Study Area were established during a desk study using the following sources:
- Google Maps and Aerial Imagery (Ref 9-39);
 - Groundsure Report (Ref 9-40);
 - MAGIC.gov.uk (DEFRA) (Ref 9-41);
 - British Geology Survey (BGS) Online Viewer (Geo-Index) (Ref 9-42);
 - Zetica UXO Risk Maps (Ref 9-43);
 - The Coal Authority (Ref 9-44); and
 - UKradon (UK Health Security Agency) (Ref 9-45).

Site Visits and Surveys

- 9.5.4 Geology and hydrogeology surveys will be undertaken to support the full assessment which will be presented in the ES. Surveys are anticipated to focus on the Immingham area of the Draft Order Limits and the Immingham Facility, with some short visits to other areas of interest along the pipeline route, and will comprise site reconnaissance with a series of photographs taken. The surveyor will assess whether any other potentially contaminative land uses may be present that have not been identified during the desktop assessment.

Existing Baseline

- 9.5.5 The Draft Order Limits have been separated into five sections as stated within *Chapter 3: The Viking CCS Pipeline*. The sections can be defined as the following:
- Section 1 – Rosper Road, Immingham to A180;
 - Section 2 – A180 to A46;

- Section 3 – A46 to Pear Tree Lane;
- Section 4 – Pear Tree Lane to B1200 (Manby Middlegate); and
- Section 5 – B1200 (Manby Middlegate) to Theddlethorpe Reception Facility and down to MLWS.

9.5.6 There are two options being considered for the Theddlethorpe Facility, Option 1 at the former Theddlethorpe Gas Terminal (TGT) and Option 2, to the west of the former TGT site.

9.5.7 The following sub-sections provide a summary of the existing ground conditions within the Study Area, based on the sources of information identified in Section 9.5.3.

Soils

9.5.8 The effects of the Project on the agricultural quality of soils are considered in *Chapter 10: Agriculture and Soils*.

Geology

9.5.9 Published geological maps and the GIS data sourced from the BGS (Ref 9-42 and Ref 9-46 to Ref 9-51) indicate that the Project is underlain by the geological succession summarised below in **Table 9-5**. Geological mapping for the Project is shown as **Figure 9-1** and **Figure 9-2**.

Table 9-5: Summary of Geology from BGS 1:50,000 mapping

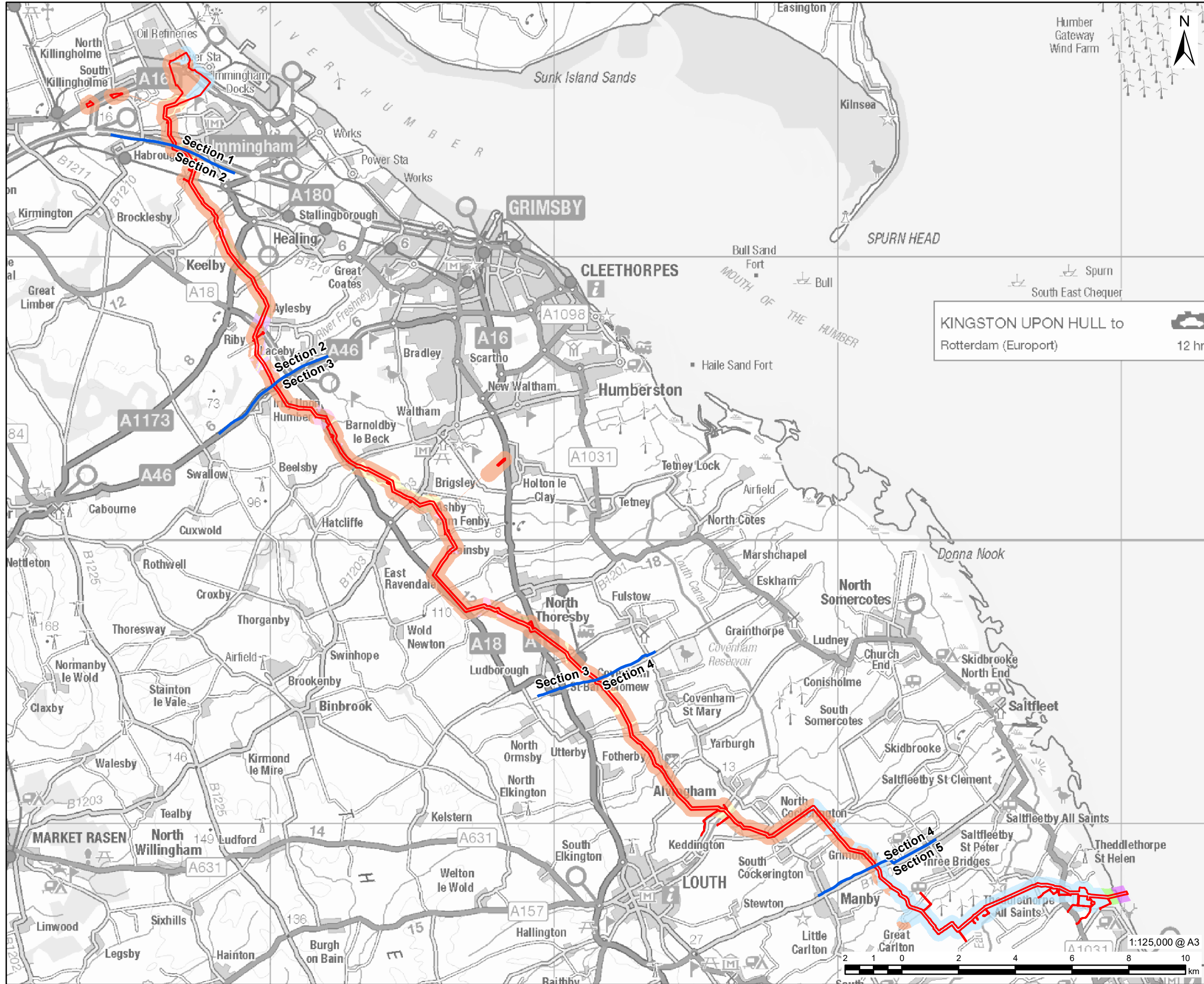
Section	Stratum Type	Description
1:50,000 Scale BGS Map Sheets 80, 81, 90, 103 and 104		
Section 1	Made Ground	There is an area of Artificial Ground located within the Draft Order Limits. Although Made Ground / Artificial Ground is only formally mapped along the east of Section 1 (around Immingham Docks), it is anticipated that most of this section will be underlain by Made Ground due to historical and current industrial use, including the VPI Immingham and P66 sites.
	Superficial	The majority of this Section is indicated to be underlain by Till, Devensian deposits which comprise Diamicton. In addition, there are also localised areas of Tidal Flat deposits, comprising of Clay and Silt along the north of the Draft Order Limits (and along the north and east of the Immingham Facility) and Alluvium comprising of Clay, Silt, Sand and Gravel immediately north of the A180 at Section Break 1.
	Bedrock	The whole Section is underlain by Chalk of the Burnham Chalk Formation.
Section 2	Made Ground	No Artificial Ground within the Draft Order Limits however, there is a small area of Artificial Ground within the wider Study Area, located east of Riby.
	Superficial	The majority of this Section is underlain by Till, Devensian deposits. However, there are localised areas of Alluvium, Lacustrine Deposits (Sand, Silt and Clay), Glaciofluvial

Section	Stratum Type	Description
		Sheet Deposits (Sand & Gravel) and Glaciofluvial deposits (Sand & Gravel), particularly around Aylesby and Laceby. There are a several small areas towards the south of this Section where there are no superficial deposits.
	Bedrock	The majority of the Section is underlain by chalk of the Burnham Chalk Formation with the exception of a thin band of chalk of the Welton Chalk Formation immediately east of Laceby.
Section 3	Made Ground	No Artificial Ground within the Draft Order Limits however, there is a small area of Artificial Ground within the wider Study Area, located southwest of North Thoresby.
	Superficial	The majority of this Section is underlain by Till, Devensian deposits. However, there are localised areas of Alluvium (particularly north west of Ashby cum Fenby), Lacustrine Deposits (Sand, Silt and Clay) and Glaciofluvial deposits (Sand & Gravel) (particularly southeast of Irby Upon Humber).
	Bedrock	The majority of the Section is underlain by chalk of the Welton Chalk Formation with the exception of the Draft Order Limits between the A46 and Welbeck Hill and to the southwest of Brigsley where the geology comprises of Burnham Chalk Formation.
Section 4	Made Ground	Not indicated on Groundsure mapping.
	Superficial	The majority of this Section is underlain by Till, Devensian deposits. However, there are localised areas of Alluvium, Lacustrine Deposits (Sand, Silt and Clay) and Glaciofluvial deposits (Sand & Gravel). There are also sections of Tidal Flat deposits between North Cockerington and the B1200.
	Bedrock	The majority of the Section is underlain by chalk of the Welton Chalk Formation with the exception of an area comprising chalk of the Ferriby Chalk Formation within the middle of this Section.
Section 5	Made Ground	Not indicated on Groundsure mapping.
	Superficial	The majority of this Section is underlain with Tidal Flat deposits. There is a small area of Till at the northern most point of the Section, and near Great Carlton, and then a band of Blown Sand (Sand), Storm Beach Deposits (Sand) and Beach and Tidal Flat Deposits (Clay, Silt and Sand) at the end of the Section along the coast.
	Bedrock	The first half of this section is underlain by chalk of the Welton Chalk Formation until Great Carlton where the Draft Order Limits extend to the east and bedrock changes to chalk of the Burnham Chalk Formation.

Section	Stratum Type	Description
<i>Source: References Ref 9-42, and Ref 9-46 to Ref 9-51</i>		

Previous Ground Investigation

9.5.10 BGS Geo-Index online resources (Ref 9-49) record ground investigation data from many boreholes drilled within and surrounding the Study Area. The number of boreholes within each section of the route is detailed in Summary of BGS Geo-Index Boreholes **Table 9-6**. The strata encountered in these exploratory locations generally correlate with information obtained from BGS mapping data. Strata encountered are summarised below in **Table 9-7**. **Figure 9-3** shows the locations of the BGS boreholes within the Study Area and further data is tabulated in *PEIR Volume IV - Appendix 9-1*.



