VikingCCS

Viking CCS Pipeline

Environmental Statement Volume IV – Appendix 9-4: Conceptual Site Model

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1 Introduction

1.1 Introduction

1.1.1 This report is appended to the Viking CCS Pipeline Environmental Statement (ES) and forms *ES Volume IV Appendix 9-4 Conceptual Site Model (Application Document 6.4.9.4).*

1.1.2 Information gathered from *Chapter 9: Geology and Hydrogeology* has been used to develop a preliminary conceptual site model (iCSM) aimed at identifying possible risks, if any, arising from substances used or deposited on-site, or from other sources of land contamination during construction of the Proposed Development. The assessment of risk is based upon the Viking CCS Pipeline (hereafter referred to as the Proposed Development) which is described in *ES Volume II Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*.

Project Description

1.1.3 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 (CO_2) 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.

1.1.4 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.

1.1.5 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.

1.1.6 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 Assessment Framework

1.2.1 Current best practice recommends that the determination of health hazards due to contaminated land is based on the principle of risk assessment, as outlined in the Statutory Guidance to Part 2A (2012) and Land Contamination: Risk Management (LCRM).

1.2.2 The “suitable for use” approach is adopted for the assessment of contaminated land where remedial measures are undertaken where unacceptable risks to human health or the environment are realised taking into account the use (or proposed use) of the land in question and the environmental setting. The proposed end-use for the Proposed Development is an underground pipeline with two reception facilities at Immingham and Theddlethorpe which will be used to transport carbon offshore via the existing LOGGS pipeline.

1.2.3 The risk assessment process for environmental contaminants is based on a source-pathway-receptor analysis. These terms can be defined as follows:

- **Source:** hazardous substance that has the potential to cause adverse impacts; and
- **Pathway:** route whereby a hazardous substance may come into contact with the receptor: examples include ingestion of contaminated soil and leaching of contaminants from soil into watercourses; and
- **Receptor:** target that may be affected by contamination: examples include human occupants/ users of site, water resources (surface waters or groundwater), or structures.

1.2.4 For a risk to be present, there must be a relevant/ viable contaminant linkage; i.e., a mechanism whereby a source impacts on a sensitive receptor via a pathway.

1.3 Sources of Contamination

1.3.1 As part of the baseline assessment in the ES, AECOM has reviewed historical mapping dating from 1886 to 2022, obtained from Groundsure along with the current land use. This review has identified the following potential sources within the DCO Site Boundary for the Proposed Development as seen in **Table 1**.

Table 1: Potential Sources of Contamination

Source Reference	Potential Sources	Associated Contaminants of Potential Concern (CoPC)
Immingham Docks Area and Theddlethorpe Gas Terminal only		
S1	Made Ground associated with current and historical industrial activities	Heavy metals and inorganics including sulphate, pH, TPH, SVOCs (Semi-Volatile Organic Compounds), VOCs (Volatile Organic Compounds), asbestos and ACMs (Asbestos Containing Materials).
DCO Site Boundary – Greenfield Land		
S2	Agricultural land use	Herbicides / pesticides, metals, TPH, ACM
S3	Railway and Sidings	Heavy metals, PAH, TPH, SVOCs, VOCs, herbicides, ACM
S4	Bulk Gases	Methane and Carbon Dioxide

1.4 Pathways

1.4.1 Potential pathways by which identified sources may impact identified receptors at the Proposed Development are shown in **Table 2.**

Table 2: Potential Pathways

Pathway Reference	Pathway	Description
P1	Human Health / Fauna: People (Human Health) and animals (Fauna)	Direct Pathway: Direct dermal contact or ingestion of soil particulate.
P2	Human Health / Fauna: People (Human Health) and animals (Fauna)	Indirect Pathway: Inhalation of soil particulate derived from soils.
P3	Human Health / Fauna: People (Human Health) and animals (Fauna)	Direct Pathway: Direct dermal contact / ingestion of contaminated shallow groundwater (e.g., during construction activities)
P4	Human Health / Fauna: People (Human Health) and animals (Fauna)	Indirect Pathway: Inhalation of soil vapour derived from soils
P5	Human Health / Fauna: People (Human Health) and animals (Fauna)	Indirect Pathway: Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/ explosion)
P6	Water Environment: Surface waters	Indirect Pathway: Surface run-off into the surface water drainage system and subsequently to surface waters;

