

Viking CCS Pipeline

**Environmental
Statement Volume IV –
Appendix 9-3
Hydrogeological Risk
Assessment – Revision
A (Clean)**

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Table of Contents

1	Introduction.....	1
1.1	Overview	1
1.2	Source Protection Zones	2
1.3	Hydrogeological Risk Assessment.....	6
1.4	References	40

Figures

Figure 1: Map showing locations of SPZ 2 (Blue) and SPZ 3 (Green) transected by the DCO Site Boundary (Red Outline).....	3
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Tables

Table 1: Summary of Historical BGS Borehole Records.....	7
Table 2: Preliminary Hydrogeological Risk Assessment	11
Table 3: Summary of Historical BGS Borehole Records.....	15
Table 4: Preliminary Hydrogeological Risk Assessment	18
Table 5: Summary of Historical BGS Borehole Records.....	21
Table 6: Preliminary Hydrogeological Risk Assessment	25
Table 7: Summary of Historical BGS Borehole Records.....	28
Table 8: Preliminary Hydrogeological Risk Assessment	32
Table 9: Summary of Historical BGS Borehole Records.....	35
Table 10: Preliminary Hydrogeological Risk Assessment	38

1 Introduction

1.1 Overview

- 1.1.1 This report is appended to the Viking CCS Pipeline Environmental Statement (ES) and forms *ES Volume IV Appendix 9-3 Preliminary Hydrogeological Risk Assessment (Application Document 6.4.9.3)*.
- 1.1.2 The baseline assessment undertaken as part of the Viking CCS Pipeline ES, identified that the development consent order boundary (DCO Site Boundary) passes through a number of groundwater abstraction Source Protection Zones (SPZ) and Drinking Water Groundwater Safeguard Zones (Groundwater SgZs) with further details provided in Section 9.2.
- 1.1.3 Additionally, following Position Statement B3 in 'The Environment Agency's approach to groundwater protection', private groundwater abstractions identified by Northeast Lincolnshire Council and East Lindsey District Council and used for human consumption or food production purposes identified to be within 50m of the DCO Site Boundary have been classified as a SPZ 1. This applies to 1 No. abstraction approximately 43m north of the DCO Site Boundary in the East Lindsey District Council boundary and within Section 5 of the DCO Site Boundary near Theddlethorpe All Saints, which is a single domestic supply from an unknown source (and therefore assumed to be an active groundwater abstraction used for human consumption as a worst-case scenario). The sensitivity of this receptor has been classified as 'high' and is assessed in this document.
- 1.1.4 Contact with the relevant landowners indicates two private water abstractions used for domestic purposes within the Northeast Lincolnshire Council district boundary and within 50m of the DCO Site Boundary are unlikely to be active and, therefore, have not been further assessed.
- 1.1.5 Whilst other private groundwater abstractions are present within 250m of the DCO Site Boundary (and therefore could have a default SPZ 2 classification based on Position Statement B3), they have not been assessed as the abstracted volumes are considered to be minimal (up to 1m³ / day within 210m of the DCO Site Boundary and 1.4m³ / day approximately 245m from the DCO Site Boundary).
- 1.1.6 This Hydrogeological Risk Assessment (HyRA) relates specifically to the SPZs that the DCO Site Boundary pass through and how the Proposed Development could impact the SPZs and nearby licensed groundwater abstractions, as well as the SPZ 1 for the private groundwater abstraction located 43m north of the DCO Site Boundary (Section 5).

Project Description

- 1.1.7 The Viking CCS Pipeline ('the Proposed Development') comprises a new 24" (609 mm) diameter onshore pipeline of approximately 55.5 km in length, which will transport Carbon Dioxide (CO₂) from the Immingham industrial area to the Theddlethorpe area on the Lincolnshire coast, where it will connect into the existing 36" (921 mm) diameter offshore LOGGS pipeline.
- 1.1.8 The Proposed Development is an integral part of the overall Viking CCS Project, which intends to transport compressed and conditioned CO₂ received at a facility at Immingham to store in depleted gas reservoirs under the Southern North Sea. The offshore elements of the Viking CCS Project, including the transport of CO₂ through the LOGGS pipeline to the Viking gas fields under the North Sea, are subject to a separate consenting process.

1.1.9 The key components of the Proposed Development comprise:

- Immingham Facility;
- Approximately 55.5 km 24 inch (") onshore steel pipeline (including cathodic protection);
- Three Block Valve Stations;
- Theddlethorpe Facility;
- Existing LOGGS pipeline and isolation valve to the extent of the Order Limits at Mean Low Water Springs (MLWS);
- Permanent access to facilities;
- Mitigation and landscaping works;
- Temporary construction compounds, laydown, parking, and welfare facilities;
- Temporary access points during construction.

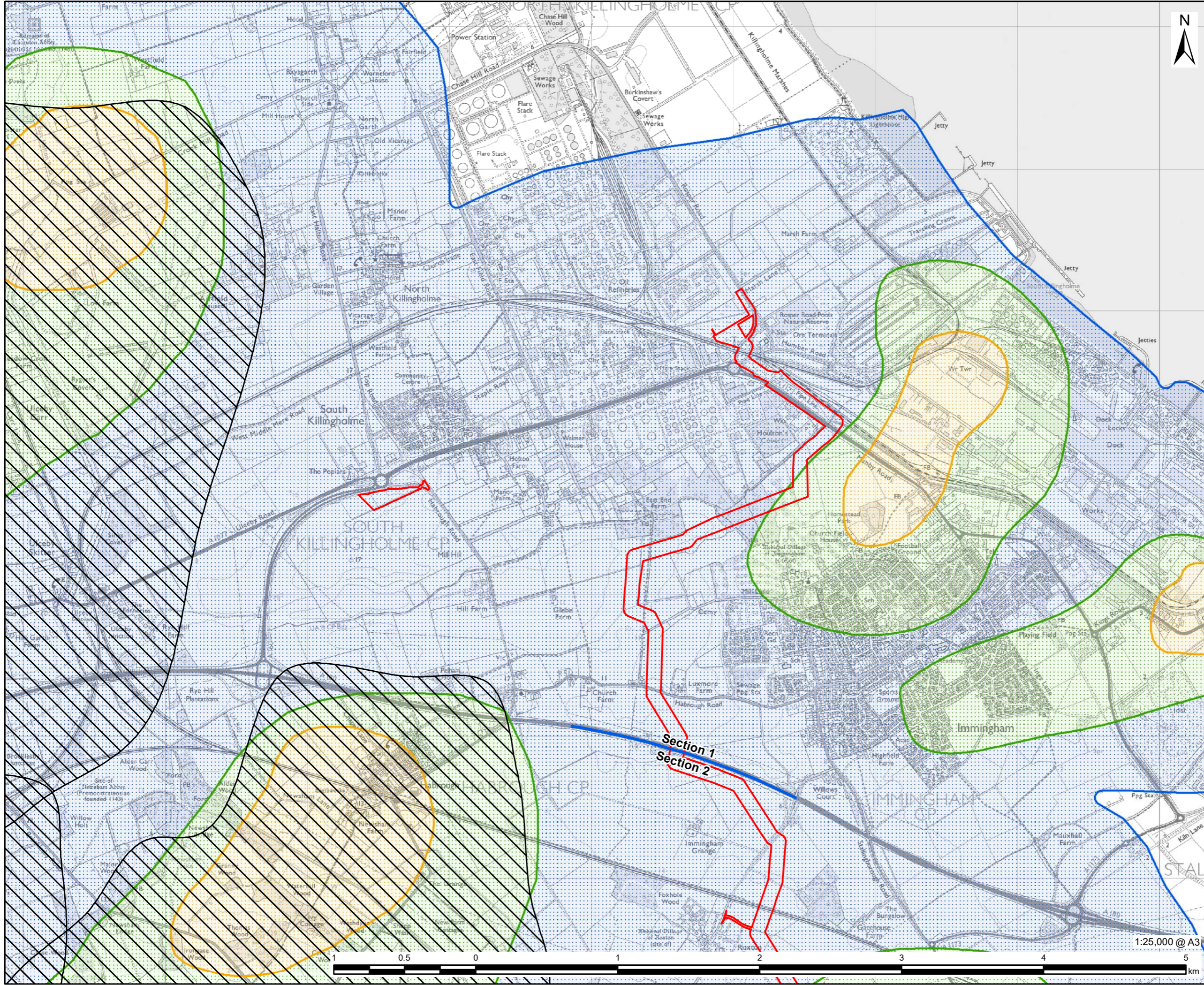
1.1.10 Further details of each element of the Proposed Development are set out in Chapter 3 of the Environmental Statement (*Application Document 6.2.3*).

1.2 Source Protection Zones

1.2.1 At the north end of the Proposed Development, to the north of Immingham, east of South Killingholme, the DCO Site Boundary in Section 1 passes through an SPZ 2 (Outer) and 3 (Total Catchment) over approximately 3.6km (see Figure 1 below). The SPZ 2 is situated between Immingham Docks and Immingham Town while the SPZ 3 covers the rest of the DCO Site Boundary from Immingham Docks down to the A180 (Section 1). The DCO Boundary does not pass within 1km of a groundwater SgZs within this area.

1.2.2 It was also noted that approximately 9km of the DCO Site Boundary in Section 2 passes through a SPZ 1 (Inner), SPZ 2 (Outer) and SPZ 3 (Total) between the A180 (Section Break 1) and the A46 (Section 2) (see Figure 1 below). The SPZ 1 is situated around Little London, the SPZ 2 is situated around Roxton and between Keelby and Aylesby and the SPZ 3 is situated near the A180 and between Laceby and the A46. The DCO Boundary also passes through several groundwater SgZs within Section 2.

1.2.3 Finally, it was noted that approximately 16.5km of the DCO Site Boundary passes through a SPZ 2 (Outer) and SPZ 3 (Total) between A46 to Pear Tree Lane, and slightly south of Pear Tree Lane, just crossing over minimally into Section 4 (see Figure 1 below). SPZ 2 are situated between Barnoldby le Beck and Brigsley and then again between Grainsby and Ludborough. The SPZ 3 is situated between the A46 and Barnoldby le Beck, Brigsley and Grainsby and then finally Ludborough and Covenham St Bartholomew (Section 3). The DCO Boundary also passes through several groundwater SgZs within Section 3.