LEGEND

- Draft Order Limits
- Route Section Break

Superficial Geology 50k (BGS)

- Alluvium - Clay, Silt, Sand and Gravel
- Beach and Tidal Flat Deposits (Undifferentiated) - Clay, Silt and Sand
- Blown Sand - Sand
- Glaciofluvial Deposits, Devensian - Sand and Gravel
- Glaciofluvial Sheet Deposits, Devensian - Sand and Gravel
- Lacustrine Deposits - Sand, Silt and Clay
- Storm Beach Deposits - Sand
- Tidal Flat Deposits - Clay and Silt
- Till, Devensian - Diamicton

KINGSTON UPON HULL to Rotterdam (Europort) 12 hrs

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FIGURE TITLE

Figure 9-1 Superficial Geology

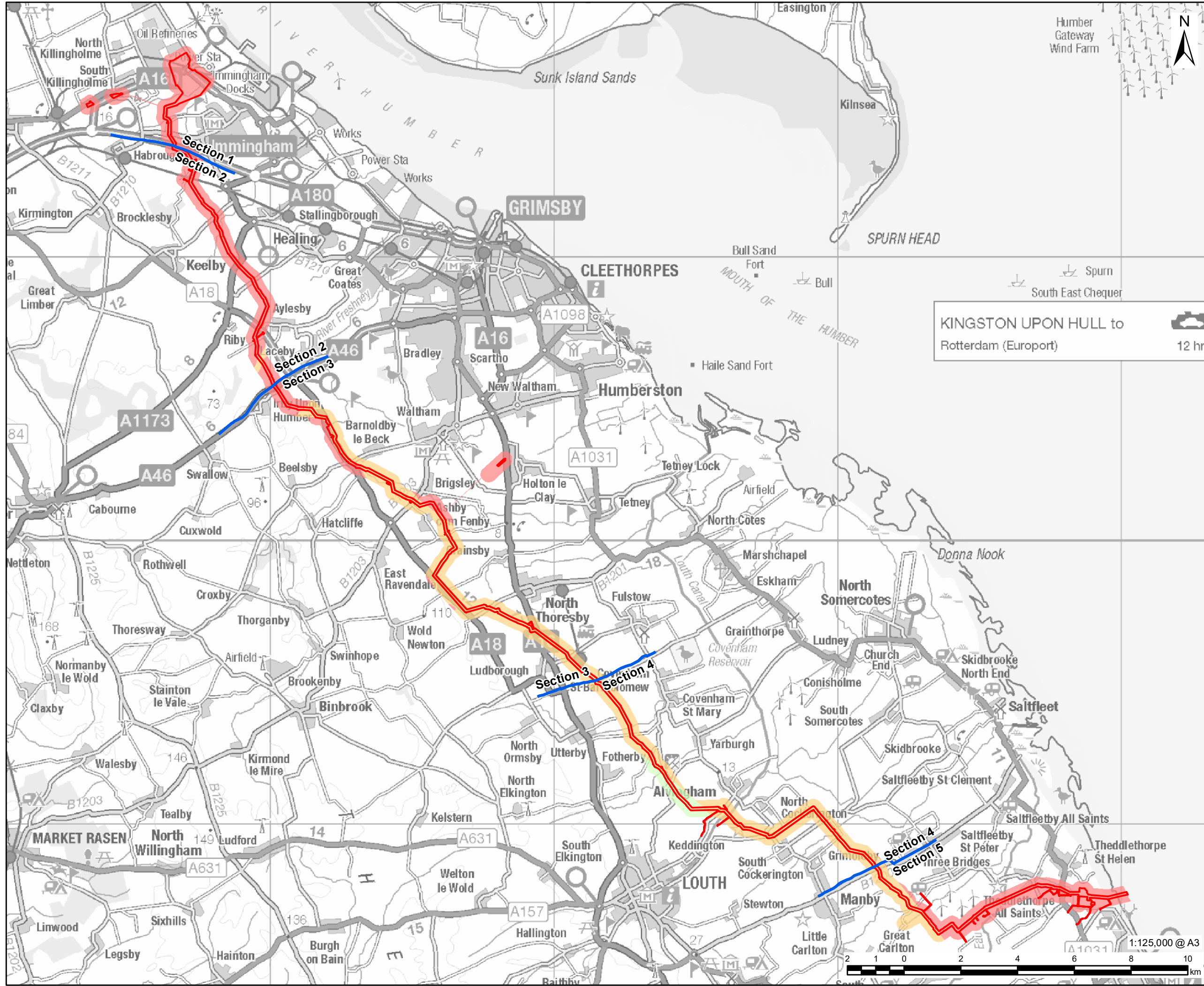
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PROJECT NUMBER / REFERENCE

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VikingCCS

AECOM

PROJECT
Viking CCS Pipeline

LEGEND

- Draft Order Limits
- Route Section Break

Bedrock Geology 10k (BGS)

- Burnham Chalk Formation - Chalk
- Ferriby Chalk Formation - Chalk
- Welton Chalk Formation - Chalk

KINGSTON UPON HULL to Rotterdam (Europort) 12 hrs

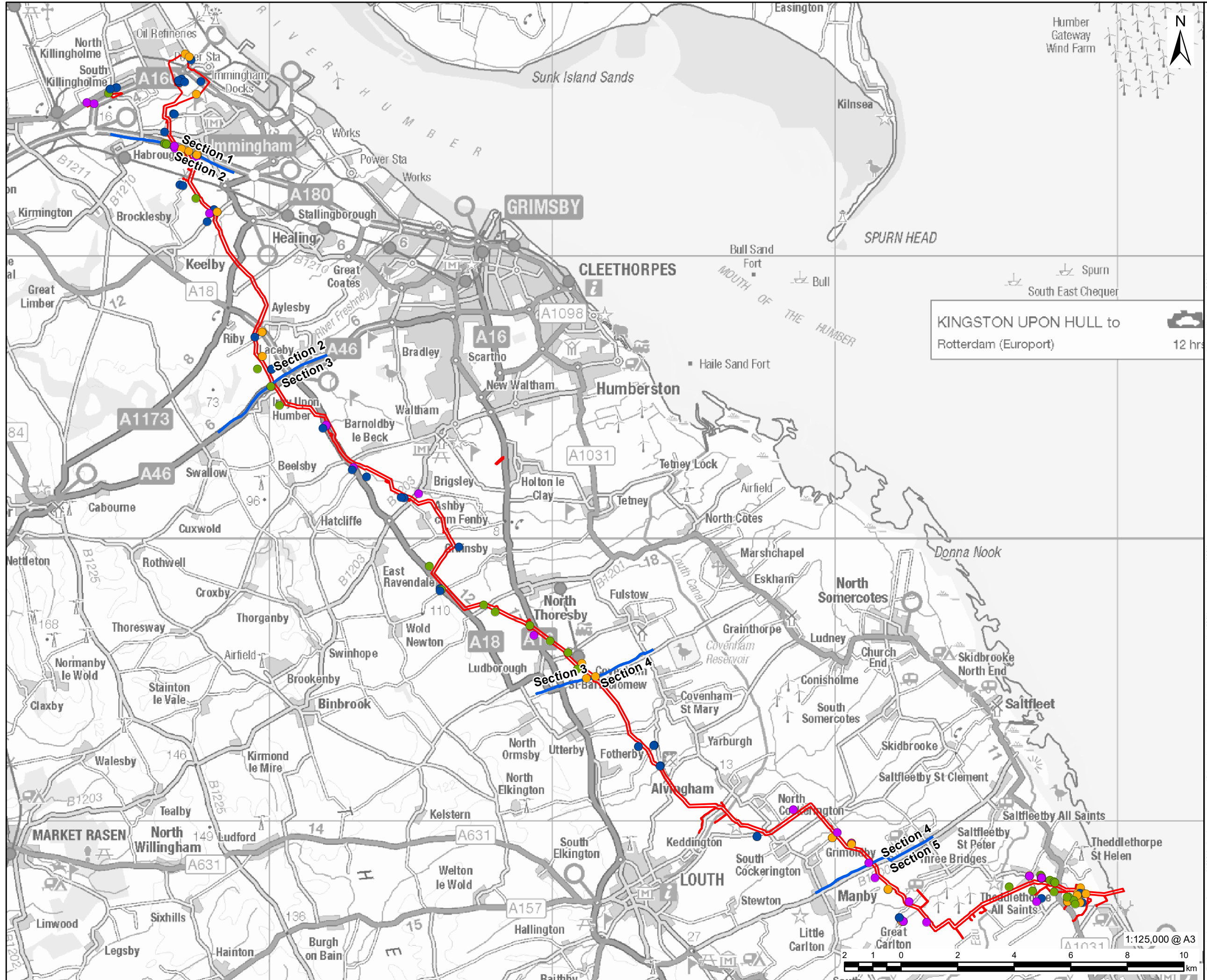
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FIGURE TITLE
Figure 9-2 Bedrock Geology

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LEGEND

- Draft Order Limits
- Route Section Break
- British Geological Survey (BGS) Borehole
 - 10m - 30m
 - Confidential
 - Greater than 30m
 - Less than 10m

KINGSTON UPON HULL to Rotterdam (Europort) 12 hrs

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FIGURE TITLE
Figure 9-3
British Geological Survey Boreholes

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Table 9-6: Summary of BGS Geo-Index Boreholes

Section	BGS Boreholes
Section 1	19 No. existing boreholes within the Study Area.
Section 2	27 No. existing boreholes within the Study Area.
Section 3	26 No. existing boreholes within the Study Area.
Section 4	16 No. existing boreholes within the Study Area.
Section 5	48 No. existing boreholes within the Study Area.

Table 9-7: Summary of BGS Geo-Index Borehole Geology

Stratum Type	Description
Artificial / Made Ground	Within Section 1 Made Ground deposits are shown to generally comprise stiff to firm, yellow / grey silty CLAY with evidence of anthropogenic materials. The origin for the described material is assumed to be re-worked Glacial Till.
Superficial	Tidal Flat Deposits: Soft to very soft dark grey silty organic CLAY. Glacial Till: Firm to stiff slightly fissured grey brown slightly gravelly CLAY. Glaciofluvial Deposits: Medium dense orange brown slightly silty fine to medium SAND. Alluvium: Soft to firm sandy gravelly CLAY with localised silt. Lacustrine Deposits: Soft to firm laminated slightly sandy silty CLAY.
Bedrock	Welton Chalk Formation: Hard white thickly bedded CHALK with common flint nodules. Burnham Chalk Formation: White thinly bedded CHALK with common discontinuous flint bands and sporadic marl seams.

Geological Sites of Special Scientific Interest and Regionally Important Geological Sites

- 9.5.11 A review of currently available information on MAGIC.gov.uk and relevant searches with local councils, did not identify any geological Sites of Special Scientific Interest (SSSI), Regionally Important Geological Sites (RIGS) or Local Geological Sites within the Draft Order Limits. Further information on RIGS and Local Geological Sites has been requested from the relevant local councils (see **Table 9-2**) and will be included within the Environmental Statement (ES) where provided.

Sensitive Land Uses

9.5.12 A review of publicly available data and the Groundsure data has identified several sensitive land uses, all of which are at the end of Section 5 where the Draft Order Limits extend to Mean Low Water Springs (MLWS). Further information can be seen in **Table 9-8**.

Table 9-8: Sensitive Land Uses

Section of Draft Order Limits and wider Study Area	Sensitive Land Use
Sections 1	None.
Section 2	None.
Section 3	Area of Outstanding Natural Beauty (AONB): <ul style="list-style-type: none"> Lincolnshire Wolds.
Section 4	None.
Section 5	Greater Wash: <ul style="list-style-type: none"> Special Protection Area. Saltfleetby Dunes – Theddlethorpe: <ul style="list-style-type: none"> SSSI; SAC; SPA; and National Nature Reserve. Humber Estuary: <ul style="list-style-type: none"> RAMSAR site.

Coal Mining and Shallow Mining

9.5.13 The Coal Authority online interactive map (Ref 9-44) and the Groundsure data (Ref 9-40) indicates that the Draft Order Limits are not within a Coal Mining Reporting Area or Development High Risk Area. The Coal Authority also confirmed this in their Scoping Opinion response. However, there is a Coal Mining Reporting Area immediately bordering the site along the east coast which is within the Study Area. Therefore, a Consultants Coal Mining Report (*PEIR Volume IV - Appendix 9-2*) was undertaken, though this identified no issues.