Pathway Reference	Pathway	Description
P7	Water Environment: Groundwater	Indirect Pathway: Leaching of contaminants of potential concern from unsaturated zone into the shallow aquifer (e.g., by infiltration of rainwater;
P8	Water Environment: Groundwater	Indirect Pathway: Vertical migration of impacted shallow groundwater) into the bedrock Principal Aquifer;
P9	Water Environment: Groundwater	Indirect Pathway: Lateral migration of impacted groundwater within the shallow or deep (bedrock) Principal Aquifers;
P10	Buildings & Infrastructure: Concrete	Direct Pathway: Direct contact of buried concrete with contaminated soils (i.e., hydrocarbons) and aggressive ground conditions (pH and sulphate).

1.5 Receptors

1.5.1 Identified receptors which have the potential to be impacted by the Proposed Development are shown in **Table 3**.

Table 3: Potential Receptors

Receptor Reference	Receptor	Description
R1	Human Health: Chronic	Current and Future Site Users
R2	Human Health: Acute	Maintenance Workers
R3	Water Environment: Surface Waters	Drainage ditches and inland rivers
R4	Water Environment: Superficial Aquifer	Shallow groundwater in the Secondary A and B Aquifers
R5	Water Environment: Bedrock Aquifer	Deeper groundwater in the Chalk (Principal Aquifer);
R6	Buildings & Infrastructure: Concrete	Future proposed services at the Proposed Development may be impacted by contamination in the ground. In particular, any existing concrete foundations if the groundwater has high sulphate levels.

1.6 Risk Assessment

1.6.1 The CSM has identified a number of potentially complete SPR linkages relating to the Proposed Development. In line with Land Contamination Risk Management (LCRM) guidance, a risk assessment has been undertaken to identify the most significant SPR linkages at the Proposed Development with respect to potential risk to environmental receptors. The methodology for the Risk Assessment has been outlined below:

Environmental Risk Assessment Methodology

Risk Assessment Principles

1.6.2 Current best practice recommends that the determination of hazards due to contaminated land is based on the principle of risk assessment, as outlined in the Environment Agency guidance on LCRM (Ref 1).

1.6.3 For a risk to be present, there must be a viable contaminant linkage; i.e., a mechanism whereby a source impacts on a sensitive receptor via a pathway.

1.6.4 Assessments of risks associated with each of these contaminant linkages are discussed in the following sections.

1.6.5 Using criteria based on those presented in the Construction Industry Research and Information Association (CIRIA) publication C552 (Ref 2), the magnitude of the risk associated with potential contamination at the Proposed Development has been assessed. To do this an estimate is made of:

- The magnitude of the potential consequence (i.e., severity); and
- The magnitude of probability (i.e., likelihood).

1.6.6 The severity of the risk is classified according to the criteria in **Table 4**.

Risk Assessment Framework

Table 4: Description of Severity of Risk

Term	Description
Severe	Short term (acute) risks to human health likely to result in “significant harm” as defined by Part 2A of the Environment Protection Act 1990(e.g., high concentrations of cyanide at the surface in recreational areas) Catastrophic damage to buildings/property (e.g., potential for explosion causing building to collapse) Short term risk pollution / major pollution of controlled waters (e.g., major spillage of contaminants into controlled waters) Short term risk to a particular ecosystem or organism forming part of an ecosystem
Medium	Chronic (long-term) risk to human health likely to result in “significant harm” (contaminant concentrations exceeding generic or site-specific assessment criteria) Pollution of sensitive controlled waters (e.g., leaching of contaminants into surface watercourses or principal / secondary aquifers) Significant change in an ecosystems or organism forming part of an ecosystem (e.g., death of a species within a designated nature reserve)
Mild	Pollution of non-sensitive waters (e.g., unproductive strata) Significant damage to crops, buildings, structures and / or services (e.g., rendering a building unsafe to occupy from instability due to foundation damage) Damage to sensitive buildings, structures, services, or the environment
Minor	Harm, although not necessarily significant harm, which may result in financial loss or expenditure to resolve (e.g., loss of plants in a landscaping scheme) Non-permanent human health effects to humans (easily prevented by means such as personal protection clothing) Easily repairable damage to buildings, structures, or services

1.6.7 The probability of the risk occurring is classified according to the criteria in **Table 5**.

Table 5: Likelihood of Risk Occurrence

Likelihood	Explanation
High	There is a pollution linkage and an event either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution
Likely	There is a pollution linkage, and all the elements are present and in the right place which means that it is probable that an event will occur
Low	There is pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and it is less likely in the shorter term.
Unlikely	There is a pollution linkage, but circumstances are such that is improbable that an event would occur even in the very long term.