LEGEND

- DCO Site Boundary
- Route Section Break
- Drinking Water Safeguard Zones - Groundwater (EA)
- Source Protection Zone (EA)
- Zone 1 - Inner Protection Zone
- Zone 2 - Outer Protection Zone
- Zone 3 - Total Catchment

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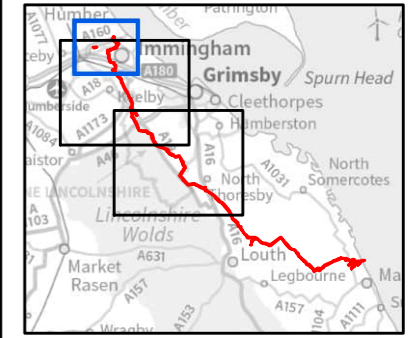
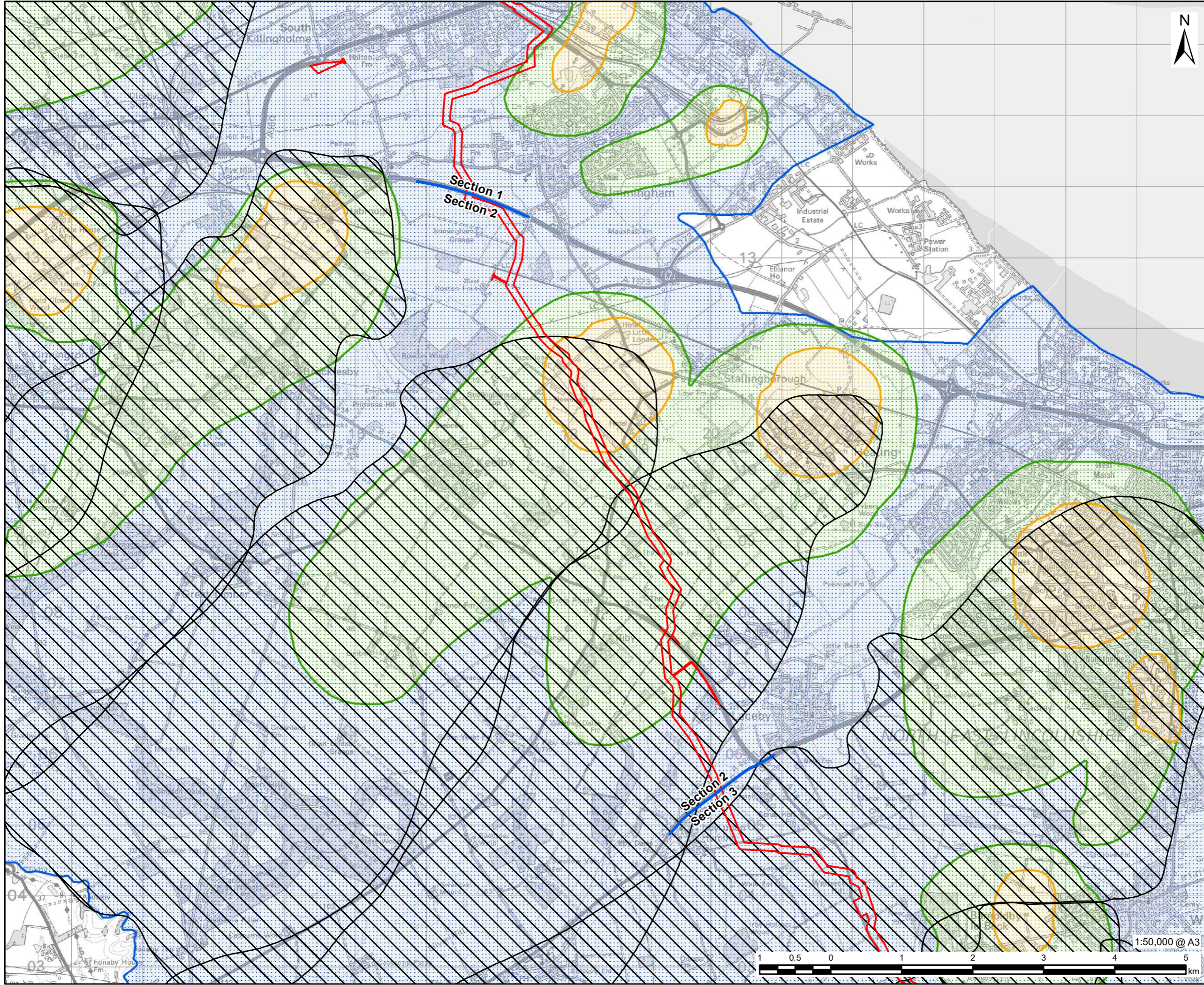


FIGURE TITLE
Figure 1 (1 of 3)
Source Protection Zones and Drinking Water Safeguard Zones (Groundwater)

ISSUE PURPOSE
 ENVIRONMENTAL STATEMENT

PROJECT NUMBER / REFERENCE
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- LEGEND**
- DCO Site Boundary
 - Route Section Break
 - Drinking Water Safeguard Zones - Groundwater (EA)
 - Source Protection Zone (EA)
Zone 1 - Inner Protection Zone
 - Zone 2 - Outer Protection Zone
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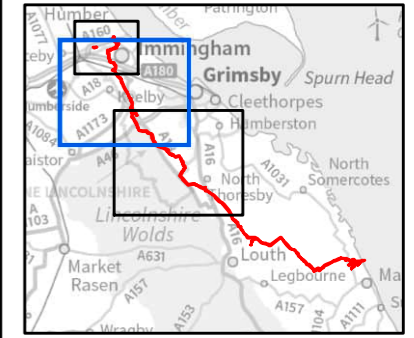
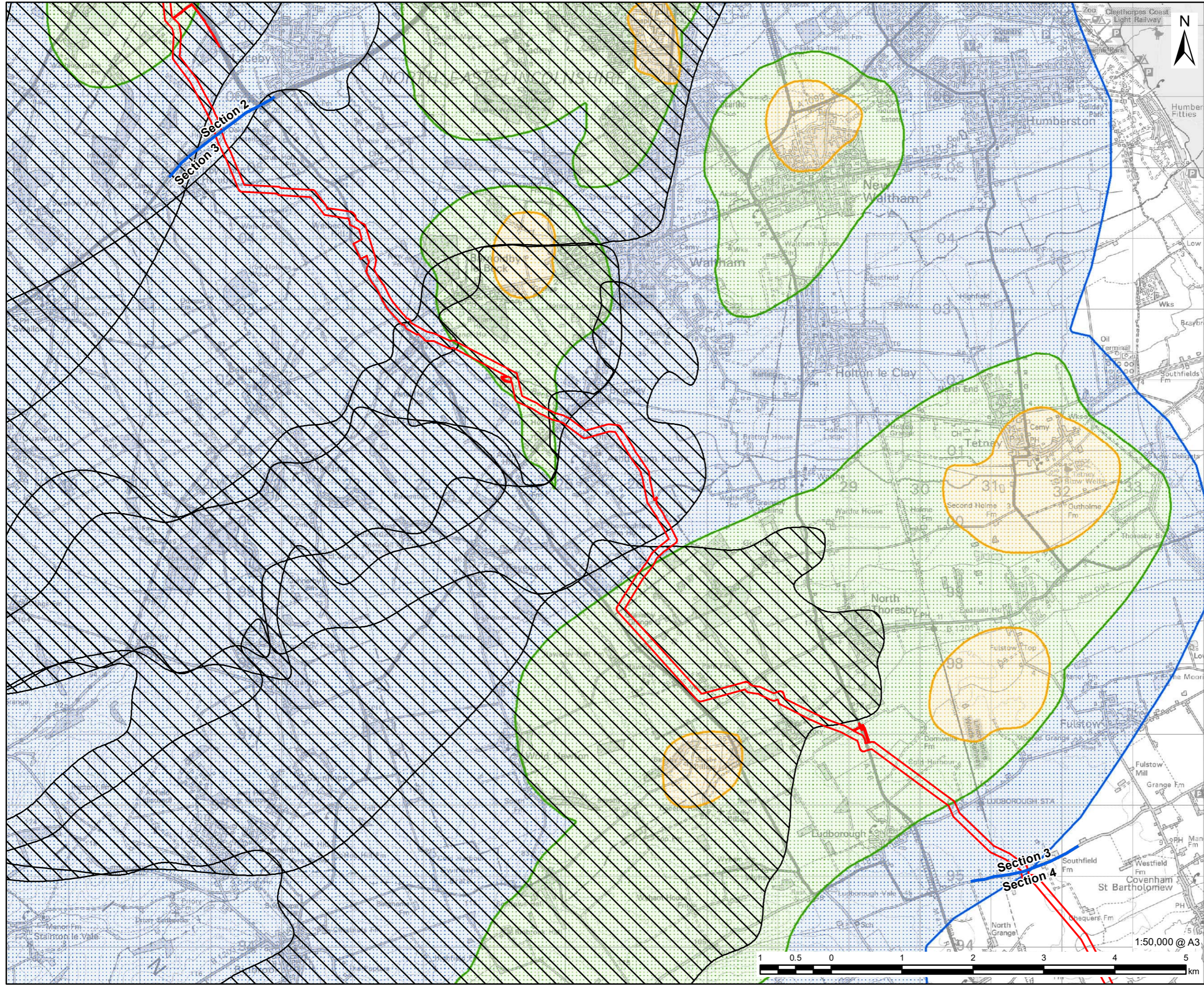


FIGURE TITLE
Figure 1 (2 of 3)
Source Protection Zones and Drinking Water Safeguard Zones (Groundwater)

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LEGEND

- DCO Site Boundary
- Route Section Break
- Drinking Water Safeguard Zones - Groundwater (EA)
- Source Protection Zone (EA)
Zone 1 - Inner Protection Zone
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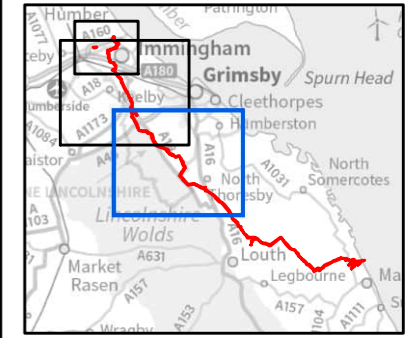


FIGURE TITLE
Figure 1 (3 of 3)
Source Protection Zones and Drinking Water Safeguard Zones (Groundwater)

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1.3 Hydrogeological Risk Assessment

1.3.1 In line with the Environment Agency's guidance (Ref 1) a Hydrogeological Risk Assessment (HyRA) has been carried out for the section of the Proposed Development which passes through the SPZ 2 north of Immingham, the SPZ 1 and SPZ 2 around Little London, the SPZ 2 west of Brigsley and the SPZ 2 between Grainsby and Ludborough and the locally designated SPZ 1 for the private groundwater abstraction in Section 5, to demonstrate that the risks are acceptable and can be mitigated. Within the EA's Approach to Groundwater Protection document, Environment Agency position statement N7 (Hydrogeological Risk Assessment) (Ref 1) states that:

“Developers proposing schemes that present a hazard to groundwater resources, quality or abstractions must provide an acceptable hydrogeological risk assessment (HRA) to the Environment Agency and the planning authority. Any activities that can adversely affect groundwater must be considered, including physical disturbance of the aquifer. If the HRA identifies unacceptable risks, then the developer must provide appropriate mitigation. If this is not done or is not possible the Environment Agency will recommend that the planning permission is conditioned, or it will object to the proposal”.