Mineral Sites and Designations

9.5.14 The effects of the Project on waste and materials are preliminarily assessed in *Chapter 18: Materials and Waste*.

9.5.15 Review of publicly available records suggest that the Draft Order Limits are governed by three mineral planning authorities.

- 9.5.16 North Lincolnshire Council are the authority for the most northerly section of the Draft Order Limits within Section 1. There are no mineral safeguarding areas or active extraction sites present within 500m of the Draft Order Limits within this area.
- 9.5.17 North East Lincolnshire Council are the mineral planning authority for Section 2 to Section 3 of the Draft Order Limits. Several mineral safeguarding areas for Sands and Gravels have been identified within the Draft Order Limits, predominantly between Riby and Grainsby; reference is made to NELC Local Plan 2013-2032. There are no active extraction sites with 500m of the Draft Order Limits.
- 9.5.18 Lincolnshire County Council is the authority for the remainder of the Draft Order Limits (where East Lindsey and West Lindsey District Councils are part of the Lincolnshire County Council Mineral Planning authority). The Lincolnshire Minerals and Waste Local Plan (2016) (Ref 9-52) has identified no active extraction sites or mineral safeguarding areas within 500m of the Draft Order Limits.

Hydrogeology - Aquifer Classifications

- 9.5.19 Aquifer classification maps on Defra’s ‘MAGIC’ mapping portal and from the Groundsure report (Ref 9-40 and Ref 9-41) indicate the following aquifer classifications are present underlying the Draft Order Limits (**Table 9-9** and **Figures 9-4** and **9-5**).

Table 9-9: Summary of Aquifer Classifications

Stratum Type	Stratum	Aquifer Classification	Definition (Environment Agency)	Section within Draft Order Limits
Superficial	Tidal Flat Deposits	Unproductive	Unproductive strata are largely unable to provide usable water supplies and are unlikely to have surface water and wetland ecosystems dependent on them.	Sections 1, 4 and 5
	Glacial Till	Secondary (Undifferentiated)	Secondary undifferentiated are aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the unit type. These have only a minor value.	All sections
	Beach and Tidal Flat Deposits	Secondary (Undifferentiated)		Section 5
	Glaciofluvial Deposits	Secondary A	Secondary A aquifers comprise permeable layers that can support local water supplies and may form	Sections 2, 3 and 4
	Glaciofluvial Sheet Deposits	Secondary A		Section 2

Stratum Type	Stratum	Aquifer Classification	Definition (Environment Agency)	Section within Draft Order Limits
	Alluvium	Secondary A	an important source of base flow to rivers.	Sections 1, 2, 3 and 4
	Blown Sand	Secondary A		Section 5
	Storm Beach Deposits	Secondary A		Section 5
	Lacustrine Deposits	Secondary B	Secondary B aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers	Sections 2, 3 and 4
Bedrock	Welton Chalk Formation	Principal	Principal aquifers provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands.	Sections 2, 3, 4 and 5
	Burnham Chalk Formation			Sections 1, 2, 3 and 4
	Ferriby Chalk Formation			Section 4

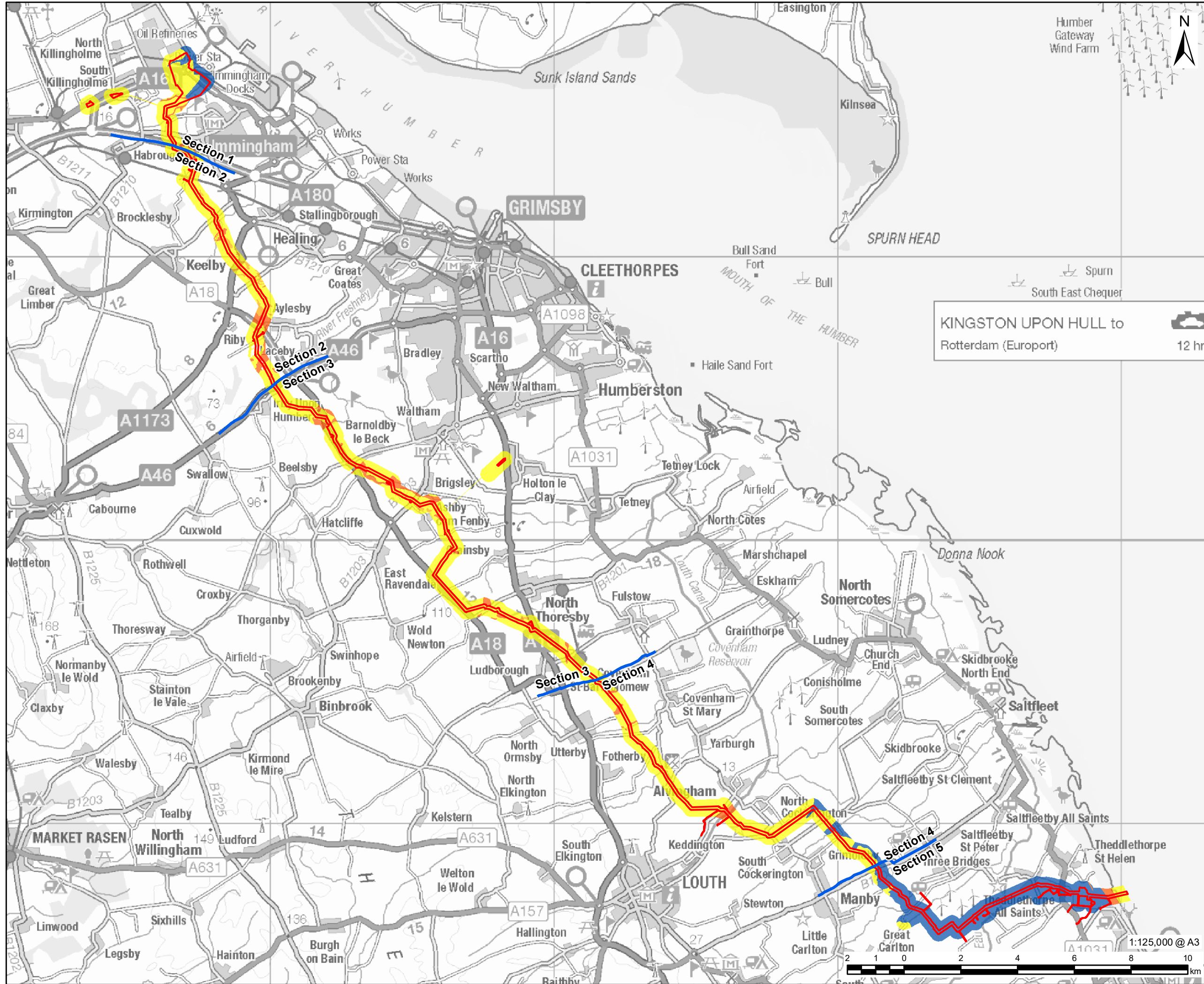
Water Framework Directive Groundwater Bodies

9.5.20 The following two Water Framework Directive (WFD) groundwater bodies have been identified within the Draft Order Limits:

- North Lincolnshire Chalk Unit; and
- South Lincolnshire Chalk Unit.

Other Hydrogeological Classifications and Features

9.5.21 The following additional hydrogeological classifications and features have been identified and are summarised in **Table 9-10** below. **Figure 9-6** shows the SPZ within the Study Area.



- LEGEND**
- Draft Order Limits
 - Route Section Break
- Superficial Aquifer Deposits (BGS)
- Secondary Superficial Aquifer - Undifferentiated
 - Secondary A Superficial
 - Secondary B Superficial Aquifer
 - Unproductive Superficial Aquifer

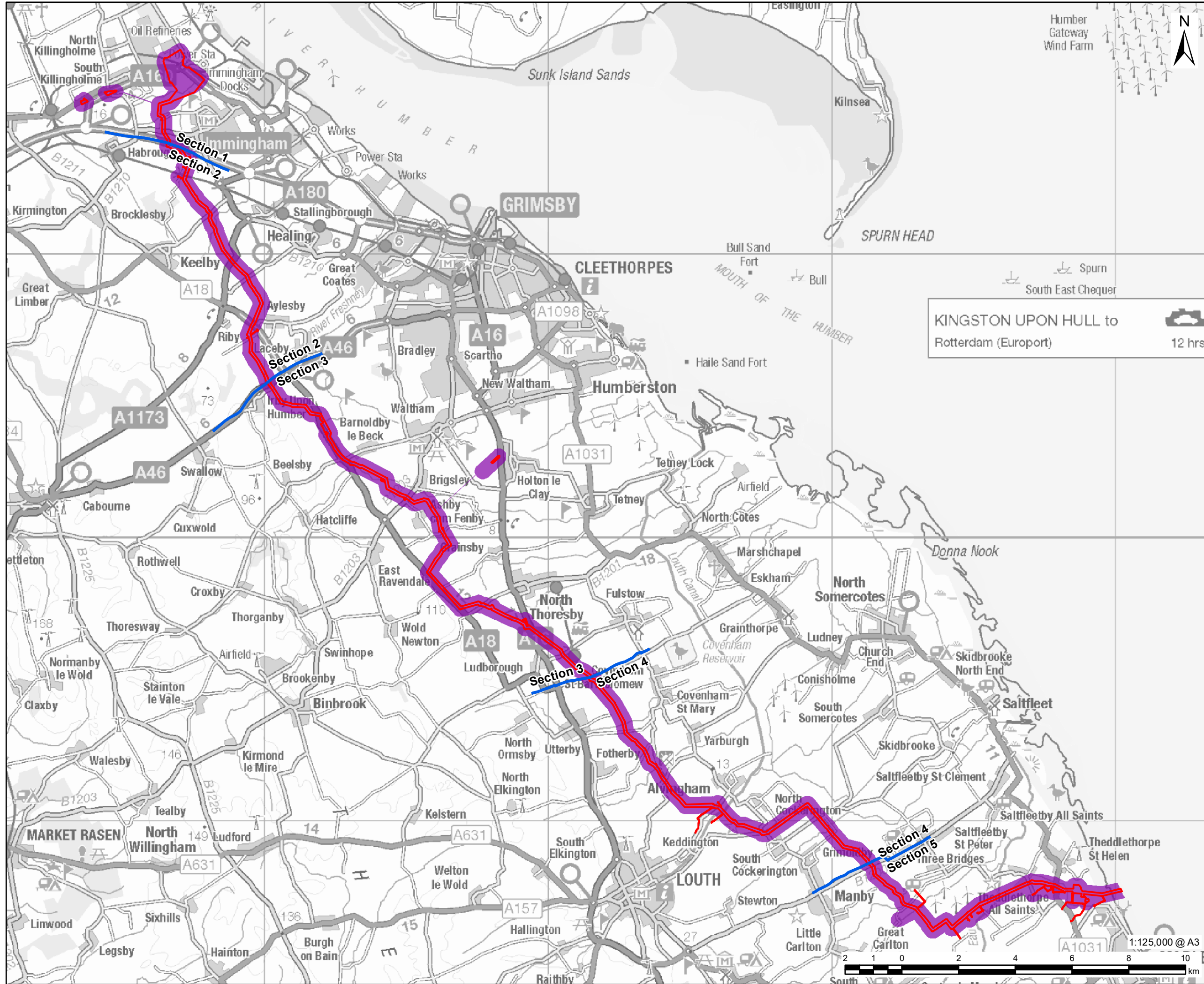
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FIGURE TITLE
 Figure 9-4
 Superficial Hydrogeology