1.6.8 An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in **Table 6**.

Table 6: Risk based on Comparison of Likelihood and Severity

		Severity			
Likelihood		**SEVERE**	**MEDIUM**	**MILD**	**MINOR**
	HIGH	Very High	High	Moderate	Low
	LIKELY	High	Moderate	Moderate/Low	Low
	LOW	Moderate	Moderate/Low	Low	Very Low
	UNLIKELY	Moderate/Low	Low	Very Low	Very Low

Preliminary Risk Assessment

1.6.9 A preliminary CSM illustrating plausible contaminant linkages has been formulated for the Proposed Development. The qualitative preliminary risk assessment of the possible linkages of the above sources, pathways and receptors is provided in the **Table 7**.

1.6.10 The level of risk is determined based on the current condition of the DCO Site Boundary (i.e., the effects of mitigation measures are not included).

1.6.11 The preliminary risk assessment undertaken with in this section does not consider acute risks for construction and maintenance workers. AECOM anticipates that these will be managed by appropriate health and safety measures.

Table 7: Preliminary Risk Assessment

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (Likelihood)	Potential Risk	Justification
Contaminants of Concern (CoPC) relating to past and present land use (S1, S2 and S3)	P1: Direct contact, dermal absorption, or ingestion of soil.	R1: Current and Future Site Users	Medium	Low	Moderate / Low	<u>Immingham Docks and Theddlethorpe Gas Terminal</u> There is potential for encountering contamination within this area of the DCO Site Boundary due to past land uses. However, the potential for exposure to current and future workers and site visitors is likely to be limited by the presence of hardstanding and buildings present. <u>Agricultural Land</u> The remainder of the DCO Site Boundary comprises mostly agricultural land which is likely to have a low potential for contamination although there is still the potential that contamination could be present in localised areas which could result in an elevated risk. Post development the land will be reinstated to the same condition prior to works. There is not thought to be any additional risk to human health upon completion.
		R2: Maintenance Workers	Medium	Low	Moderate / Low	
	P2: Inhalation of soil particulates derived from soils.	R1: Current and Future Site Users	Medium	Low	Moderate / Low	
		R2: Maintenance Workers	Medium	Low	Moderate / Low	
	P3: Direct Pathway: Direct dermal contact /	R2: Maintenance Workers	Medium	Low	Moderate / Low	Groundwater could be encountered during excavations although the potential for contamination across the

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (Likelihood)	Potential Risk	Justification
	ingestion of contaminated shallow groundwater					majority of the DCO Site Boundary is considered to be low. As with all construction works the Principal Contractor will need to comply with the CDM 2015 regulations and, therefore, the workforce should be appropriately protected from exposure to potential contaminants during any planned maintenance activities (including those that may require excavations).
	P4: Inhalation of vapour derived from soils and / or groundwater	R1: Current and Future Site Users	Medium	Low	Moderate / Low	The majority of the DCO Site Boundary area comprises agricultural land with limited potential for contaminants which could result in vapours. A potential risk could exist where structures are introduced or in confined spaces including deeper excavations where vapours are present, although DCO Site Boundary the majority of the site will be returned to agricultural land upon completion of the pipeline excavation and there is unlikely to be a risk from vapours in these areas.
		R2: Maintenance Workers	Medium	Low	Moderate / Low	
	P6: Indirect Pathway: Surface run-off into the	R3: Drainage Ditches and inland rivers	Medium	Likely	Moderate	There is a potential for run-off from excavations and stockpiling to impact surface water quality where these are located close to water features.