1.3.2 Furthermore, the areas designated as SPZ around Little London (Section 2) and Grainsby – Ludborough (Section 3) are also classified as Groundwater SgZs (shown by areas of grey shading on Figure 1, above). The Water Framework Directive (WFD) requires that drinking water protected areas are identified (WFD Article 7.1) and given the necessary protection (WFD Article 7.3) with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water” (Ref 2).

1.3.3 In the absence of site-specific ground investigation data at this stage, the HyRA is considered to be 'preliminary' and will be reviewed and updated based on the findings of future ground investigation. The following sections summarise the findings from the preliminary HyRA.

Proposed Development within SPZ 2 to the North of Immingham

Proposed Development

1.3.4 The Proposed Development within the SPZ 2 identified in Section 1 of the DCO Site Boundary, and shown in 1, comprises the following elements:

Pipeline Construction

- Stripping of topsoil and stockpiling in a suitable location;
- Pipeline sections are placed on supports and welded together in sections called 'strings';
- Pipeline trench dug (to a minimum of 2.0-2.2m) and pipeline 'strings' lowered using 'side boom' vehicles;
- Trench filled with previously excavated materials, and topsoil carefully replaced; and

Crossings

- Potential HDD (Children's Avenue HDD) – Option to avoid P66 and Children's Avenue (Length: 636m, Depth: to be confirmed subject to additional geotechnical ground investigation work). If drilling is required greater than a depth of 10 metres within the chalk bedrock, the EA would be consulted.

Potential Sources of Contamination

Identified Historical Sources of Contamination

1.3.5 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping obtained from Groundsure which dates from 1886 to 2022. This review identified no potential historical sources of contamination within both the DCO Site Boundary and SPZ 2.

1.3.6 However, there is still the potential for unidentified sources of contamination to be present within this area that have not been identified by the review.

Potential sources of Contamination during Construction Phase

1.3.7 The following potential sources of contamination have been identified associated with the proposed construction works within the SPZ North of Immingham:

- Imported materials (e.g., backfilling of the trench, although it is noted that backfill with previously excavated materials is proposed);
- Plant used for excavation of the trench (e.g., fuel/oil spillage); and
- Temporary drainage discharge.
- No construction compounds or storage of fuels is proposed within the SPZ 2.

Potential Sources of Contamination during Operational Phase

1.3.8 Once construction is completed, the trench will be backfilled, and all surface areas reinstated to their current condition. No potential sources of contamination will remain during the operational phase.

Environmental Setting

Geology

1.3.9 Published geological maps (Ref 3, Ref 4, Ref 5, Ref 6, Ref 7), and the GIS data sourced from the BGS (Ref 8), indicate that the Proposed Development is underlain by the geological succession in the mapped SPZ 1 and SPZ 2 areas summarised below:

- Superficial deposits comprising Glacial Till and Tidal Flat Deposits; and
- Bedrock comprising Burnham Chalk Formation.

1.3.10 BGS Geo-Index online viewer (Ref 9) provides records for ground investigation data from many boreholes drilled within the surrounding area of the Proposed Development. Strata encountered has been summarised below in **Table 1**.

Table 1: Summary of Historical BGS Borehole Records

BGS Borehole Ref.	TA11NE83	TN11NE265
Location	Staves Marsh, Immingham	Unspecified Location, Immingham
Distance	Within DCO Site Boundary, within the SPZ 2 boundary	430m east of DCO Site Boundary, within the SPZ 2 boundary
Superficial Deposits	Warp (artificially induced Alluvium) encountered to 4.8m bgl (4.42m thickness), sands and gravel to 6.7m bgl (1.83m), clay to 9.1m bgl (2.44m), sand and gravel to	Clay encountered to 35m bgl.

BGS Borehole Ref.	TA11NE83	TN11NE265
	9.6m bgl (0.46m), clay to 13.7m bgl (4.11m) and gravel to 15m bgl (depth unproven).	
Bedrock	No bedrock encountered at final depth of 15m bgl.	Chalk bearings encountered at 35m bgl, Chalk at 36.5m bgl to 43.89m bgl (base of hole).
Groundwater Levels	Resting water level at 1m bgl.	Resting water level at 0.7m bgl, above top of pipe, indicating artesian water conditions from the chalk.

Hydrogeology

1.3.11 Aquifer classification maps on Defra’s ‘MAGIC’ mapping portal (Ref 10) and from the Groundsure report (Ref 8) indicate the following aquifer classifications are present within this area of the DCO Site Boundary:

- Superficial: Glacial Till – Secondary (Undifferentiated) Aquifer and Tidal Flat Deposits – Unproductive Strata;
- Bedrock: Burnham Chalk Formation – Principal Aquifer;
- Groundwater Vulnerability is classed as ‘Low’; and

1.3.12 Based on BGS records (above), the bedrock may be confined by the overlying clay (Glacial Till), however some areas have sand and gravel lenses throughout (Tidal Flat Deposits). Groundwater is assumed to be potentially artesian from the principal chalk aquifer, although the BGS records in **Table 1** did not have recorded water strikes, only resting water levels.

Identified Hydrogeological Receptors

1.3.13 A groundwater abstraction at Associated British Ports (ABP), located off Southern Way, approximately 484m southeast of the DCO Site Boundary, is operated by Anglian Water for raw water supply, which is assumed to abstract from the Principal Bedrock Aquifer, but this information is not publicly available.

Mitigating Factors and Mitigation Measures

1.3.14 Main pipeline construction will be no more than 2.2m in depth (with exception of HDD crossings which may reach typically less than 10m but up to 20m subject to agreement with the Environment Agency and are therefore anticipated to be entirely within the topsoil, subsoil, and superficial deposits (Glacial Till). Based on available BGS data, chalk bedrock may be present below 10m bgl. If drilling/excavation is required within the chalk bedrock, the EA would be consulted. Other BGS records indicate chalk may be potentially up to 35m bgl and in this case land should therefore be afforded sufficient protection by low permeability Glacial Till beneath the base of the proposed excavations.

1.3.15 Groundwater is considered unlikely to be encountered within the shallow excavations for the main pipeline and open cut trenches, with the potential exception of perched (i.e., not laterally continuous) groundwater within more permeable lenses within the Glacial Till. If

groundwater is encountered, a dewatering plan will be in place to manage the water appropriately.

- 1.3.16 Where sand and gravel lenses are identified, with lesser thicknesses of Glacial Till, additional mitigation measures may be required for deeper excavation for the HDD crossing to protect the underlying chalk Principal Aquifer. Clean drilling will be undertaken if evidence of contamination is identified, using a bentonite seal to seal off the contamination. This is secured via commitment E27 in the Draft CEMP (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*). Additionally, based on local geological features previously identified in the Immingham area and close to the coastline, such as blow wells, there is a possibility that groundwater will be artesian in the chalk. If drilling into the chalk Principal Aquifer is required, the EA would be consulted to ensure appropriate mitigation measures (e.g., clean drilling as described above) are in place prior to the works commencing and to ensure no delays.
- 1.3.17 All works will be undertaken in accordance with the Viking CCS Pipeline CEMP, detailing the following:
- **E18:** Chemical testing of materials imported to site (other than primary aggregates) will be tested to mitigate the risk to groundwater and stored appropriately on site;
 - **E22:** Unless essential (e.g., for safety at road crossings), vehicle washing will not take place within the SPZ2. Where vehicle washing does take place, this will be undertaken in designated areas in which the arising effluent can be captured and managed appropriately; and
 - **E23:** Water Management Plan (WMP) will be in place to mitigate potential impacts to identified receptors by ensuring surface water runoff quality and quantity is managed effectively. This includes intercepting surface run-off from the works areas by filters and 'header' drains running along the edge of the temporary haul roads, which will lead to attenuation ponds prior to being discharged to appropriate surface watercourses (subject to agreement from the relevant IDB);
 - **E29:** The drilling fluid within the annular space between the installed pipe and the HDD bore will be left in-situ on completion of the pipe pull back. Any surplus drilling fluid will be removed off-site for recycling and/or disposal. Contingency plans will be in place to deal with any indications of drilling fluid release;
 - **E30:** Measures for appropriate temporary storage of soil. In addition, ground investigation will include chemical testing and risk assessment to identify potential risks to groundwater from mobilisation of contaminants, if present, within soil in the SPZ2;
 - **E32:** No storage of fuel, or refuelling of plant and equipment, within the SPZ2. Refuelling will be restricted to designated areas within construction compounds, of which none are to be located within the SPZ2;
 - **E31:** Inspection and maintenance of plant and equipment, and the provision of spill kits on site in order to mitigate the potential risk of spills or losses (e.g., of fuel, hydraulic oil) to identified receptors;

Potential Pollutant Linkages and HyRA

- 1.3.18 Potential Source – Pathway – Receptor (SPR) linkages with respect to hydrogeology are summarised as follows:

Sources

- 1.3.19 Potential unidentified historical contamination.