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LEGEND

- Draft Order Limits
- Route Section Break

Bedrock Aquifer Classification (BGS)

- Principal Bedrock Aquifer

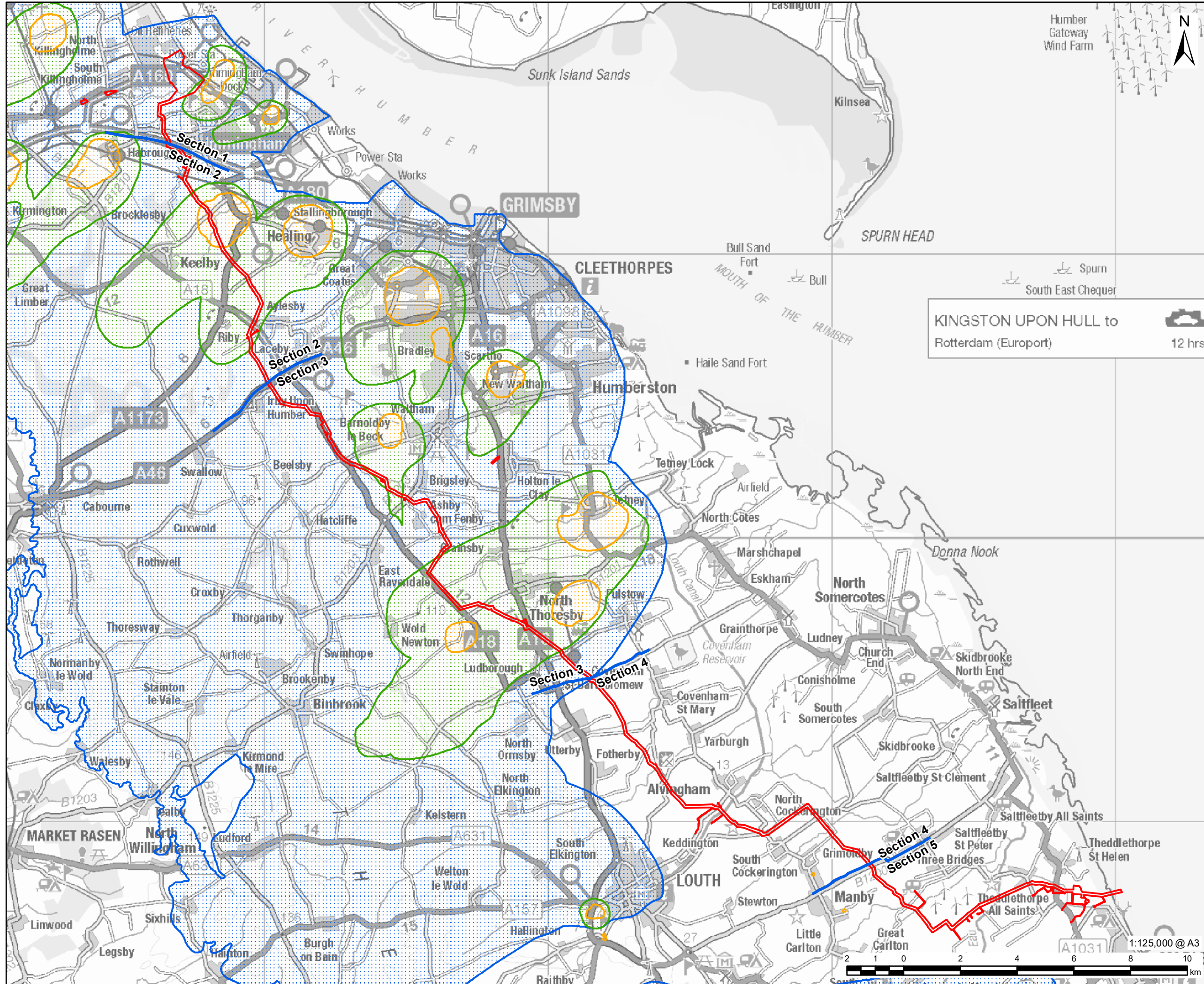
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FIGURE TITLE
Figure 9-5
Bedrock Hydrogeology

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LEGEND

- Draft Order Limits
- Route Section Break

Source Protection Zone (EA)

- Zone I - Inner Protection Zone
- Zone II - Outer Protection Zone
- Zone III - Total Catchment

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Rotterdam (Europort)

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FIGURE TITLE

Figure 9-6
Source Protection Zones

Table 9-10: Other Hydrogeological Classifications

Section of Draft Order Limits and Study Area	Description of other Hydrogeological Classifications and Features
Section 1	<p>Source Protection Zones</p> <p>This section of the Draft Order Limits contains one Source Protection Zone:</p> <ul style="list-style-type: none"> • Zone III – Total Catchment, present between Immingham Docks and Section Break 1. • Within the wider Study Area, this section includes an additional two Source Protection Zones: • Zone I – Inner Protection Zone, present from Immingham Docks to Immingham town; and • Zone II – Outer Protection Zone, present from Immingham Docks to Immingham town. <p>Drinking Water Safeguard Zones</p> <p><u>Groundwater</u></p> <p>Within this section of the Draft Order Limits there are two Drinking Water Safeguard Zones (Ground Water):</p> <ul style="list-style-type: none"> • GWSGZ0286 – Present west of Draft Order Limits (and 2 separate parcels within the Draft Order Limits but separated from the main pipeline, where it is understood materials may be stored for the Project) around South Killingholme; • GWSGZ0281 – Present west of Draft Order Limits and north of A180. <p><u>Surface Water</u></p> <p>None within this section.</p> <p>Nitrate Vulnerable Zones 2021 to 2024 (pre appeals)</p> <p>This section is within several Nitrate Vulnerable Zones as detailed below:</p> <p><u>Groundwater</u></p> <ul style="list-style-type: none"> • Groundwater G80 – Lincolnshire Chalk NVZ <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • Surface Water S359 – North Beck Drain NVZ • Surface Water S361 – Skitter Beck / East Halton Beck NVZ
Section 2	<p>Source Protection Zones</p> <p>This section of the Draft Order Limits and Study Area contains three Source Protection Zones:</p> <ul style="list-style-type: none"> • Zone I – Inner Protection Zone, present between Keelby and Stallingborough. The Draft Order Limits pass directly through the Inner Protection Zone; • Zone II – Outer Protection Zone, present around Roxton and between Keelby and Laceby; and • Zone III – Total Catchment, present around Section Break 1 and between Laceby and Section Break 2.

Section of Draft Order Limits and Study Area	Description of other Hydrogeological Classifications and Features
	<p><i>Drinking Water Safeguard Zones</i></p> <p><u>Groundwater</u></p> <p>This section of the Draft Order Limits contains two Drinking Water Safeguard Zone (Ground Water):</p> <ul style="list-style-type: none"> • GWSGZ0281 – Present west of Draft Order Limits between Immingham and Brocklesby; • GWSGZ0284 – Present within Draft Order Limits and to the east and west between Brocklesby and Keelby; • GWSGZ0283 – Present within Draft Order Limits and to the east and west between Keelby and Laceby. • GWSGZ0015 – Present east of Draft Order Limits within this section north of A46. <p><u>Surface Water</u></p> <p>None within this section.</p> <p><i>Nitrate Vulnerable Zones 2021 to 2024 (pre appeals)</i></p> <p>This section is within several Nitrate Vulnerable Zones as detailed below:</p> <p><u>Groundwater</u></p> <ul style="list-style-type: none"> • Groundwater G80 – Lincolnshire Chalk NVZ; <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • Surface Water S359 – North Beck Drain NVZ; and • Surface Water S357 - Laceby Beck / River Freshney Catchment (to N Sea) NVZ.
Section 3	<p><i>Source Protection Zones</i></p> <p>This section of the Draft Order Limits contains three Source Protection Zones:</p> <ul style="list-style-type: none"> • Zone II – Outer Protection Zone, present between Barnoldby le Beck and Brigsley and a separate Outer Protection Zone between Grainsby and Ludborough (understood to be protective of public water supply abstractions at Tetney and Fulstow); and • Zone III – Total Catchment Protection Zone, present between Section Break 2 and Barnoldby le Beck, Brigsely and Grainsby and then Ludborough and Section Break 3. <p><i>Drinking Water Safeguard Zones</i></p> <p><u>Groundwater</u></p> <p>Within this section of the Draft Order Limits there are four Drinking Water Safeguard Zones (Ground Water):</p> <ul style="list-style-type: none"> • GWSGZ0015 - Present within Draft Order Limits and to the east and west between Laceby and Barnoldby le Beck; • GWSGZ0282 – Present within Draft Order Limits and to the east and west between Barnoldby le Beck and Ashby cum Fenby; • GWSGZ0285 - Present within Draft Order Limits and to the east and west between Grainsby to North Thoresby

Section of Draft Order Limits and Study Area	Description of other Hydrogeological Classifications and Features
	<ul style="list-style-type: none"> • GWSGZ0288 – Present within Draft Order Limits and to the east and west between Brigsley to Grainsby <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • SWSGZ1001 – Present from Barnoldby le Beck into next section. <p><i>Nitrate Vulnerable Zones 2021 to 2024 (pre appeals)</i> This section is within several Nitrate Vulnerable Zone as detailed below:</p> <p><u>Groundwater</u></p> <ul style="list-style-type: none"> • Groundwater G80 – Lincolnshire Chalk NVZ; <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • Surface Water S357 - Laceby Beck / River Freshney Catchment (to N Sea) NVZ; • Surface Water S354 - Waithe Beck lower catchment (to Tetney Lock) NVZ; and • Surface Water S353 - Louth Canal NVZ.
Section 4	<p><i>Source Protection Zones</i> This section of the Draft Order Limits contains two Source Protection Zones:</p> <ul style="list-style-type: none"> • Zone III – Total Catchment Protection Zone, present surrounding Covenham St Bartholomew, which is understood to be protective of several public water supply abstractions within the area. <p><i>Drinking Water Safeguard Zones</i></p> <p><u>Groundwater</u> None within this section.</p> <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • SWSGZ1001 Present between Covenham St Bartholomew and Keddington. <p><i>Nitrate Vulnerable Zones 2021 to 2024 (pre appeals)</i> This section is within several Nitrate Vulnerable Zones as detailed below:</p> <p><u>Groundwater</u> None within this section.</p> <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • Surface Water S353 - Louth Canal NVZ; and • Surface Water S366 - South Dike and Grayfleet Drain NVZ.
Section 5	<p><i>Source Protection Zones</i> This section of the Draft Order Limits does not contain any Source Protection Zones.</p> <p><i>Drinking Water Safeguard Zones</i></p> <p><u>Groundwater</u> None within this section.</p> <p><u>Surface Water</u></p>

Section of Draft Order Limits and Study Area	Description of other Hydrogeological Classifications and Features
	<ul style="list-style-type: none"> • SWSGZ1002 – Present between Manby and Theddlethorpe St Helen. <p>Nitrate Vulnerable Zones 2021 to 2024 (pre appeals)</p> <p>This section is within several Nitrate Vulnerable Zones as detailed below:</p> <p><u>Groundwater</u></p> <p>None within this section.</p> <p><u>Surface Water</u></p> <ul style="list-style-type: none"> • Surface Water S363 – Woldgrift Drain NVZ; and • Surface Water S365 - Great Eau (downstream of South Thoresby) NVZ.