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (Likelihood)	Potential Risk	Justification
	surface water drainage system and subsequently to surface waters;					However, the potential for contamination across the majority of the DCO Site Boundary is considered to be limited. Sediment in run-off could still affect water quality without mitigation.
	P7: Indirect Pathway: Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater	R4: Superficial Aquifers (Secondary A and B Aquifers)	Medium	Low	Moderate / Low	A number of aquifers (Principal, Secondary A & B) and groundwater abstraction Source Protection Zones have been identified within the DCO Site Boundary. The superficial geology varies across the DCO Site Boundary significantly. There is also thought to be significant thickness of low permeability Glacial Till across the majority of the DCO Site Boundary which would act as a barrier to the Principal Aquifer within the Chalk bedrock. However, in certain areas sand & gravel lenses have been identified and, therefore, could be a potential pathway for impacted shallow groundwater to migrate towards deeper groundwater. Groundwater located within the Glacial Till is likely to be 'Perched' in nature (i.e., laterally, and vertically discontinuous).
	P8: Indirect Pathway: Vertical migration of impacted shallow groundwater) into the bedrock Principal Aquifer;	R5: Bedrock Aquifer (Principal Aquifer)	Medium	Low	Moderate / Low	

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (Likelihood)	Potential Risk	Justification
	P9: Indirect Pathway: Lateral migration of impacted groundwater within the shallow or deep (bedrock) Principal Aquifers	R4: Superficial Aquifers (Secondary A and B Aquifers)	Medium	Likely	Moderate	However, the potential for contamination across the majority of the DCO Site Boundary is considered to be limited and the proposed works is unlikely to have a significant impact on the existing hydrogeological regime given the nature of the development. It will be necessary to ensure the works do not introduce preferential pathways which could increase the risks from contamination, particularly to the Chalk aquifer.
		R5: Bedrock Aquifer (Principal Aquifer)	Medium	Likely	Moderate	
	P9: Indirect Pathway: Lateral migration of impacted groundwater within the shallow or deep (bedrock) Principal Aquifers	R3: Drainage Ditches and inland rivers	Medium	Low	Moderate/Low	Lateral migration of impacted shallow groundwater to surface water (along with flora and fauna within these waters). However, the potential for encountering contamination across the majority of the DCO Site Boundary is considered to be limited. There will be no unauthorised discharge to surface water receptors during the construction phase and / or operational phase if maintenance works are required.
	P10: Direct Pathway: Direct contact of buried	R6: Future proposed services and	Mild	Likely	Moderate / Low	The ground chemistry is currently unknown and therefore there is the potential for encountering potentially aggressive ground conditions which

Source	Pathway	Receptor	Potential Consequence (Severity)	Magnitude of Probability (Likelihood)	Potential Risk	Justification
	concrete and services with aggressive ground conditions (e.g., pH and sulphate)	foundations (concrete)				will need to be considered as part of the design including the suitability of excavated material for use as backfill.
S4: Bulk Gases	P5: Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/ explosion)	R1: Current and Future Site Users	Medium	Low	Moderate / Low	There is known Made Ground, Tidal Flat Deposits and Alluvium within the DCO Site Boundary which have the potential to generate ground gases. In addition, historical landfills have been identified in or close to the DCO Site Boundary which could give rise to gases / vapours. Overall, the potential for significant gas generation is likely be low within the DCO Site Boundary area, but this could increase in some areas and mitigation could be required where structures are proposed.
		R2: Maintenance Workers	Medium	Low	Moderate / Low	

Discussion of Acute Risk to Future Construction Workers and Off-Site Receptors

1.6.12 AECOM understands that the Proposed Development works will be undertaken in compliance with Construction Design and Management (CDM) 2015 regulations.

1.6.13 Prior to work commencing, a health and safety risk assessment should be carried out by the appointed Principal Contractor / developed in accordance with current health and safety regulations. This assessment should cover potential risks to construction staff, permanent site staff and the local population. Based on the findings of this risk assessment, appropriate mitigation measures should be implemented during the construction period.

1.6.14 The greatest potential for generation of dust will be during the construction phase works and therefore dust generation should be kept to a minimum in accordance with general best practice, as outlined in, for example, 'Environmental Good Practice on Site', CIRIA Publication C692 to reduce this risk.

1.6.15 The overall risk to construction workers during the excavation and construction phases in terms of potential exposure to contaminants is considered to be low given the historical and current land uses identified along the DCO Site Boundary, although this could be higher in some areas. Should gross contamination be identified during the construction phase, then this may pose a potential acute risk to construction works. It is likely to be able to be effectively managed through good health and safety practices and protocols. Adoption of appropriate mitigation, such as dust suppression techniques and measures to prevent run-off, would also reduce the potential for migration off-site.

References

Ref 1 Environment Agency, 2021, “Land Contamination Risk Management,” 2020. [Online]. Available: *https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks.*

Ref 2 CIRIA, 2001 Contaminated land risk assessment. A guide to good practice (C552).

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