1.3.20 Contaminants associated with the construction of the Proposed Development through the North of Immingham SPZ2, including:

- Fuels, Oils and Lubricants from plant / equipment; and
- Materials stored/used on site (e.g., imported backfill, soil arisings from drilling).

Pathways

- Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling; and
- Lateral migration within the bedrock aquifer towards the licensed water supply borehole (which is assumed to abstract from the Principal Bedrock Aquifer) as a result of pumping.

Receptors

- Principal Bedrock Aquifer (specifically the licensed ABP Reception Bore for private water undertaking (Raw water supply)).

1.3.21 The preliminary HRA in **Table 2**, has been produced taking into consideration the hydrogeological setting and mitigation measures described above:

Table 2: Preliminary Hydrogeological Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (likelihood)	Potential Risk ¹	Justification
Potential unidentified historical contamination and contaminants associated with the construction of the Proposed Development	Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;	Principal Bedrock Aquifer (specifically the ABP licensed water supply), SPZ 2 & Groundwater SgZs	Medium	Unlikely	Low	Although a sensitive receptor has been identified, the potential risk is considered to be low for the following reasons: The relatively significant distance from the proposed development to the abstraction point (c.500m); The anticipated presence of at least 15 m of low permeability Glacial Till between the base of the excavation and the underlying aquifer unit. If sand and gravel horizons are identified with evidence of contamination, or weathered chalk, additional mitigation measures will be adopted; No water strikes recorded in the Chalk based on the nearest BGS log. If groundwater is present in the Glacial Till it is
	Lateral migration within the bedrock aquifer towards the licensed supply borehole					

¹ Potential consequence (severity), magnitude of probability (likelihood) and potential risk ratings have been assigned based on criteria presented in the Contaminated Land Risk Assessment: A Guide to Good Practice C552 (CIRIA C552, 2001).

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (likelihood)	Potential Risk ¹	Justification
						<p>considered likely to be 'perched' in nature (i.e., laterally, and vertically discontinuous); All works will be undertaken in accordance with the CEMP, and mitigation measures described therein.</p>

Dewatering

- 1.3.22 Any dewatering activities in this area of the Proposed Development will be on a small scale, abstracting low volumes of water over a limited period of time and is anticipated to be within the superficial deposits. As such it is unlikely any groundwater abstraction will have a significant long-term impact on the groundwater levels in the Principal Aquifer or at the ABP abstraction well.
- 1.3.23 If dewatering activities require the abstraction of more than 20m³ / day of groundwater, a licence will need to be obtained. In consultation with the Environment Agency, more detailed assessment of the potential impacts would be undertaken as part of the dewatering strategy, and appropriate mitigation implemented if required.

Summary

- 1.3.24 Given the proposed construction methodology, pipeline design, the anticipated geological conditions and the mitigation measures which will be in place, the potential risk to the chalk aquifer and licensed water supply at ABP is considered to be low.
- 1.3.25 This preliminary HyRA will be reviewed and updated in light of any changes in methodology, pipeline design and/or site-specific ground investigation data that becomes available.

Proposed Development within SPZ 1 around Little London and SPZ 2 around Roxton and between Keelby and Aylesby

Proposed Development

- 1.3.26 The Proposed Development within the SPZ 1 and SPZ 2 identified in Section 2 of the DCO Site Boundary, and presented on **Figure 1** comprises the following elements:

Pipeline Construction

- Stripping of topsoil and stockpiling in a suitable location;
- Pipeline sections are placed on supports and welded together in sections called 'strings';
- Pipeline trench dug (to a minimum of 2.0-2.2m) and pipeline 'strings' lowered using 'side boom' vehicles;
- Trench filled with previously excavated materials, and topsoil carefully replaced; and

Crossings

- North Beck Drain HDD – (Length: 360m, Depth: to be confirmed subject to additional geotechnical ground investigation work). If drilling is required greater than a depth of 10 metres within the chalk bedrock, the EA would be consulted.
- Auger Bore – (Multiple locations, up to 10m)
- Open cut trenching (Watercourse and Track) – (Multiple locations, up to 5m)

Laydown Area

- 1.3.27 (Keelby Road – SPZ 1 and A1173 Riby Road and Washingdale Lane – SPZ 2)
- Stripping of topsoil and stockpiling in a suitable location;
 - Placement of geo textile and stone surface for construction of a temporary haul road/lay down area to comprise welfare and parking.

Above Ground Infrastructure (SPZ 2 only)

- Washingdales Lane Block Valve Station – Washingdales Lane (SPZ 2 only).

Potential Sources of Contamination

Identified Historical Sources of Contamination

- 1.1.1 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping dating from 1886 to 2022, obtained from Groundsure. This review identified no potential historical sources within both the DCO Site Boundary and SPZ 1 and SPZ 2.
- 1.3.28 However, there is still the potential for unidentified sources of contamination to be present within this area that have not been identified by the review.

Potential sources of Contamination during Construction Phase

- 1.3.29 The following potential sources of contamination have been identified associated with the proposed works within the SPZ between Little London and Aylesby:
- Imported materials (e.g., backfilling of the trench, although it is noted that backfill with previously excavated materials is proposed for the pipeline);
 - Plant used for excavation of the trench (e.g., fuel/oil spillage);
 - Temporary storage of excavated soil; and
 - Temporary drainage discharge.
- 1.3.30 Three Major Laydown areas are proposed, one within the SPZ 1 (Keelby Road) and two within the SPZ 2 (Riby Road and Washingdales Lane), these areas will be used for welfare and parking and will be covered in hardstanding. The laydown areas are located separately from the main construction compounds.
- 1.3.31 No construction compounds or storage of fuels is proposed within the SPZ 1 and SPZ 2.

Potential Sources of Contamination during Operational Phase

- 1.3.32 Once construction is completed, the trench will be backfilled, and all surface areas reinstated to their current condition. No potential sources of contamination will remain during the operational phase.

Environmental Setting

Geology

- 1.3.33 Published geological maps (Ref 3, Ref 4, Ref 5, Ref 6 and Ref 7) and the GIS data sourced from the BGS (Ref 8), indicate that the Project is underlain by the geological succession in the mapped SPZ 1 and SPZ 2 areas summarised below:
- Superficial deposits comprising Glacial Till, Alluvium, Lacustrine Deposits, Glaciofluvial Deposits; and
 - Bedrock comprising Burnham Chalk Formation.
- 1.3.34 BGS Geo-Index online viewer (Ref 9) provides records for ground investigation data from many boreholes drilled within the surrounding area of the Project. Strata encountered has been summarised below in **Table 3**.

Table 3: Summary of Historical BGS Borehole Records

BGS Borehole Ref.	TA11NE88	TN10NE66
Location	Greenland Top Aerodrome	The Lindens, Riby
Distance	97m east of DCO Site Boundary, within SPZ 1 boundary	105m west of DCO Site Boundary, within SPZ 2 boundary
Superficial Deposits	Drift and clay encountered to ~15m bgl (sand and gravel lenses to a maximum thickness of 0.9m.	Clay encountered to ~20m bgl.
Bedrock	Chalk bearings encountered at ~19.8m bgl and competent Chalk encountered at ~23.4m bgl. *	Chalk bearings encountered at ~20m bgl and competent Chalk encountered at ~22m bgl.
Groundwater Levels	Shallow groundwater within the superficial approximately 3.2m bgl.	No groundwater encountered.

* Confidential information within this area indicates that chalk bearings may be present at shallower depths, from approximately 15m and groundwater may be present from approximately 18m.

Hydrogeology

1.3.35 Aquifer classification maps on Defra’s ‘MAGIC’ mapping portal (Ref 10) and from the Groundsure report (Ref 9) indicate the following aquifer classifications are present within this area of the DCO Site Boundary:

- Superficial Aquifers: Glacial Till – Secondary (Undifferentiated) Aquifer, Alluvium – Secondary A Aquifer, Lacustrine Deposits – Secondary B Aquifer, Glaciofluvial Deposits – Secondary A Aquifer;
- Bedrock Aquifer: Burnham Chalk Formation – Principal Aquifer.
- Groundwater Vulnerability is classed as ‘Medium’; and
- Based on BGS records (above), the bedrock in places is confined by the overlying clay (Glacial Till). There are two small areas in this section with no mapped superficial deposits, which the DCO Site Boundary pass through and no heavy plan storage would be permitted in these locations.

Identified Hydrogeological Receptors

1.3.36 4 No. groundwater abstractions located from approximately 600m east of the DCO Site Boundary are operated by Anglian Water for public potable water supply (which are assumed to abstract from the Principal Bedrock Aquifer).

Mitigating Factors and Mitigation Measures

1.3.37 Main pipeline excavations will be no more than 2.2m in depth, however specialised crossings (Auger Bore) could be up to 10m bgl or up to 20m (HDD) and are therefore anticipated to be entirely within the topsoil, subsoil, and superficial deposits (Glacial Till and Alluvium). Based on available BGS data, chalk bedrock is anticipated to be present at a depth of at least 15 m bgl and should therefore be afforded protection by at least 5 m of low permeability Glacial Till beneath the base of the proposed excavations. If deeper

drilling/excavation is required which is anticipated to be within the chalk bedrock for HDD crossings, the EA should be consulted.