Abstraction Data from Environment Agency

9.5.23 Abstraction data have been obtained from the EA however the dataset does not include any information regarding abstractions along the Draft Order Limits north of Alvingham. The limited dataset makes it difficult to determine the full extent of the baseline conditions at this stage of the assessment. The missing data have been requested from the EA and will be included in the ES if received.

9.5.24 From the data received, there are 14 No. groundwater abstractions within 2km of the Draft Order Limits. Further details can be seen in **Table 9-6**.

Hydrology

9.5.25 The effects of the Project on surface water features are considered in *Chapter 11: Water Environment*.

Current Potentially Contaminative Land Uses

9.5.26 A review of the current potentially contaminative land uses within the Draft Order Limits and wider Study Area, suggests that contaminative land uses are likely to be generally confined to agriculture with the exception of industrial land such as the VPI Immingham and P66 sites and at the Immingham Docks in the north of the Draft Order Limits and the former TGT site in the south of the Draft Order Limits.

9.5.27 Other current potentially contaminative land uses have been identified and are shown on **Figure 9-7**. Further details are provided in *PEIR Volume IV: Appendix 9-1*. These include the following:

- Waste Storage, Processing and Disposal (Sewage Works & Outfalls);
- Farming (Poultry Houses, Silo, Livestock);
- Fuel Distributors & Suppliers (associated with Immingham Docks / Industrial Area and past activities at the former TGT site);
- Gas Valve Compound (associated with Immingham Docks / Industrial Area);
- Engineering and Maintenance Services;

- Tanks (Generic) (associated with Immingham Docks / Industrial Area and Theddlethorpe Gas Terminal);
- Energy Production (Solar Panels & Wind Turbines); and
- Electrical Features (Sub Stations, Masts, Poles & Pylons).

Historic Potentially Contaminative Land Uses

9.5.28 A review of the data currently available through historical mapping and the Groundsure Report (Ref 9-40) indicates that throughout the Draft Order Limits and wider Study Area, numerous localised potentially contaminative historical land uses have been identified.

9.5.29 Historical land uses have been identified and further details can be seen on **Figure 9-8** in addition to *PEIR Volume IV - Appendix 9-1*. These include the following:

- Historical Energy Features (Sub Stations and Liquid Gas Depot (Immingham Docks / Industrial Area) and a Gas Terminal (Theddlethorpe Gas Terminal));
- Historical Garages;
- Docks (Immingham Docks);
- Mills (Unspecified);
- Tanks (Unspecified) (associated with Immingham Docks / Industrial Area and Theddlethorpe Gas Terminal);
- Railway (Tracks, Sidings & Cuttings) (associated with Immingham Docks / Industrial Area and Theddlethorpe Gas Terminal);
- Pits (Gravel, Chalk, Unspecified); and
- Disused Airfield.

Current and Historic Landfills

9.5.30 The effects of the Project on waste and materials are covered in *Chapter 18: Materials and Waste*. Where this overlaps with the geology and hydrogeology preliminary assessment, is detailed below as both current and historic landfills act as a contaminated land use and have therefore also been included in this preliminary assessment.

9.5.31 Recorded current and historic landfills from the Groundsure data (Ref 9-40) identified within the Study Area are summarised below in **Table 9-11**. Locations of landfills are shown in **Figure 9-9**.

Table 9-11: Summary of Current and Historic Landfills

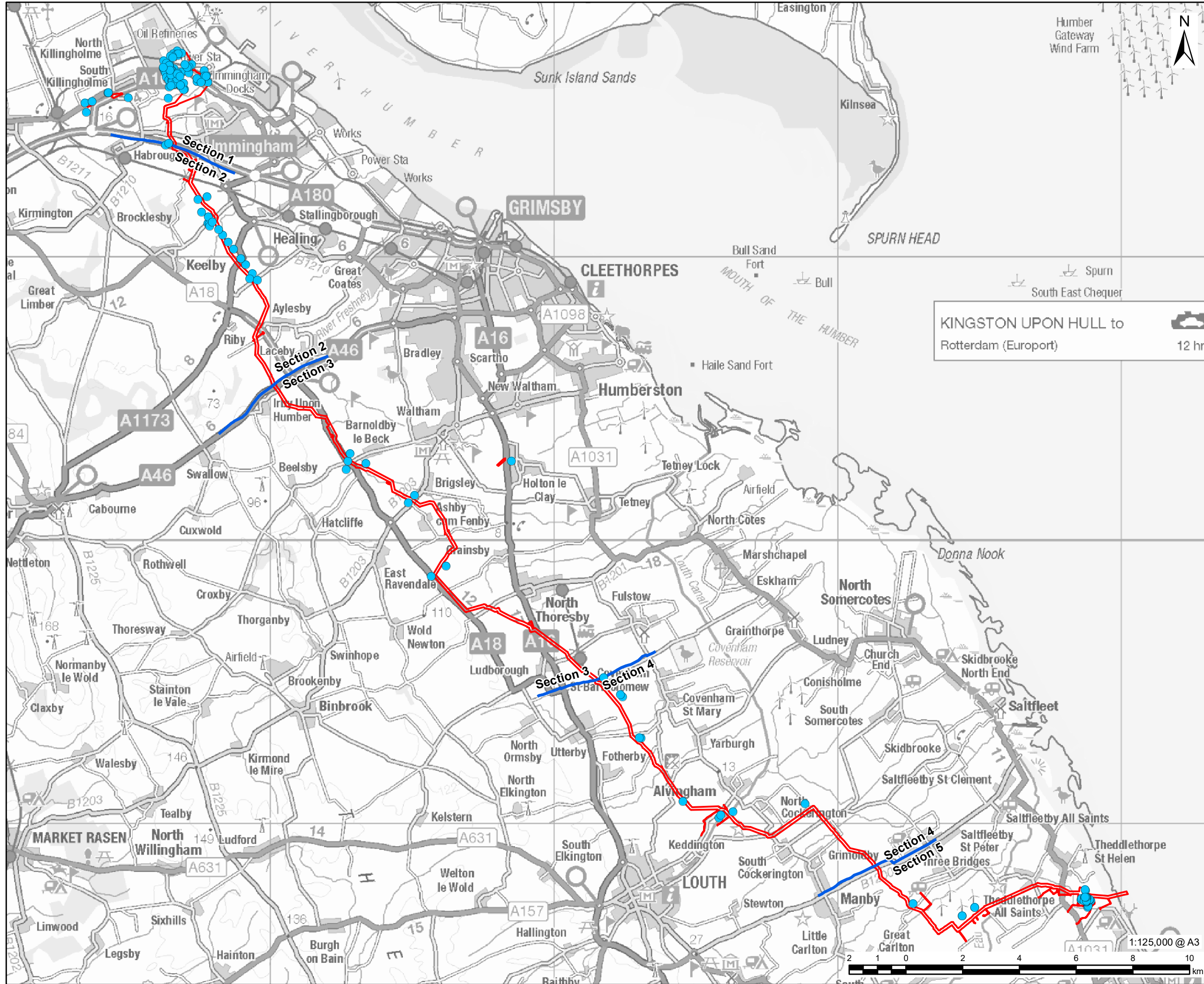
Section of the Draft Order Limits	Landfill Type	Description
1	EA Historic Landfill	Site name: Lindsey Oil Refinery Site reference: EAHLD01515 Location: Approximately 500m North of the Draft Order Limits
		Site name: Conoco Site reference: 55/19/0148, 1480, 2000/5295

Section of the Draft Order Limits	Landfill Type	Description
		<p>Location: Located within the Draft Order Limits</p> <p>Site name: Mill Lane Site reference: 55/17/0026, 55/17/0029 Location: Approximately 250m East of the Draft Order Limits</p>
	EA Permitted Waste Sites Authorised Landfill	There are no active landfill sites that have been identified within the Study Area.
2	EA Historic Landfill	<p>Site name: Washingdales Site reference: 2000/0369 Location: Approximately 300m West of the Draft Order Limits</p> <p>Site name: Aylesby Site reference: 2000/0294 Location: Approximately 200m East of the Draft Order Limits</p> <p>Site name: Barton Street Site reference: 2000/0388 Location: Approximately 200m West of the Draft Order Limits</p> <p>Site name: Hatcliffe Top Site reference: 2000/0296 Site location: Approximately 500m South-West of the Draft Order Limits</p>
	EA Permitted Waste Sites Authorised Landfill	There are no active landfill sites that have been identified within the Study Area.
3	EA Historic Landfill	<p>Site name: Barton Street Site reference: 55/19/0635,55/20/0113 Site location: Approximately 150m West of the Draft Order Limits</p>
	EA Permitted Waste Sites Authorised Landfill	There are no active landfill sites that have been identified within the Study Area.
4	EA Historic Landfill	<p>Site name: Os Field No 9000 Site reference: L163, EL-110-01/97, RD2-0309 Site location: Approximately 80m South-West of the Draft Order Limits</p>

Section of the Draft Order Limits	Landfill Type	Description
	EA Permitted Waste Sites Authorised Landfill	There are no active landfill sites that have been identified within the Study Area.
5	EA Historic Landfill	There are no historic landfill sites that have been identified within the Study Area.
	EA Permitted Waste Sites	There are no active landfill sites that have been identified within the Study Area.

Ground Gas

- 9.5.32 Ground gas including methane and carbon dioxide may be present associated with the natural strata and Made Ground deposits, where present, throughout the Draft Order Limits. Ground gas may also be associated with recorded landfills, as well as unregistered infilled land (e.g., backfilled sand and chalk pits).
- 9.5.33 There is one chalk pit listed as within the Draft Order Limits, this is located in Section 2 approximately 450m north of the Section 3 break. There are an additional two pits within the wider Study Area approximately 30m west of the Draft Order Limits.



VikingCCS

AECOM

PROJECT
Viking CCS Pipeline

LEGEND

- Draft Order Limits
- Route Section Break
- Current Industrial Land Use (OS)

KINGSTON UPON HULL to
Rotterdam (Europort)
12 hrs

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FIGURE TITLE
**Figure 9-7
Current Potentially Contaminative
Land Uses**

ISSUE PURPOSE
PEIR

PROJECT NUMBER / REFERENCE
60668955 / VCCS_221103_PEIR_1-2



PROJECT
Viking CCS Pipeline

- LEGEND**
- Draft Order Limits
 - Route Section Break
 - Licensed Waste Site (EA)
 - Waste Exemption (EA)
 - Historical Waste Site
 - Historical Landfill

KINGSTON UPON HULL to
 Rotterdam (Europort) 12 hrs

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FIGURE TITLE
Figure 9-9
Current and Historic Landfills

ISSUE PURPOSE
 PEIR
PROJECT NUMBER / REFERENCE
 60668955 / VCCS_221103_PEIR_9-9

Unexploded Ordnance Potential

9.5.35 Online Zetica Unexploded Ordnance (UXO) risk mapping shows “Low Risk” (15 bombs per 1000 acres or less) for most of the Study Area (Sections 2 to 5). The Study Area between Immingham Docks and Grimsby (Section 1) records an UXO “Moderate Risk” (15 to 49 bombs per 1000 acres). An assessment has been commissioned from Zetica of the Draft Order Limits in review of the UXO risk, the findings of which will be included within the ES.