- 1.3.38 Groundwater is considered unlikely to be encountered within the shallow excavations for the main pipeline and open cut trenches, with the potential exception of perched (i.e., not laterally continuous) groundwater within more permeable lenses within the Glacial Till. If groundwater is encountered, a dewatering plan will be in place to manage the water appropriately.
- 1.3.39 Where sand and gravel lenses are identified, with lesser thicknesses of Glacial Till, additional mitigation measures may be required for deeper excavation for the HDD crossing and the Auger Bore, to prevent contamination of the underlying chalk Principal Aquifer. Clean drilling will be undertaken if evidence of contamination is identified, using a bentonite seal to seal off the contamination. This is secured via commitment E27 in the Draft CEMP (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*). Additionally, based on local geological features previously identified in the Lincolnshire area and close to the coastline, such as blow wells, there is a possibility that groundwater will be artesian in the chalk. If drilling into the chalk Principal Aquifer is required, the EA would be consulted to ensure appropriate mitigation measures (e.g., clean drilling as described above) are in place prior to the works commencing and to ensure there is not a pathway created for groundwater to rise up to the ground surface and potentially affecting the water supply for the public potable water supply wells and other groundwater resources in the area.
- 1.3.40 All works will be undertaken in accordance with the Viking CCS Pipeline CEMP, detailing the following:
- **E18:** Chemical testing -of materials imported to site (other than primary aggregates) will be tested to mitigate the risk to groundwater and stored appropriately on site;
 - **E22:** Unless essential (e.g., for safety at road crossings), vehicle washing will not take place within the SPZ 1 or 2. Where vehicle washing does take place, this will be undertaken in designated areas in which the arising effluent can be captured and managed appropriately; and
 - **E23:** Water Management Plan (WMP) will be in place to mitigate potential impacts to identified receptors by ensuring surface water runoff quality and quantity is managed effectively. This includes intercepting surface run-off from the works areas by filters and 'header' drains running along the edge of the temporary haul roads, which will lead to attenuation ponds prior to being discharged to appropriate surface watercourses (subject to agreement from the relevant IDB);
 - **E29:** The drilling fluid within the annular space between the installed pipe and the HDD bore will be left in-situ on completion of the pipe pull back. Any surplus drilling fluid will be removed off-site for recycling and/or disposal. Contingency plans will be in place to deal with any indications of drilling fluid release;
 - **E30:** Measures for appropriate temporary storage of soil. In addition, ground investigation will include chemical testing and risk assessment to identify potential risks to groundwater from mobilisation of contaminants, if present, within soil in the SPZ 1 or 2;
 - **E32:** No storage of fuel, or refuelling of plant and equipment, within the SPZ 1 or 2. Refuelling will be restricted to designated areas within construction compounds, of which none are to be located within the SPZ 1 or 2;

- **E31:** Inspection and maintenance of plant and equipment, and the provision of spill kits on site in order to mitigate the potential risk of spills or losses (e.g., of fuel, hydraulic oil) to identified receptors;

Potential Pollutant Linkages and HyRA

1.3.41 Potential Source – Pathway – Receptor (SPR) linkages with respect to hydrogeology are summarised as follows:

Sources

1.3.42 Potential unidentified historical contamination.

1.3.43 Contaminants associated with the construction of the Proposed Development through Little London to Aylesby SPZ1 and SPZ2, including:

- Fuels, Oils and Lubricants from plant / equipment; and
- Materials stored/used on site (e.g., imported backfill, drilling arisings).

Pathways

- Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling; and
- Lateral migration within the bedrock aquifer towards the licensed public water supply boreholes (which are assumed to abstract from the Principal Bedrock Aquifer) as a result of pumping.

Receptors

- Principal Bedrock Aquifer (specifically the public potable water supply abstractions near Little London).

1.3.44 The preliminary HRA in **Table 4**, has been produced taking into consideration the hydrogeological setting and mitigation measures described above:

Table 4: Preliminary Hydrogeological Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Probability (Likelihood)	Potential Risk ²	Justification
Potential unidentified historical contamination and contaminants associated with the construction of the Proposed Development	Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;	Principal Bedrock Aquifer (specifically the licensed Little London Public water supplies), SPZ 1, 2 & Groundwater SgZs.	Medium	Unlikely	Low	<p>Although a sensitive receptor has been identified, the potential risk is considered to be low for the following reasons:</p> <p>The relatively significant distance from the proposed development to the abstraction point (over 500m); If HDD reaches 20m it is likely to extend into the chalk bedrock and based on BGS records groundwater may be present from approximately 17m bgl. However, the likelihood of contaminants entering the chalk groundwater considered to be low with appropriate mitigation measures in place. If sand and gravel horizons are identified with evidence of contamination, or weathered chalk is identified, additional mitigation measures will be adopted;</p> <p>If groundwater is present in the Glacial Till it is considered likely to be 'perched' in nature (i.e.,</p>
	Lateral migration within the bedrock aquifer towards the licensed potable supply borehole					

² Potential consequence (severity), magnitude of probability (likelihood) and potential risk ratings have been assigned based on criteria presented in the Contaminated Land Risk Assessment: A Guide to Good Practice C552 (CIRIA C552, 2001).

Source	Pathway	Receptor	Potential Consequence (Severity)	Probability (Likelihood)	Potential Risk ²	Justification
						<p>laterally, and vertically discontinuous); All works will be undertaken in accordance with the CEMP, and mitigation measures described therein.</p>

Dewatering

- 1.3.45 Any dewatering activities in this area of the Proposed Development will be on a small scale, abstracting low volumes of water over a limited period of time and is anticipated to be within the superficial deposits. As such it is unlikely any groundwater abstraction will have a significant long-term impact on the groundwater levels locally in the Principal Aquifer or at the public supply wells.
- 1.3.46 If dewatering activities require the abstraction of more than 20m³ / day of groundwater, a licence will need to be obtained. In consultation with the Environment Agency, more detailed assessment of the potential impacts would be undertaken as part of the dewatering strategy, and appropriate mitigation implemented if required.

Summary

- 1.3.47 Given the proposed construction methodology, pipeline design, the anticipated geological conditions and the mitigation measures which will be in place, the potential risk to the chalk aquifer and the potable water supply near Little London is considered to be low.
- 1.3.48 This preliminary HyRA will be reviewed and updated in light of any changes in methodology, pipeline design and/or site-specific ground investigation data that becomes available.

Proposed Development within SPZ 2 between Barnoldby le Beck and Brigsley Proposed Development

- 1.3.49 The Proposed Development within the SPZ 2 identified in Section 3 of the DCO Site Boundary, and presented on **Figure 1** comprises the following elements:

Pipeline Construction

- Stripping of topsoil and stockpiling in a suitable location;
- Pipeline sections are placed on supports and welded together in sections called 'strings';
- Pipeline trench dug (to a minimum of 2.0-2.2m) and pipeline 'strings' lowered using 'side boom' vehicles;
- Trench filled with previously excavated materials, and topsoil carefully replaced;

Crossings

- Auger Bore – (One location, up to 10m).

Potential Sources of Contamination

Identified Historical Sources of Contamination

- 1.3.50 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping dating from 1886 to 2022, obtained from Groundsure. This review identified no potential historical sources within both the DCO Site Boundary and SPZ 2.
- 1.3.51 However, there is still the potential for unidentified sources of contamination to be present within this area that have not been identified by the review.

1.3.52

Potential sources of Contamination during Construction Phase

- 1.3.53 The following potential sources of contamination have been identified associated with the proposed works within the SPZ between Barnoldby le Beck and Brigsley:

- Imported materials (e.g., backfilling of the trench, although it is noted that backfill with previously excavated materials is proposed);
- Plant used for excavation of the trench (e.g., fuel/oil spillage);
- Temporary storage of excavated soil; and
- Temporary drainage discharge.

1.3.54 No construction compounds or storage of fuels is proposed within the SPZ 2.

Potential Sources of Contamination during Operational Phase

1.3.55 Once construction is completed, the trench will be backfilled, and all surface areas reinstated to their current condition. No potential sources of contamination will remain during the operational phase.

Environmental Setting

Geology

1.3.56 Published geological maps (Ref 3, Ref 4, Ref 5, Ref 6, Ref 7) and the GIS data sourced from the BGS (Ref 9) indicate that the Project is underlain by the geological succession in the mapped SPZ 1 and SPZ 2 areas summarised below:

- Superficial deposits comprising Glacial Till and Alluvium; and
- Bedrock comprising Welton Chalk Formation.

1.3.57 BGS Geo-Index online viewer (Ref 9) provides records for ground investigation data from many boreholes drilled within the surrounding area of the Project. Strata encountered has been summarised below in **Table 5**.

Table 5: Summary of Historical BGS Borehole Records

BGS Borehole Ref.	TA20SW6	TA20SW43
Location	Ashby-cum-Fenby	Moor House
Distance	50m south of DCO Site Boundary and within SPZ 2	10m south of DCO Site Boundary and within SPZ 2
Superficial Deposits	Boulder Clay (interpreted to be Glacial Till) encountered to a maximum depth of 36.58m bgl.	Boulder Clay (interpreted to be Glacial Till) encountered to a maximum depth of 36.57m bgl.
Bedrock	Chalk encountered at 36.58m bgl.	Chalk encountered at 36.57m bgl.
Groundwater Levels	Water rises to within 9m of the surface, assumed to be sub-artesian from the chalk aquifer.	Water rises to within 9m of the surface, assumed to be sub-artesian from the chalk aquifer.

Hydrogeology

1.3.58 Aquifer classification maps on Defra's 'MAGIC' mapping portal (Ref 10) and from the Groundsure report (Ref 8) indicate the following aquifer classifications are present within this area of the DCO Site Boundary:

- Superficial Aquifers: Glacial Till – Secondary (Undifferentiated) Aquifer and Alluvium – Secondary A Aquifer;
- Bedrock Aquifer: Welton Chalk Formation – Principal Aquifer.
- Groundwater Vulnerability is classed as 'Medium'; and
- Based on BGS records (above), the bedrock in places is confined by the overlying clay (Glacial Till).

Identified Hydrogeological Receptors

1.3.59 SPZ 2 between Barnoldby le Beck and Brigsley and associated Groundwater SgZs.

1.3.60 Four Barnoldby Pumping Stations (Bores A-D) have been identified off Waltham Road, situated from approximately 1.3km northeast of the DCO Site Boundary. These are operated by Anglian Water for public potable water supply (which is assumed to abstract from the Principal Bedrock Aquifer).

Mitigating Factors and Mitigation Measures

1.3.61 Main pipeline excavations will be no more than 2.2m in depth and specialised crossings (Auger Bore) will be no more than 10m and are therefore anticipated to be entirely within the topsoil, subsoil, and superficial deposits (Glacial Till and Alluvium). Based on available BGS data, chalk bedrock is anticipated to be present at a depth of approximately 36m bgl and should therefore be afforded protection by at least 25 m of low permeability Glacial Till beneath the base of the proposed excavations.; If deeper drilling/excavation is required within the chalk bedrock, the EA would be consulted.

1.3.62 Groundwater is considered unlikely to be encountered within the excavations, with the potential exception of perched (i.e., not laterally continuous) groundwater within more permeable lenses within the Glacial Till. If groundwater is encountered, a dewatering plan will be in place to manage the water appropriately.

1.3.63 If sand and gravel lenses are identified, with lesser thicknesses of Glacial Till, additional mitigation measures may be required for the Auger Bore crossings, to prevent contamination of the underlying Chalk Principal Aquifer. Clean drilling will be undertaken if evidence of contamination is identified, using a bentonite seal to seal off the contamination. Additionally, there is the possibility of artesian groundwater within the chalk, based on the reported groundwater rises in the reviewed BGS logs. If drilling into the chalk Principal Aquifer is required, the EA would be consulted to ensure appropriate mitigation measures (e.g., clean drilling as described above) are in place prior to the works commencing and to ensure If the top of the weathered chalk is encountered during drilling, drilling will be ceased, and the weathered bedrock backfilled appropriately. This is to prevent drilling into the chalk aquifer there is not, creating a pathway created for groundwater to rise up to the ground surface and potentially affecting the water supply for the public potable water supply wells and other groundwater resources in the area. All works will be undertaken in accordance with the Viking CCS Pipeline CEMP, detailing the following:

- **E18:** Chemical testing of materials imported to site (other than primary aggregates) will be tested to mitigate the risk to groundwater and stored appropriately on site;

- **E22:** Unless essential (e.g., for safety at road crossings), vehicle washing will not take place within the SPZ2. Where vehicle washing does take place, this will be undertaken in designated areas in which the arising effluent can be captured and managed appropriately;
- **E23:** Water Management Plan (WMP) will be in place to mitigate potential impacts to identified receptors by ensuring surface water runoff quality and quantity is managed effectively. This includes intercepting surface run-off from the works areas by filters and 'header' drains running along the edge of the temporary haul roads, which will lead to attenuation ponds prior to being discharged to appropriate surface watercourses (subject to agreement from the relevant IDB);
- **E29:** The drilling fluid within the annular space between the installed pipe and the HDD bore will be left in-situ on completion of the pipe pull back. Any surplus drilling fluid will be removed off-site for recycling and/or disposal. Contingency plans will be in place to deal with any indications of drilling fluid release;
- **E30:** Measures for appropriate temporary storage of soil. In addition, ground investigation will include chemical testing and risk assessment to identify potential risks to groundwater from mobilisation of contaminants, if present, within soil in the SPZ2;
- **E32:** No storage of fuel, or refuelling of plant and equipment, within the SPZ2. Refuelling will be restricted to designated areas within construction compounds, of which none are to be located within the SPZ2;
- **E31:** Inspection and maintenance of plant and equipment, and the provision of spill kits on site in order to mitigate the potential risk of spills or losses (e.g., of fuel, hydraulic oil) to identified receptors;

Potential Pollutant Linkages and HyRA

1.3.64 Potential Source – Pathway – Receptor (SPR) linkages with respect to hydrogeology are summarised as follows:

Sources

1.3.65 Potential unidentified historical contamination.

1.3.66 Contaminants associated with the construction of the Proposed Development through SPZ 2 between Barnoldby le Beck and Brigsley including:

- Fuels, Oils and Lubricants from plant / equipment; and
- Materials stored/used on site (e.g., imported backfill, soil arisings from drilling).

Pathways

- Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling; and
- Lateral migration within the bedrock aquifer towards the licensed public water supply boreholes (which are assumed to abstract from the Principal Bedrock Aquifer) as a result of pumping.

Receptors

- Principal Bedrock Aquifer (specifically the Barnoldby Pumping Stations for Public Water Supply).

1.3.67 The preliminary HRA in **Table 6**, has been produced taking into consideration the hydrogeological setting and mitigation measures described above:

Table 6: Preliminary Hydrogeological Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Probability (likelihood)	Potential Risk ³	Justification
Potential unidentified historical contamination and contaminants associated with the construction of the Proposed Development	Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;	Principal Bedrock Aquifer (specifically Barnoldby Pumping Station's Public water supply), SPZ2 & Groundwater SgZs.	Medium	Unlikely	Low	Although a sensitive receptor has been identified, the potential risk is considered to be low for the following reasons: The relatively significant distance from the proposed development to the abstraction point (over 1km); The anticipated presence of at least 25 m of low permeability Glacial Till between the base of the excavation and the underlying aquifer unit. If sand and gravel horizons are identified with evidence of contamination, or weathered chalk, additional mitigation measures will be adopted;
	Lateral migration within the bedrock aquifer towards the licensed supply boreholes					

³ Potential consequence (severity), magnitude of probability (likelihood) and potential risk ratings have been assigned based on criteria presented in the Contaminated Land Risk Assessment: A Guide to Good Practice C552 (CIRIA C552, 2001).

Source	Pathway	Receptor	Potential Consequence (Severity)	Probability (likelihood)	Potential Risk ³	Justification
						<p>Groundwater within the chalk may have a resting water level of 9m bgl which is assumed to be sub-artesian. If in connectivity with the superficial deposits, additional mitigation measures may be required.</p> <p>All works will be undertaken in accordance with the CEMP, and mitigation measures described therein.</p>

Dewatering

- 1.3.68 Any dewatering activities in this area of the Proposed Development will be on a small scale, abstracting low volumes of water over a limited period of time and is anticipated to be within the superficial deposits. As such it is unlikely any groundwater abstraction will have a significant long-term impact on the groundwater levels locally in the aquifer or at the public supply wells.
- 1.3.69 If dewatering activities require the abstraction of more than 20m³ / day of groundwater, a licence will need to be obtained. In consultation with the Environment Agency, more detailed assessment of the potential impacts would be undertaken as part of the dewatering strategy and appropriate mitigation implemented if required.

Summary

- 1.3.70 Given the proposed construction methodology, pipeline design, the anticipated geological conditions and the mitigation measures which will be in place, the potential risk to the chalk aquifer and licensed abstractions at Barnoldby Pumping Station is considered to be low.
- 1.3.71 This preliminary HyRA will be reviewed and updated in light of any changes in methodology, pipeline design and/or site-specific ground investigation data that becomes available.

Proposed Development within SPZ 2 between Grainsby and Ludborough Proposed Development

- 1.3.72 The Proposed Development within the SPZ 2 identified in Section 3 (and marginally into Section 4) of the DCO Site Boundary, and presented on **Figure 1** comprises the following elements:

Pipeline Construction

- Stripping of topsoil and stockpiling in a suitable location;
- Pipeline sections are placed on supports and welded together in sections called 'strings';
- Pipeline trench dug (to a minimum of 1.2m) and pipeline 'strings' lowered using 'side boom' vehicles;
- Trench filled with previously excavated materials, and topsoil carefully replaced;

Crossings

- Auger Bore – (Multiple locations, up to 10m maximum);
- Open cut trenching (Watercourse and Track) – (Multiple locations, up to 5m maximum);

Laydown Areas

- Stripping of topsoil and stockpiling in a suitable location; and
- Placement of geo textile and stone surface for construction of a temporary haul road/lay own area.

Potential Sources of Contamination

Identified Historical Sources of Contamination

- 1.3.73 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping dating from 1886 to 2022, obtained from Groundsure. This review identified no potential historical sources within both the DCO Site Boundary and SPZ 2.
- 1.3.74 However, there is still the potential for unidentified sources of contamination to be present within this area that have not been identified by the review.

Potential sources of Contamination during Construction Phase

- 1.3.75 The following potential sources of contamination have been identified associated with the proposed works within the SPZ between Grainsby and North Thoresby:
- Imported materials (e.g., backfilling of the trench, although it is noted that backfill with previously excavated materials is proposed for the pipeline);
 - Plant used for excavation of the trench (e.g., fuel/oil spillage);
 - Temporary storage of excavated soil;
 - Temporary drainage discharge; and
 - No construction compounds or storage of fuels is proposed within the SPZ 2.

Potential Sources of Contamination during Operational Phase

- 1.3.76 Once construction is completed, the trench will be backfilled, and all surface areas reinstated to their current condition. No potential sources of contamination will remain during the operational phase.

Environmental Setting

Geology

- 1.3.77 Published geological maps (Ref 3, Ref 4, Ref 5, Ref 6, Ref 7) and the GIS data sourced from the BGS (Ref 9), indicate that the Project is underlain by the geological succession in the mapped SPZ 1 and SPZ 2 areas summarised below:
- Superficial deposits comprising Glacial Till, Alluvium, Glaciofluvial Deposits, and Lacustrine Deposits; and
 - Bedrock comprising Welton Chalk Formation.
- 1.3.78 BGS Geo-Index online viewer (Ref 9) provides records for ground investigation data from many boreholes drilled within the surrounding area of the Project. Strata encountered has been summarised below in **Table 7**.

Table 7: Summary of Historical BGS Borehole Records

BGS Borehole Ref.	TF29NE26	TF29NE46
Location	The Cottage, Hawerby Crossroads	Theddlethorpe to Killingholme pipeline
Distance	90m west of DCO Site Boundary and within the SPZ 2 Boundary	Within the DCO Site Boundary and SPZ 2 Boundary

BGS Borehole Ref.	TF29NE26	TF29NE46
Superficial Deposits	Clay inferred to be Glacial Till encountered to 30m bgl. Glacial Sand & Gravel encountered to 46m bgl.	Clay encountered to 2m bgl (1.8m thickness), sand to 2.85m bgl (0.85m), clay to 3.2m bgl (0.35m), sand and gravel to 3.80m bgl (depth not proven).
Bedrock	Welton Chalk Formation encountered at 46m bg.	No bedrock encountered.
Groundwater Levels	Resting water level 31.90m bgl but depth of strike unknown.	Water strike at 3.45m and rose to 1.95m bgl.