Information from Statutory Authorities

9.5.36 Information determined to be relevant has been summarised below in **Table 9-12**. Further information and details can be seen in **Figure 9-10** and tabulated in *PEIR Volume IV - Appendix 9-1*. The majority of the entries are concentrated around Industrial land/Immingham Docks in Section 1 and TGT in Section 5. There are several other entries scattered along the length of the Draft Order Limits.

Table 9-12: Statutory Authority Information

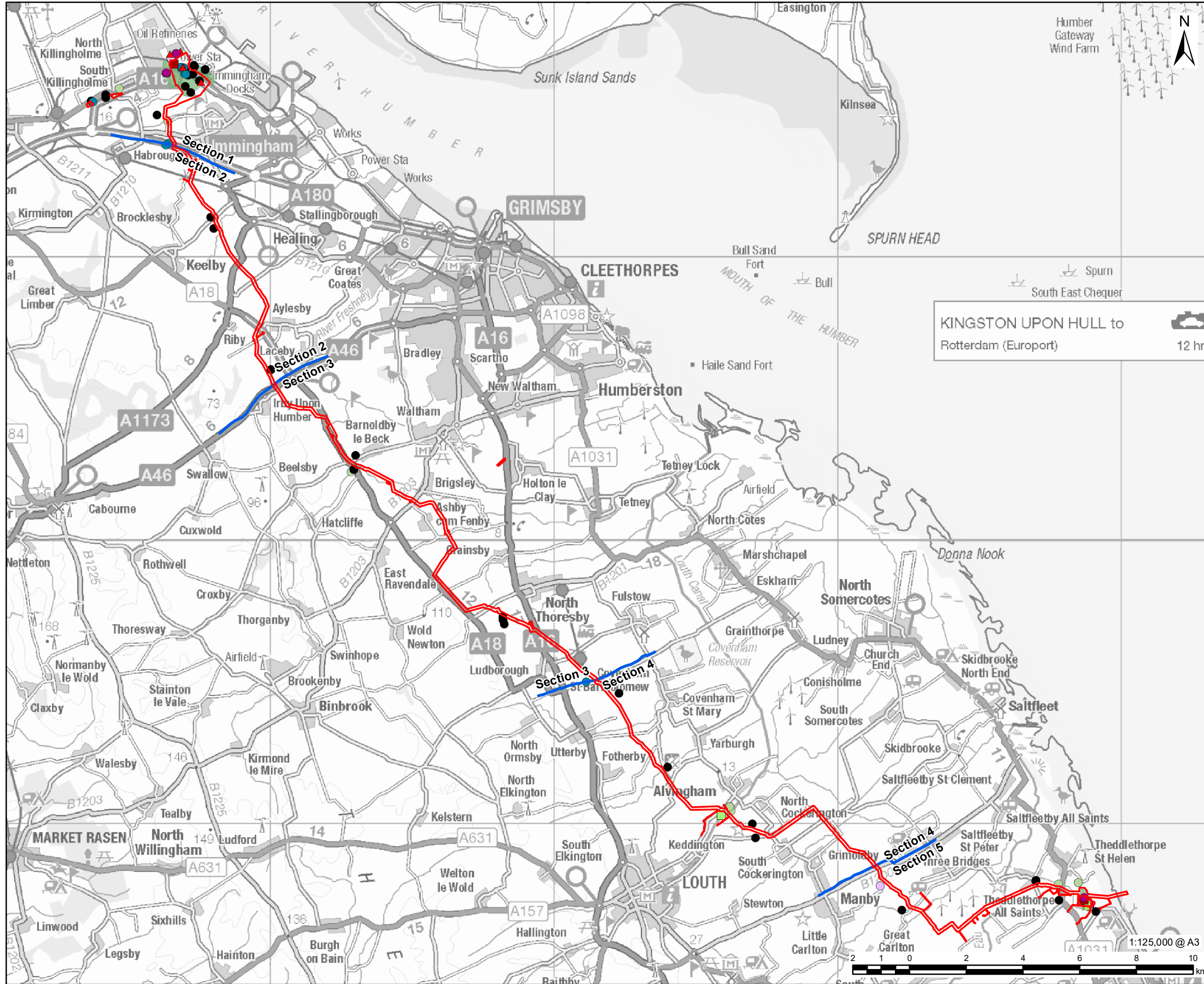
Section of the Draft Order Limits	Summary of Statutory Information	Details
Section 1	3 No. COMAH sites (1 No. Historical, 2 No. Current)	Historical COMAH: Conoco Manufacturing Ltd. Current COMAH: Phillips 66 Limited and Associated British Ports. (Immingham Docks)
	4 No. Hazardous Substance Storage (1 No. Historical, 3 No. Current)	Historical HSS: Hazardous Substances Consent to store 3050 tonnes of petroleum gas oil (VPI Immingham LLP). Current HSS: No details (VPI Immingham LLP); Ammonium Nitrate based fertilizer. Max quantity present during established period – 35,000 tonnes. Established quantity - 52,500 tonnes (Humberside Sea and Land Services Ltd; and Hazardous Substances Consent to increase the amount of LPG cylinder storage from 25 tonnes to 44 tonnes (Calor Gas Ltd). (Immingham Docks)
	19. No Licensed Discharges to Controlled Waters (16 No. Historic, 3 No. Current)	Licensed discharges to water include: Trade Discharges Drainage; Sewage – Final Treated Effluent – Not Water – Site Company; and Miscellaneous – Surface Water.

Section of the Draft Order Limits	Summary of Statutory Information	Details
	12 No. Licensed Industrial Activities Part A1 (1. No. Effective, 11 No. Superseded)	Licensed Industrial Activities: 6 No. VPI Immingham LLP – Combustion; 5 No. Immingham CHP LLP – Combustion. (Immingham Docks)
	7 No. Licensed Pollutant Release Part A2 B (3 No. Active, 4 No. Historic)	Licensed Pollutant Releases: PD Port Services Limited – Coal and Coke; Gradebrook Filling Stations Ltd – Unloading of petrol into storage; and Phillips 66 Limited – Coal and Coke. (Immingham Docks)
	1 No. List 1 Dangerous Substances (Not Active)	List 1 Dangerous Substances: Mercury; and Cadmium. (Immingham Docks)
	1 No. List 2 Dangerous Substances (Active)	List 2 Dangerous Substances: Arsenic; Chromium; Copper; Lead; Nickel; and Zinc. (Immingham Docks)
	5 No. Pollution Incident	Pollutant Type: 2 No. Diesel – Category 3 (Minor) Land; 1 No. Smoke – Category 4 (No Impact) Air; 1 No. Crude Oil – Category 3 (Minor) Land, Category 2 (Significant) Water; and 1 No. Construction Waste – Category 3 (Minor) Land.
	39 No. Pollution Inventory Substances	Type: 30 No. Phillips 66 Limited – Refineries and Fuel; and 9 No. VPI Immingham LLP – Power, Combustion. (Immingham Docks)
	2 No. Pollution Inventory Waste Transfer	Type: VPI Immingham LLP – Combustion; and Phillips 66 Limited – Combustion. (Immingham Docks)

Section of the Draft Order Limits	Summary of Statutory Information	Details
Section 2	4 No. Licensed Discharges to Controlled Waters (3 No. Historic, 1 No. Current)	Licensed discharges to water include: Trade Discharges – Site Drainage; Sewage – Final Treated Effluent – Not Water Company; and Miscellaneous – Surface Water.
	1 No. Licensed Pollutant Release Part A2 B (1 No. Active)	Licensed Pollutant Releases: Gradebrook Filling Stations Ltd – Unloading of petrol into storage.
Section 3	6 No. Licensed Discharges to Controlled Waters (6 No. Historic)	Licensed discharges to water include: Trade Discharges – Site Drainage; Sewage – Process Effluent – Not Water Company; and Miscellaneous – Surface Water.
	2 No. Pollution Incident	Pollutant Type: Process Effluent – Category 3 (Minor) Land; and Inert Materials and Wastes – Category 4 (No Impact).
Section 4	27 No. Licensed Discharges to Controlled Waters (11 No. Historic, 16 No. Current)	Licensed discharges to water include: Trade Discharges – Site Drainage; Sewage – Final Treated Effluent – Not Water Company; and Miscellaneous – Surface Water.
	1 No. Licensed Pollutant Release Part A2 B (1 No. Historical)	Licensed Pollutant Releases: Royal Crushing & Earthmoving – Other Mineral Resources.
	16 No. List 2 Dangerous Substances (6 No. Active, 10 No. Not Active)	List 2 Dangerous Substances: Chromium; Copper; Lead; pH; and Zinc.
	4 No. Pollution Incidents	Pollutant Type: 1 No. Household Waste – Category 3 (Minor) Air and Land; 1 No. Vegetable Cuttings – Category 3 (Minor) Air and Land;

Section of the Draft Order Limits	Summary of Statutory Information	Details
		1 No. Unidentified – Category 4 (No Impact); and 1 No. Vegetable Cuttings and Household Waste – Category 3 (Minor) Air and Land.
Section 5	1 No. COMAH site (Historical)	Historical COMAH: Conoco Phillips Petroleum Company U.K. Limited. (Theddlethorpe Gas Terminal)
	2 No. Hazardous Substance Storage (1 No. Historical, 1 No. Current)	Current HSS: For the process and storage of flammable substances- Conoco Philips Petroleum Company Ltd. (Theddlethorpe Gas Terminal) Historical HSS: Application to increase the amount of stored hazardous materials -Conoco Philips Petroleum Company Ltd. (Theddlethorpe Gas Terminal)
	8 No. Historical Licensed Activities	Historical Licensed Activities: Conoco Phillips Petroleum Company U.K. Limited - Gasification And Associated Processes. (Theddlethorpe Gas Terminal)
	7 No. Licensed Discharges to Controlled Waters (7 No. Historic)	Licensed discharges to water include: Unspecified, Sewage – Final Treated Effluent – Not Water Company and Agricultural – Fish Farming.
	15 No. Licensed Industrial Activities Part A1 (4. No. Effective, 11 No. Superseded)	Licensed Industrial Activities: 2 No. Chrysaor Production Limited – Combustion and Gasification; 11 No. Conoco Phillips UK LTD – Combustion and Gasification; and 2 No. Annyalla Chicks UK Ltd – Associated Process and Intensive. (Theddlethorpe Gas Terminal)
	1 No. Licensed Pollutant Release Part A2 B (1 No. Historical)	Licensed Pollutant Releases: British Gas – Gas Processes. (Theddlethorpe Gas Terminal)
	1 No. List 1 Dangerous Substances (Not Active)	List 1 Dangerous Substances: Mercury; and Cadmium. (Theddlethorpe Gas Terminal)