Hydrogeology

1.3.79 Aquifer classification maps on Defra’s ‘MAGIC’ mapping portal (Ref 10) and from the Groundsure report (Ref 8) indicate the following aquifer classifications are present within this area of the DCO Site Boundary:

- Superficial Aquifers: Glacial Till – Secondary (Undifferentiated) Aquifer and Alluvium – Secondary A Aquifer; Glaciofluvial Deposits – Secondary A Aquifer, and Lacustrine Deposits – Secondary B Aquifer;
- Bedrock Aquifer: Burnham Chalk Formation – Principal Aquifer.
- Groundwater Vulnerability is classed as ‘Medium to High’; and
- Based on BGS records (above), the bedrock in places is confined by the overlying clay (Glacial Till).

Identified Hydrogeological Receptors

1.3.80 SPZ 2 between Grainsby and Ludborough and associated Groundwater SgZs.

1.3.81 Four groundwater abstractions have been identified off Barton Street, situated approximately 600m south of the DCO Site Boundary. These are operated by Lunette Properties Ltd; 3 no. abstractions relate to process water and 1 no. abstraction relates to private water undertaking which could include domestic consumption.

Mitigating Factors and Mitigation Measures

1.3.82 Main pipeline excavations will be no more than 2.2m in depth and specialised crossings (Open Cut and Auger Bore, up to 10m) and are therefore anticipated to be entirely within the topsoil, subsoil, and superficial deposits (Glacial Till). Based on available BGS data, chalk bedrock is anticipated to be present at a depth of 46m bgl, beneath glacial sand and gravels which were encountered at a depth of 30m bgl. Therefore, both geological strata will be afforded protection by at least 15 m of low permeability Glacial Till beneath the base of the proposed excavations. If deeper drilling/excavation is required to be within the chalk bedrock, the EA would be consulted.

1.3.83 Groundwater is considered unlikely to be encountered within the shallow excavations, with the potential exception of perched (i.e., not laterally continuous) groundwater within more permeable lenses within the Glacial Till. If groundwater is encountered, a dewatering plan will be in place to manage the water appropriately;

- 1.3.84 If sand and gravel lenses are identified, with lesser thicknesses of Glacial Till, additional mitigation measures may be required for the Auger Bore crossings, to prevent contamination of the underlying Chalk Principal Aquifer. Clean drilling will be undertaken if evidence of contamination is identified, using a bentonite seal to seal off the contamination. Additionally, there is the possibility of artesian groundwater within the chalk. If drilling into the chalk Principal Aquifer is required, the EA would be consulted to ensure appropriate mitigation measures (e.g., clean drilling as described above) are in place prior to the works commencing and to ensure If the top of the weathered chalk is encountered during drilling, drilling will be ceased, and the weathered bedrock backfilled appropriately. This is to prevent drilling into the chalk aquifer there is not, creating a pathway created for groundwater to rise up to the ground surface and potentially affecting the water supply for the public potable water supply wells and other groundwater resources in the area. Additionally, if sands and gravels are identified beneath the Glacial Till (as was identified in BGS log TF29NE26) during drilling, drilling works will be stopped and assessed, as there could be a direct pathway between the permeable sands and gravels and the underlying chalk.
- 1.3.85 All works will be undertaken in accordance with the Viking CCS Pipeline CEMP, detailing the following:
- **E18:** Chemical testing -of materials imported to site (other than primary aggregates) will be tested to mitigate the risk to groundwater and stored appropriately on site;
 - **E22:** Unless essential (e.g., for safety at road crossings), vehicle washing will not take place within the SPZ2. Where vehicle washing does take place, this will be undertaken in designated areas in which the arising effluent can be captured and managed appropriately;
 - **E23:** Water Management Plan (WMP) will be in place to mitigate potential impacts to identified receptors by ensuring surface water runoff quality and quantity is managed effectively. This includes intercepting surface run-off from the works areas by filters and 'header' drains running along the edge of the temporary haul roads, which will lead to attenuation ponds prior to being discharged to appropriate surface watercourses (subject to agreement from the relevant IDB);
 - **E30:** Measures for appropriate temporary storage of soil. In addition, ground investigation will include chemical testing and risk assessment to identify potential risks to groundwater from mobilisation of contaminants, if present, within soil in the SPZ2;
 - **E32:** No storage of fuel, or refuelling of plant and equipment, within the SPZ2. Refuelling will be restricted to designated areas within construction compounds, of which none are to be located within the SPZ2;
 - **E31:** Inspection and maintenance of plant and equipment, and the provision of spill kits on site in order to mitigate the potential risk of spills or losses (e.g., of fuel, hydraulic oil) to identified receptors;

Potential Pollutant Linkages and HyRA

- 1.3.86 Potential Source – Pathway – Receptor (SPR) linkages with respect to hydrogeology are summarised as follows:

Sources

1.3.87 Potential unidentified historical contamination.

1.3.88 Contaminants associated with the construction of the Proposed Development through SPZ 2 between Grainsby and Ludborough, including:

- Fuels, Oils and Lubricants from plant / equipment;
- Materials stored/used on site (e.g., imported backfill, drilling arisings);

Pathways

- Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;
- Lateral migration within the bedrock aquifer towards the licensed supply borehole operated by Lunette Properties Ltd as a result of pumping; and

Receptors

- Principal Bedrock Aquifer (specifically the Lunette Properties Ltd abstractions).

1.3.89 The preliminary HRA in **Table 8**, has been produced taking into consideration the hydrogeological setting and mitigation measures described above:

Table 8: Preliminary Hydrogeological Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (likelihood)	Potential Risk ⁴	Justification
Potential unidentified historical contamination and contaminants associated with the construction of the Proposed Development	Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;	Principal Bedrock Aquifer (specifically the licensed abstractions operated by Lunette Properties Ltd) , SPZ 2 & Groundwater SgZs.	Medium	Unlikely	Low	<p>Although a sensitive receptor has been identified, the potential risk is considered to be low for the following reasons:</p> <p>The relatively significant distance from the proposed development to the abstraction point (over 500m);</p> <p>The anticipated presence of at least 15 m of low permeability Glacial Till between the base of the excavation and the underlying aquifer unit. If sand and gravel horizons are identified with evidence of contamination, or weathered chalk is identified, additional mitigation measures will be adopted;</p> <p>The relatively significant depth to groundwater (c. 31.90 m bgl) in a nearby BGS log. If groundwater is present in the Glacial Till it is considered likely to be ‘perched’</p>
	Lateral migration within the bedrock aquifer towards the licensed supply borehole					

⁴ Potential consequence (severity), magnitude of probability (likelihood) and potential risk ratings have been assigned based on criteria presented in the Contaminated Land Risk Assessment: A Guide to Good Practice C552 (CIRIA C552, 2001).

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (likelihood)	Potential Risk ⁴	Justification
						<p>in nature (i.e., laterally, and vertically discontinuous); All works will be undertaken in accordance with the CEMP, and mitigation measures described therein.</p>

Dewatering

- 1.3.90 Any dewatering activities in this area of the Proposed Development will be on a small scale, abstracting low volumes of water over a limited period of time and is anticipated to be within the superficial deposits. As such it is unlikely any groundwater abstraction will have a significant long-term impact on the groundwater levels locally in the Principal aquifer or at the licensed abstraction well operated by Lunette Properties Ltd.
- 1.3.91 If dewatering activities require the abstraction of more than 20m³ / day of groundwater, a licence will need to be obtained. In consultation with the Environment Agency, more detailed assessment of the potential impacts would be undertaken as part of the dewatering strategy and appropriate mitigation implemented if required.

Summary

- 1.3.92 Given the proposed construction methodology, pipeline design, the anticipated geological conditions and the mitigation measures which will be in place, the potential risk to the chalk aquifer and the Lunette Properties Ltd abstractions is considered to be low.
- 1.3.93 This preliminary HyRA will be reviewed and updated in light of any changes in methodology, pipeline design and/or site-specific ground investigation data that becomes available.

Proposed Development within SPZ 1 around identified private abstraction in Section 5 (near Theddlethorpe All Saints)

Proposed Development

- 1.3.94 The Proposed Development within the 50m diameter SPZ 1 identified in Section 5 of the DCO Site Boundary, and associated with a private single domestic supply from an unknown source (and therefore assumed to be an active groundwater abstraction used for human consumption as a worst-case scenario) comprises the following elements:

Pipeline Construction

- Stripping of topsoil and stockpiling in a suitable location;
- Pipeline sections are placed on supports and welded together in sections called 'strings';
- Pipeline trench dug (to a minimum of 1.2m) and pipeline 'strings' lowered using 'side boom' vehicles;
- Trench filled with previously excavated materials, and topsoil carefully replaced;

Crossings and Laydown Areas

- An HDD crossing for a drain is located in close vicinity of the SPZ 1, to the southwest of it; and
- A laydown area is located in close vicinity of the SPZ 1, to the southeast of it. This will comprise the stripping of topsoil and stockpiling in a suitable location; and placement of geotextile and stone surface for construction of a temporary haul road/lay down area to comprise welfare and parking.

Potential Sources of Contamination

Identified Historical Sources of Contamination

- 1.3.95 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping dating from 1886 to 2022, obtained from Groundsure. This review identified no potential historical sources within both the DCO Site Boundary and SPZ 1 around the private abstraction.

1.3.96 However, there is still the potential for unidentified sources of contamination to be present within this area that has not been identified by the review.

1.3.97

Potential sources of Contamination during Construction Phase

1.3.98 The following potential sources of contamination have been identified associated with the proposed works within the SPZ 1 for the private abstraction in the vicinity of Theddlethorpe All Saints:

- Imported materials (e.g., backfilling of the trench, although it is noted that backfill with previously excavated materials is proposed for the pipeline);
- Plant used for excavation of the trench (e.g., fuel/oil spillage);
- Temporary storage of excavated soil; and
- Temporary drainage discharge.

1.3.99 No laydown areas, construction compounds or storage of fuels is proposed within the SPZ 1, and potentially contaminative sources should be stored outside of the 50m SPZ 1.

Potential Sources of Contamination during Operational Phase

1.3.100 Once construction is completed, the trench will be backfilled, and all surface areas reinstated to their current condition. No potential sources of contamination will remain during the operational phase.

Environmental Setting

Geology

1.3.101 Published geological maps (Ref 3, Ref 4, Ref 5, Ref 6, Ref 7) and the GIS data sourced from the BGS (Ref 9), indicate that the Project is underlain by the geological succession in the mapped SPZ 1 areas summarised below:

- Superficial deposits comprising Tidal Flat Deposits; and
- Bedrock comprising Burnham Chalk Formation.

1.3.102 BGS Geo-Index online viewer (Ref 9) provides records for ground investigation data from many boreholes drilled within the surrounding area of the Project. Strata encountered has been summarised below in **Table 9**.

Table 9: Summary of Historical BGS Borehole Records

BGS Borehole Ref.	TF48NE31	TF48NE59
Location	Theddlethorpe to Killingholme pipeline 2/3	Neves Farm Theddlethorpe
Distance	>250m north of DCO Site Boundary, outside of SPZ 1 boundary	380m south of DCO Site Boundary, outside SPZ 1 boundary
Superficial Deposits	Silty clay identified from 0.20m to 6.40m bgl	Clay identified to 22.9m bgl, underlain by sand to 25.3m bgl

BGS Borehole Ref.	TF48NE31	TF48NE59
Bedrock	Not encountered	Chalk encountered at 25.3m bgl
Groundwater Levels	Not groundwater recorded.	Water strike not recorded but lining tubes of the well installed into the chalk. Resting groundwater level recorded as 0.61m bgl.

Hydrogeology

1.3.103 Aquifer classification maps on Defra’s ‘MAGIC’ mapping portal (Ref 10) and from the Groundsure report (Ref 8) indicate the following aquifer classifications are present within this area of the DCO Site Boundary:

- Superficial Aquifers: Tidal Flat Deposits – Unproductive Aquifer;
- Bedrock Aquifer: Burnham Chalk Formation – Principal Aquifer.
- Groundwater Vulnerability is classed as ‘Medium’; and

1.3.104 Based on BGS records (above), the bedrock in places may be confined by the overlying clay (Tidal Flat Deposits); however, these two borehole records are more than 250m from the DCO Site Boundary and the identified private water abstraction within the 50m SPZ 1.

Identified Hydrogeological Receptors

1.3.105 1 No. private water abstraction approximately 43m north of the DCO Site Boundary in the East Lindsey District Council boundary and within Section 5 of the DCO Site Boundary near Theddlethorpe All Saints. The abstraction is a single domestic supply from an unknown source (and therefore assumed to be an active groundwater abstraction used for human consumption as a worst-case scenario).

Mitigating Factors and Mitigation Measures

1.3.106 Main pipeline excavations will be no more than 2.2m in depth and are therefore anticipated to be entirely within the topsoil, subsoil, and superficial deposits (Tidal Flat Deposits). Based on available BGS data, chalk bedrock may be present at a depth of approximately 20m bgl and should therefore be afforded protection by the thickness of the overlying Tidal Flat Deposits. However, it is noted that the borehole records outlined above are greater than 250m from the DCO Site Boundary. If deeper drilling/excavation is required within the chalk bedrock, the EA would be consulted.

1.3.107 Groundwater is considered unlikely to be encountered within the shallow excavations for the main pipeline with the potential exception of perched (i.e., not laterally continuous) groundwater within more permeable lenses within the Tidal Flat Deposits. Whilst the resting groundwater level in one of the BGS borehole logs was reported to be 0.61m bgl, this is likely to be groundwater from the underlying chalk bedrock and shallow excavations for the main pipelines are not anticipated to reach the chalk. If groundwater is encountered, a dewatering plan will be in place to manage the water appropriately;

1.3.108 All works will be undertaken in accordance with the Viking CCS Pipeline CEMP, detailing the following:

- **E18:** Chemical testing -of materials imported to site (other than primary aggregates) will be tested to mitigate the risk to groundwater and stored appropriately on site;

- **E22:** Unless essential (e.g., for safety at road crossings), vehicle washing will not take place within the SPZ 1 or 2. Where vehicle washing does take place, this will be undertaken in designated areas in which the arising effluent can be captured and managed appropriately; and
- **E23:** Water Management Plan (WMP) will be in place to mitigate potential impacts to identified receptors by ensuring surface water runoff quality and quantity is managed effectively. This includes intercepting surface run-off from the works areas by filters and 'header' drains running along the edge of the temporary haul roads, which will lead to attenuation ponds prior to being discharged to appropriate surface watercourses (subject to agreement from the relevant IDB);
- **E30:** Measures for appropriate temporary storage of soil. In addition, ground investigation will include chemical testing and risk assessment to identify potential risks to groundwater from mobilisation of contaminants, if present, within soil in the SPZ 1 or 2;
- **E32:** No storage of fuel, or refuelling of plant and equipment, within the SPZ 1 or 2. Refuelling will be restricted to designated areas within construction compounds, of which none are to be located within the SPZ 1 or 2;
- **E31:** Inspection and maintenance of plant and equipment, and the provision of spill kits on site in order to mitigate the potential risk of spills or losses (e.g., of fuel, hydraulic oil) to identified receptors;

Potential Pollutant Linkages and HyRA

1.3.109 Potential Source – Pathway – Receptor (SPR) linkages with respect to hydrogeology are summarised as follows:

Sources

1.3.110 Potential unidentified historical contamination.

1.3.111 Contaminants associated with the construction of the Proposed Development through the SPZ 1 associated with a private water supply, which is a single domestic supply from an unknown source (and therefore assumed to be a groundwater abstraction used human consumption as a worst-case scenario comprise:

- Fuels, Oils and Lubricants from plant / equipment; and
- Materials stored/used on site (e.g., imported backfill, drilling arisings).

Pathways

- Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling; and
- Lateral migration within the superficial or bedrock aquifer towards the private water supply borehole (it is not known which aquifer the abstraction is utilising currently) as a result of pumping.

Receptors

- Principal Bedrock Aquifer (specifically the private abstraction near Theddlethorpe All Saints).

1.3.112 The preliminary HRA in **Table 10**, has been produced taking into consideration the hydrogeological setting and mitigation measures described above:

Table 10: Preliminary Hydrogeological Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Probability (Likelihood)	Potential Risk ⁵	Justification
Potential unidentified historical contamination and contaminants associated with the construction of the Proposed Development	Migration of contaminants into shallow groundwater within the superficial deposits (if present), followed by vertical migration to the underlying bedrock aquifer due to HDD or piling;	Principal Bedrock Aquifer (specifically the private abstraction near Theddlethorpe All Saints)	Medium	Unlikely	Low	<p>Although a sensitive receptor has been identified, the potential risk is considered to be low for the following reasons:</p> <p>The anticipated presence of up to 20m of low permeability Tidal Flat Deposits between surface and the underlying Principal Aquifer in the bedrock. If more granular horizons are identified with evidence of contamination, or weathered chalk is identified, additional mitigation measures will be adopted;</p> <p>If groundwater is present in the Tidal Flat Deposits, it is considered likely to be 'perched' in nature (i.e., laterally, and vertically discontinuous);</p> <p>All works will be undertaken in accordance with the CEMP, and mitigation measures described therein.</p>
	Lateral migration within the superficial or bedrock aquifer towards the private water supply borehole.					

⁵ Potential consequence (severity), magnitude of probability (likelihood) and potential risk ratings have been assigned based on criteria presented in the Contaminated Land Risk Assessment: A Guide to Good Practice C552 (CIRIA C552, 2001).

Dewatering

- 1.3.113 Any dewatering activities in this area of the Proposed Development will be on a small scale, abstracting low volumes of water over a limited period of time and is anticipated to be within the superficial deposits. As such it is unlikely any groundwater abstraction will have a significant long-term impact on the groundwater levels locally in the Principal Aquifer or at the private supply well.
- 1.3.114 If dewatering activities require the abstraction of more than 20m³ / day of groundwater, a licence will need to be obtained. In consultation with the Environment Agency, more detailed assessment of the potential impacts would be undertaken as part of the dewatering strategy and appropriate mitigation implemented if required.

Summary

- 1.3.115 Given the proposed construction methodology, pipeline design, the anticipated geological conditions and the mitigation measures which will be in place, the potential risk to the chalk aquifer and the private water supply near Theddlethorpe All Saints is considered to be low.
- 1.3.116 This preliminary HyRA will be reviewed and updated in light of any changes in methodology, pipeline design and/or site-specific ground investigation data that becomes available.

1.4 References

- Ref 1** “*The Environment Agency’s Approach to Groundwater Protection. Version 1.2,*” Environment Agency , February 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/692989/Environmment-Agency-approach-to-groundwater-protection.pdf). [Accessed 25 May 2023].
- Ref 2** “*Drinking Water Safeguard Zones (Groundwater),*” Environment Agency, 31 March 2023. [Online]. Available: <https://data.gov.uk/dataset/7fe90245-d6e8-4d7c-a13a-65a87455f429/drinking-water-safeguard-zones-groundwater> [Accessed 25 May 2023].
- Ref 3** British Geological Survey, “*Map Sheet No. 80 Kingston upon Hull, Solid 1:50,000 Scale*”.
- Ref 4** British Geological Survey, “*Map Sheet No. 80 Kingston upon Hull, Drift 1:50,000 Scale*”.
- Ref 5** British Geological Survey, “*Map Sheet No. 81 Partington, Solid and Drift 1:50,000 Scale*”.
- Ref 6** British Geological Survey, “*Map Sheet No. 90 including No. 91 Grimsby, Solid and Drift 1:50,000 Scale*”.
- Ref 7** British Geology Survey, “*Map Sheet No. 103 Louth, Solid and Drift 1:50,000 Scale*”.
- Ref 8** Groundsure, “*Enviro Insight GIS Data,*” Groundsure, 2023.
- Ref 9** British Geological Survey, “*GeoIndex Web viewer,*” British Geological Survey, 2023. [Online]. Available: https://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes&_ga=2.149525238.1957354716.1685008923-1245091780.1683896208. [Accessed May 2023].
- Ref 10** “*Multi-Agency Geographic Information for the Countryside (MAGIC),*” Department of Agriculture, Environment and Rural Affairs, 2023. [Online]. Available: https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.139948279.53941229.1614087105-556125256.1573056023. [Accessed May 2023].