Section of the Draft Order Limits	Summary of Statutory Information	Details
	1 No. List 2 Dangerous Substances (Active)	List 2 Dangerous Substances: Arsenic; Chromium; Copper; Iron; Lead; and Zinc. (Theddlethorpe Gas Terminal)
	3 No. Pollution Incidents	Pollutant Type: 1 No. Unidentified – Category 3 (Minor) Water; and 2 No. Oils and Fuel – Category 3 (Minor) Water.
	1 No. Pollution Inventory Radioactive	Conoco Phillips UK Ltd: Total Alpha, Total BETA/Gamma. (Theddlethorpe Gas Terminal)
	1 No. Pollution Inventory Substance	Type: Chrysaor Production UK Ltd – Refineries and Fuel – Combustion. (Theddlethorpe Gas Terminal)
	1 No. Pollution Inventory Waste Transfer	Type: Chrysaor Production UK Ltd – Refineries and Fuel – Combustion. (Theddlethorpe Gas Terminal)
	2 No. Radioactive Substance Authorisations	Type: 2 No. Conoco Phillips UK Ltd - Disposal Of Radioactive Waste (was Rsa60 Section 6) Superseded /Revoked. (Theddlethorpe Gas Terminal)



LEGEND

- Draft Order Limits
- Route Section Break
- ▲ Hazardous Substance Storage (HSE)
- Historical Licensed Industrial Activity (EA)
- Licensed Discharge to Controlled Waters (EA)
- Licensed Industrial Activity Part A1 (EA)
- Licensed Pollution Release Part A2 (EA)
- List 1 Dangerous Substance (EA)
- List 2 Dangerous Substance (EA)
- Pollution Incident (EA)
- Pollution Inventory Radioactive (EA)
- Pollution Inventory Substance (EA)
- Pollution Inventory Waste Transfer (EA)
- Radioactive Substance Authorisation (EA)
- Control of Major Accident Hazards (COMAH) Site (HSE)

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FIGURE TITLE

Figure 9-10
Information from Statutory Authorities

ISSUE PURPOSE

PEIR

PROJECT NUMBER / REFERENCE

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9.6 Mitigation

Embedded Mitigation

- 9.6.1 EIA is an iterative process which informs the development of the project 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 avoid or reduce these effects.
- 9.6.2 This type of mitigation is defined as embedded mitigation, as the mitigation measures have been identified and adopted as part of the evolution of the project design (i.e., “embedded” into the project design).
- 9.6.3 The design of the Project will be further developed to reflect the findings of ongoing environmental studies, comments raised during this statutory consultation and ongoing engagement with stakeholders.
- 9.6.4 The Project is being designed to avoid important geological features or resources, and sources of contamination, through careful routeing and site selection.

Additional Mitigation and Enhancement Measures

- 9.6.5 Preliminary desk study work has identified areas of potential soil and/or groundwater contamination and there may be a requirement to undertake ground investigation and risk assessment of potential contaminant linkages, in order to determine the actual nature, extent, and magnitude of any significant potential contamination.
- 9.6.6 A Preliminary Draft Construction Environmental Management Plan (CEMP) has been prepared as part of this PEIR and is presented in *PEIR Volume IV - Appendix 3.1*. This sets out the preliminary additional mitigation measures in a preliminary mitigation register and those relevant to geology and hydrogeology are presented below with the associated reference number:

Ground Contamination

- **E1:** *An appropriate intrusive ground investigation of selected areas of the Draft Order Limits will be undertaken in accordance with all relevant guidance and legislation including BS 10175:2011, Environment Agency/DEFRA LCRM series of reports. The ground investigation will be undertaken to achieve the following objectives:*
 - *Determine the ground conditions to allow design of foundations and structures;*
 - *Assess the nature, extent and magnitude of soil and groundwater contamination present;*
 - *Assessment of artesian groundwater conditions and identification of where unique groundwater features could occur within the Draft Order Limits;*
 - *Assess the risks (if any) from potential contaminants to human health and Controlled Waters; and*
 - *Assess the ground gas regime.*

If areas of the Draft Order Limits are shown to pose a risk, if feasible, infrastructure would be moved to a different location. However, if it is not possible to move the infrastructure in contact with the ground, remedial measures would be implemented.

- **E2:** *A remediation strategy will be devised and discussed with the regulatory authorities (including relevant local authorities and the Environment Agency) prior to any remedial*

works. Contaminated material that is considered to pose a risk would be remediated in line with the remediation strategy or disposed of appropriately.

- **E3:** *A more detailed hydrogeological assessment will be undertaken at detailed design stage, where trenchless techniques or dewatering is required in high sensitivity groundwater environments. Where dewatering is required, a dewatering scheme will be developed prior to construction (in consultation with the Environment Agency and appropriate public water abstraction companies) to demonstrate that there is an effective strategy to manage water arising from the operations and, where required, sufficient proposals to treat the water prior to controlled discharge. Any such assessment will consider the effects of any draw down or impacts on nearby abstractions or resources.*
- **E4:** *A watching brief will be maintained during construction works to confirm the absence of potential sources of contamination such as Made Ground, visual or olfactory evidence of hydrocarbons etc. If identified, these areas of potentially contaminated ground and/or water will be sampled and undergo appropriate sampling and laboratory analysis.*
- **E5:** *A dynamic risk assessment will be undertaken in accordance with the Environment Agency report Land Contamination Risk Management (LCRM) to identify if these areas of potential contaminants pose a risk to construction workers or site operators and Controlled Waters. If areas of the site are shown to pose a risk, remedial measures required will be implemented. A discovery and disposal strategy will be devised and agreed with the regulatory authorities prior to construction works to outline this process to allow the dealing of risks in a timely manner.*
- **E6:** *The determination of the risks through ground investigation, watching briefs, risk assessment, and the potential remediation of areas of the site may result in the reduction of the significance, or even removal, of some of the potential effects identified. Should contaminated material that poses a risk be identified, it will be treated and/or disposed of appropriately.*
- **E7:** *Where risks are identified to construction workers, these should be communicated and managed by the appointed contractor as a construction management measure, to prevent potentially complete contaminant linkages.*

9.6.7 Mitigation measures to prevent the creation of contaminant linkages would be required; these include the following commitments within the Preliminary Draft CEMP:

- **E8:** *Risk assessments in accordance with the Health and Safety at Work Act to restrict exposure to potentially harmful substances to a safe level for construction workers. Construction Design and Management practices will be applied;*
- **J2:** *Dust suppression measures to reduce the generation of dust from excavated contaminated soils, for example impermeable covers spread over mounds of bare contaminated soil. Implementation of these simple measures can reduce the risk of effects to construction workers and adjacent site users from potentially contaminated dusts. These will be included within the Dust Management Plan;*
- **J20:** *Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use;*
- **J22:** *Vehicles carrying contaminated soils off-site will only to be loaded up to appropriate levels and be covered to prevent contaminated materials dropping onto roads.*

- **E9:** Where, if required, piled foundations are used, they will be designed in accordance with the EA guidance document 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention' (Ref 9-53); and
- **E10:** Any material imported to site, such as for supporting foundations, will be natural quarried stone or, if recycled, the material will undergo chemical testing. The suite of contaminants and site use criteria will be agreed with regulatory authorities, in order to demonstrate that the material is suitable for use on site and does not pose a risk to construction workers or the environment.

Groundwater - Dewatering

9.6.8 As per the EA's Approach to Groundwater Protection (Ref 9-37), 'Where a new infrastructure development presents a significant risk to groundwater, the Environment Agency may require a programme of groundwater monitoring to be designed, agreed, installed and undertaken to give early warning of any developing groundwater pollution and/or interference to groundwater flow. This programme may include off-site locations if necessary to identify pollution and to allow monitoring in the event that the site becomes inaccessible. Where appropriate, the Environment Agency will use its powers to require this at existing sites.' Therefore, the following commitment are included in the Preliminary Draft CEMP:

- **E11:** During ground investigation surveys, ground water levels will be recorded and piezometers installed in boreholes at certain locations to allow groundwater levels to be monitored. This is to record the level changes throughout the year to inform design. From these groundwater profiles will be derived, from which the requirements for de-watering will be identified.
- **E12:** Where required, a detailed dewatering scheme will be developed prior to construction (in consultation with EA) to manage the water arising from dewatering operations and treat the water prior to controlled discharge. This may include the construction of raised lagoons for the storage of water and to allow the settlement of any sediment prior to discharge. Consideration will be given to the potential effects of dewatering on adjacent water features both from draw down during abstraction and from flood risk during discharge, and mitigation applied. To mitigate risks associated with potentially contaminating groundwater, creating a pathway to surface level for artesian groundwater, and creating issues with water resources, dewatering schemes and associated excavations should be designed to avoid, where possible, the Principal Aquifer underlying the Draft Order Limits.

Private Water Supplies

9.6.9 Where available from the relevant local authorities, details of private water supplies will be presented as part of the ES chapter assessment. However, until this information is received, the following commitment is included in the Preliminary Draft CEMP:

- **E13:** During the detailed design phase of the Project, investigations will be completed to identify all private water supplies that may be affected by the Project. Where identified and deemed necessary, questionnaires will be conducted to obtain further information. Following this, a risk assessment will be conducted to assess whether these water supplies could be affected by construction activities. Selected private water supplies will then be monitored before, during and after construction, with water quality testing completed where required, to protect the affected private water supply.

Operation

9.6.10 It is not anticipated that dewatering will be required During operation, as groundwater will be managed through detailed design. Further design measures, such as the use of anti-buoyancy measures, are discussed in *Chapter 3: The Viking CCS Pipeline*.

Decommissioning

9.6.11 The it is assumed that the pipeline will be left in-situ and therefore the decommissioning will include the removal of Above Ground Infrastructure (AGIs) only. The works and therefore the effects to decommission the Project will be similar to those of construction in relation to the AGIs only. The additional mitigation measures detailed in this section are therefore also considered to be applicable and relevant to the decommissioning phase.

9.6.12 The preliminary assessment is undertaken with the assumption that the embedded and additional mitigation measures are in place.

9.7 Preliminary Assessment of Effects

9.7.1 This section details the preliminary assessment of potential impacts for the Project during construction, operation, and decommissioning phases.

9.7.2 The potential impacts for the Project during construction are listed below:

- Chemical spillages and leaks from plant and machinery, and from chemicals and other contaminants stored on site causing pollution of ground or groundwater;
- Changes in subsoil structure and reduction of subsoil quality due to compaction or erosion during storage;
- Compaction of subsoil due to construction vehicle movements degrading soil quality and causing potential water logging;
- Requirement for dewatering, which may reduce flow to groundwater supported sites and unique features such as blow wells, abstractions (regulated and non-regulated) and surface water bodies and change soil hydrology locally;
- Requirement for dewatering, reducing quality or levels of groundwater supporting sites protected under European and UK habitat legislation, such as a RAMSAR Site, a SSSI or SPZ 1;
- Disturbance of potentially contaminated soils, sediments and waters posing a risk to construction workers, groundwater, and geology;
- Importation of contaminated aggregates posing a potential risk to human health and underlying geology and groundwater;
- Trenchless techniques whereby excavations/ drilling creates the potential for groundwater losses, should artesian flow be encountered during construction excavations affecting sensitive groundwater receptors (e.g., Principal Aquifers or regulated and non-regulated abstractions) or sensitive surface water receptors or unique groundwater features such as blow wells, chalk streams and springs; and
- Requirement to remove excess potentially contaminated soils from pipeline route posing a potential risk to human health and the environment.

9.7.3 The preliminary assessment of the potential impacts of the Project construction phase on Geology and Hydrogeology is provided in **Table 9-13**.

Operation

- 9.7.4 The potential impacts of the Project during operation on Geology and Hydrogeology are listed below:
- Requirement for dewatering (although not anticipated), reducing flow to groundwater abstractions, unique groundwater features such as blow wells, chalk streams, springs and surface water bodies, and changes to soil hydrology;
 - The foundations of structures and pipelines may provide a preferential pathway for contaminants to migrate to non-contaminated soils, geology and groundwater; and
 - The potential for aggressive ground contaminants posing a risk to the pipeline.
- 9.7.5 The preliminary assessment of the potential impacts of the operational phase of the Project on Geology and Hydrogeology is provided in **Table 9-14**.

Table 9-13: Preliminary Assessment of Geology and Hydrogeology for the Construction Phase

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
Human Health: Construction Workers/Site Users - Low	Chemical spillages and leaks from plant and machinery, and from chemicals and other contaminants stored on site causing pollution of ground or groundwater.	Short Term	Good practice measures as set out in the Preliminary Draft CEMP.	Not Significant	High – the mitigation to be applied is standard practice and regularly applied to similar pipeline schemes where it has proven to be effective.
Geology: Superficial deposits and Bedrock - Low		Short Term		Not Significant	
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions - High		Short Term		Not Significant	
Geology: Superficial deposits - Low	Changes in subsoil structure and reduction of subsoil quality due to compaction or erosion during storage.	Short Term	Good practice measures as set out in the Preliminary Draft CEMP.	Not Significant	High – the mitigation to be applied is standard practice and regularly applied to similar pipeline schemes where it has proven to be effective.
Geology: Superficial deposits - Low	Compaction of subsoil due to construction vehicle movements degrading soil quality	Medium Term	Good practice measures as set out in the Preliminary Draft CEMP.	Not Significant	High – the mitigation to be applied is standard practice and regularly applied to similar pipeline
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated		Medium Term		Not Significant	

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions - High	and causing potential water logging.				schemes where it has proven to be effective.
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions – High	Requirement for dewatering, which may reduce flow to groundwater supported sites, abstractions (regulated and non-regulated) and surface water bodies and change soil hydrology locally.	Medium Term	Good practice measures as set out in the Preliminary Draft CEMP. Determination of groundwater regime through ground investigation and monitoring. Development of and implementation of a dewatering scheme in consultation with Environment Agency.	Not Significant	Moderate - The ground investigation data is still outstanding, and a hydrogeological risk assessment has not been undertaken therefore more detailed information is still required but dewatering schemes have been adopted successfully on similar schemes.
Hydrology: Surface Water Features - High		Medium Term		Not Significant	
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and	Requirement for dewatering, reducing quality or levels of groundwater supporting sites protected under	Medium Term	Good practice measures as set out in the CEMP. Determination of groundwater regime	Not Significant	Moderate - The ground investigation data is still outstanding, and a hydrogeological risk assessment has not

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
unregulated abstractions - High	European and UK habitat legislation, such as a RAMSAR Site or a SSSI.	Medium Term	through ground investigation and monitoring. Development of and implementation of a dewatering scheme in consultation with Environment Agency.	Not Significant	been undertaken therefore more detailed information is still required but dewatering schemes have been adopted successfully on similar schemes.
Hydrology: Surface Water Features - High					
Human Health: Construction Workers/Site Users - Low	Disturbance of potentially contaminated soils, sediments and waters posing a risk to construction workers, groundwater, and geology.	Short Term	Ground investigation and subsequent risk assessment during design to determine risk. Design to avoid contamination sources or remediation of contamination if required. Good practice measures as set out in the Preliminary Draft CEMP. A watching brief will be required during works.	Not Significant	Moderate – although appropriate mitigation measures will be implemented as per the Preliminary Draft CEMP and good practice, a ground investigation to examine the chemical composition of the ground within the Draft Order Limits has not yet occurred.
Geology: Superficial deposits and Bedrock - Low		Short Term		Not Significant	
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions - High		Short Term		Not Significant	
Hydrology: Surface Water Features – High		Short Term		Not Significant	

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
Human Health: Construction Workers/Site Users - Low	Importation of contaminated aggregates posing a potential risk to human health and underlying geology and groundwater.	Short Term	Good practice measures as set out in the Preliminary Draft CEMP.	Not Significant	High – the mitigation to be applied is standard practice and regularly applied to similar pipeline schemes where it has proven to be effective.
Geology: Superficial deposits and Bedrock – Low		Medium Term		Not Significant	
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions – High		Medium Term		Not Significant	
Geology: Superficial deposits and Bedrock - Low	Trenchless techniques whereby excavations/ drilling creates a pathway for drilling fluids or other fluids used during construction to reach sensitive groundwater receptors (e.g., Principal Aquifers or abstractions (regulated and non-regulated)) or sensitive surface	Short Term	Good practice measures as set out in the Preliminary Draft CEMP.	Not Significant	High – the mitigation to be applied is standard practice and regularly applied to similar pipeline schemes where it has proven to be effective.
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions - High		Short Term		Not Significant	
Hydrology: Surface Water Features – High		Short Term		Not Significant	

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
	water receptors, or unique groundwater features such as blow wells, chalk streams and springs.				
Human Health: Construction Workers/Site Users – Low	Requirement to remove spoil from excess potentially contaminated soils from pipeline route posing a potential risk to human health and the environment.	Short Term	Good practice measures as set out in the Preliminary Draft CEMP. A watching brief will be required during works.	Not Significant	Moderate - the mitigation to be applied is standard practice and regularly applied to similar pipeline schemes where it has proven to be effective however, the ground investigation data is still outstanding and more detailed information is still required to give a high level of confidence.
Geology: Superficial deposits and Bedrock - Low		Short Term		Not Significant	
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions – High		Short Term		Not Significant	

Table 9-14: Preliminary Assessment of Geology and Hydrogeology during the Operational Phase

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions – High	Requirement for dewatering (although not anticipated), which may reduce flow to groundwater supported sites, abstractions (regulated and non-regulated), unique groundwater features such as blow wells, chalk streams and springs and surface water bodies and change soil hydrology locally.	Long Term	Determination of groundwater regime through ground investigation and monitoring. Development of and implementation of a dewatering scheme in consultation with Environment Agency.	Not Significant	Moderate - The ground investigation data is still outstanding, and a hydrogeological risk assessment has not been undertaken therefore more detailed information is still required but dewatering schemes have been adopted successfully on similar schemes.
Hydrology: Surface Water Features - High		Long Term		Not Significant	
Hydrology: Surface Water Features - High		Long Term		Not Significant	
Geology: Superficial deposits and Bedrock - Low	The foundations of structures and pipelines may provide a preferential pathway for contaminants to migrate to non-contaminated geology, and groundwater.	Long Term	Ground investigation to inform design of foundations and prevent creation of pollutant linkages. Where piled foundations are used, they will be designed in	Not Significant	Moderate – although appropriate mitigation measures will be implemented as per the CEMP and good practice, a ground investigation to examine the chemical composition of the ground within the
Hydrogeology: Aquifers (Principal, Secondary A & B and undifferentiated Aquifers), Source Protection Zones (SPZ 1, 2 and 3) and Regulated and unregulated abstractions - High		Long Term		Not Significant	

Receptor (Sensitivity)	Potential Impact	Duration	Mitigation	Likely significance of effect	Confidence in Prediction
			accordance with the EA guidance document 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention'		Draft Order Limits has not yet occurred.
Development Infrastructure: AGIs and Pipelines – Medium	The potential for aggressive ground contaminants posing a risk to the pipelines.	Long Term	Design of suitable pipeline materials and in ground structures. Appropriate testing of backfill materials prior to use on site.	Not Significant	Moderate – although appropriate mitigation measures will be implemented through design, a ground investigation to examine the chemical composition of the ground within the Draft Order Limits has not yet occurred.

Decommissioning

- 9.7.6 The assumed scenario is that as part of the decommissioning phase the pipeline will be left in-situ with only the AGIs being removed. The works and therefore effects to decommission the Project will be similar to those of construction in relation to the AGIs. Refer to **Table 9-14** for potential effects.

9.8 Summary and Next Steps

- 9.8.1 This chapter has identified baseline conditions and the potential effects of the Project on geological and hydrogeological characteristics within the Study Area.
- 9.8.2 The Draft Order Limits are mainly within a rural setting. The Draft Order Limits are predominantly underlain by Glacial Till (Secondary Undifferentiated Aquifer) with some areas of Tidal Flat Deposits (Secondary Undifferentiated Aquifer) and Glaciofluvial Deposits (Secondary A Aquifer), the bedrock geology is Chalk (Principal Aquifer). A number of SPZs are present within the Draft Order Limits, with Section 2 passing through an Inner Protection Zone (SPZ 1). However, no significant sources of potential ground contamination have been identified within the majority of the Draft Order Limits. It is recognised that ground contamination may be present at Option 1 of the Theddlethorpe Facility (at the former TGT), but it is assumed that by the time of construction, this specific area of the former TGT site within the Draft Order Limits will have been fully remediated, with mitigation in place to avoid disturbing remedial works. Likewise, if remedial works are required at the Immingham Facility, it is assumed remediation will have occurred prior to construction, as part of this Project.
- 9.8.3 The preliminary assessment of potential impacts that could occur during the construction phase are those associated with spillages and leaks of fuel and chemicals during the operation of construction plant, degradation of soil quality during the handling and movement of soils, as well as dewatering affecting groundwater levels. However, with the appropriate Additional Mitigation in place, as presented in the Preliminary Draft CEMP (Appendix 3.1), no significant effects on geology and hydrogeology are expected. The preliminary assessment of impacts identified during the operational phase of the Project has also predicted there would be no significant effects on geology and hydrogeology. Further stakeholder engagement will be undertaken as and when required throughout the next stage of the assessment. This is likely to comprise a meeting with the Environment Agency to discuss groundwater conditions in the Chalk bedrock Principal Aquifer, and with Anglian Water where the Draft Order Limits pass through an SPZ 1.

Surveys

- 9.8.4 Site walkover surveys will be undertaken at specific points of interest along the Draft Order Limits and any areas of potential concern for contamination. This is considered to comprise the Immingham Facility and the Theddlethorpe Facility (Option 1). Smaller areas of interest such as the area where the Draft Order Limits pass through the SPZ 1 may also be visited.
- 9.8.5 Information relating to Private Water Supplies has been requested from the four relevant Local Authorities as part of this assessment. Depending on the results of the identification of Private Water Supplies, questionnaires may be conducted by a suitably qualified and experienced consultant with the registered owners to investigate the private water supplies to gather more information to include within the ES. Where required, a risk assessment will be undertaken as part of the ES chapter and mitigation (such as water quality monitoring) will be stipulated in the Draft CEMP.

- 9.8.6 It is unlikely that the Project specific ground investigation will have been completed before the submission of the ES chapter, however, some existing GI data at the former TGT will be available to review as part of the full impact assessment to refine the understanding of ground conditions.
- 9.8.7 As part of the full impact assessment, the baseline conditions, potential impacts and assessment of significant effects will be reviewed and refined based on the further design of the pipeline and AGIs along with feedback from this Statutory Consultation, and other stakeholder engagement. This will provide a more detailed assessment of the potential impacts of the Project within the ES.

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