H2Teesside Project

Environmental Permit Application Reference: [EPR/AP3328SQ/A001]

Land at and in the vicinity of the former Redcar Steel Works site, Redcar and in Stockton-on-Tees, Teesside

Appendix B – Application Site Condition Report

Environmental Permitting (England and Wales) Regulations 2016

Applicants: H2 Teesside Ltd

Date: October 2024

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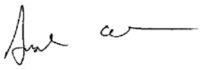
Signed		Date	10/10/2024
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GLOSSARY

Abbreviation	Description
Applicant/Operator	H2 Teesside Ltd
ATR	Auto Thermal Reforming
BGS	British Geological Survey
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CO_2	Carbon dioxide
CSM	Conceptual Site Model
DCO	Development Consent order
FEED	Front-End Engineering Design
FID	Final Investment Decision
GWth	Gigawatt Thermal
H_2	Hydrogen (gaseous)
HRA	Habitats Regulations Assessment
LHV	Lower Heating Value
LNR	Local Nature Reserve
mAOD	Metres Above Ordnance Datum
MWth	Megawatt Thermal
NEP	Northern Endurance Partnership
NNR	National nature Reserve
NWL	Northumbrian Water Limited
NZT	Net Zero Teesside
O_2	Oxygen
PAHs	Polyaromatic hydrocarbons
STDC	South Tees Development Corporation
SAC	Special Area of Conservation

Abbreviation	Description
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
WwTW	Wastewater Treatment Works

CONTENTS

TABLES

ANNEXES

1.0 INTRODUCTION

1.1.1 This document has been prepared by AECOM Ltd ('AECOM') on behalf of H2 Teesside Limited ('the Applicant), a company with bp and ADNOC as shareholders, in support of an Environmental Permit application for the proposed H2 Teesside 1.2-Gigawatt Thermal (GWth) Lower Heating Value (LHV) Carbon Capture and Storage (CCS) enabled Hydrogen Production Facility ('proposed Installation') on land in the Teesside industrial cluster area in Redcar and Stockton-on-Tees ('the Site').

1.1.2 This site condition report provides details for the proposed Installation site and the condition of land at permit issue.

2.0 SITE DETAILS

2.1 Overview

Name of the applicant	H2Teesside Limited
Name of the installation	H2Teeside Hydrogen Facility
Activity address	The Foundry, Teesworks, Lackenby and Grangetown, Redcar, Teesside, TS10 5NX
National grid reference	NZ 57048 25427

2.2 Document References

Site Location Plan and Layout	Annex 1
Raw Materials List	Annex 2
DCO, Environmental Statement; Chapter 10 Geology, Hydrogeology and Contaminated Land Assessment with appendices. This Chapter and supporting appendices covers the full DCO Development area and only entries related to the 'Main Site' cover the area incorporated by the permit Installation boundary. The Annex includes the full DCO Chapter and the following: • Summary Report – Main Site Sections only (Document Reference: 6.4.11 Environmental Statement, Appendix 10A) – Groundsure Report – Main Site (Document Reference 284970768_1_1 – 21/09/2021) – Envirocheck Report – Main Site (Document Reference: GS-9167761 – 01/11/2022) – Site Walkover Survey – Previous Reports Summary – Detailed Unexploded Ordnance Desktop Survey • Conceptual Site Model – Main Site Sections only (Document Reference: 6.4.12 Environmental Statement, Appendix 10B) • Contaminated Land Environmental Risk Assessment – Main Site Sections only (Document Reference: 6.4.12 Environmental Statement, Appendix 10B) • Geotechnical Risk Register – Main Site Sections only (Document Reference: 6.4.13 Environmental Statement, Appendix 10C) • Figures and Drawings – Figures 10-1, 10-3 to 10-23 inclusive.	Annex 3

2.3 Site Setting

2.3.1 The proposed Installation will be located within approximately 91 ha of land (known as the 'The Foundry' site) previously within the Redcar steelworks site. The land was used for iron and steel manufacture, together with associated ancillary development. The former steelworks shut in October 2015 and much of the existing infrastructure, including industrial buildings, conveyors, tanks, and overhead pipes, have been either demolished or are in the process of being dismantled by the landowner as part of the decommissioning of Redcar Steelworks, to prepare the site for future development. A combination of hardstanding, road networks and railway tracks remain, surrounded by informal vegetation (primarily grass, with occasional shrubs and small trees). Prior to construction of the proposed Installation, the Site will be levelled and appropriately remediated.

2.3.2 Annex 1 shows the proposed Installation boundary, within the immediate setting:

- The operational Redcar Bulk Terminal is located immediately adjacent to the west of the site, on the south bank of the River Tees;
- To the south lies the Northumbrian Water Ltd (NWL) Bran Sands sewage treatment plant, operational land of PD Ports Teesport and the Wilton International industrial complex;
- West of the Site, on the North bank of the River Tees, similar industrial complexes are present (at Seal Sands);
- The town of Dormanstown is located approximately 1.3 km southeast of the Site, whilst Redcar is situated approximately 2.6 km to the east of the Site; and
- The Site is located approximately 680 m south of the North Sea shoreline.

2.3.3 There are no residential receptors within 500 m of the site. The closest residential properties (individual receptors) to the site are those at Marsh House Farm, in Warrenby approximately 1.3 km to the east.

2.3.4 A number of nationally designated ecological sites are situated within close proximity to the Site; including the Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI)/ Special Protection Area (SPA)/ Ramsar site located immediately north of the Site. These are shown on Figure 10-10 (Annex 3).

2.3.5 There is a SSSI within 5 km of the Installation Site, that being Teesmouth and Cleveland Coast SSSI, adjacent to the northern boundary of the Site.

2.3.6 A further three European designated sites are located within 15 km of the Site:

- Northumbria Coast SPA/ Ramsar site (approximately 13.5 km northwest);
- Durham Coast Special Area of Conservation (SAC) (approximately 13.5 km northwest); and
- North York Moors SAC/ SPA/ National Park (approximately 12.2 km southeast)

2.3.7 There is one Local Nature Reserve (LNR) within 5 km of the Installation, that being Seaton Dunes and Common LNR, located approximately 3.1 km north-west.

2.3.8 The River Tees flows approximately 0.9 km to the west of the Site and is tidal at that point, with the normal tidal limit approximately 14 km upstream (at the Tees Barrage).

2.3.9 There are also a number of surface water features in the vicinity of the Site, including the Dabholm Gut which flows into the River Tees approximately 0.7 km south of the Site. The Dabholm Gut is tidal and accepts water from smaller streams, namely the Fleet (that runs from Coatham Marsh to the west of Redcar), the Mill Race (from east of the Wilton international complex); and Dabholm Beck (from the west of the Wilton International complex). The Dabholm Gut also receives consented discharge streams from the Wilton International Complex and the NWL Bran Sands waste water treatment works (WwTW).

3.0 PERMITTED ACTIVITIES

3.1.1 This environmental permit application is made under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) ('the EP Regulations'). The Operator has made an application for a DCO (Ref: EN070009), for the project to the Secretary of State for the Department of Energy Security and Net Zero (DESNZ), under Section 37 of the Planning Act 2008, and this application for an Environmental Permit is submitted in parallel to the DCO application.

3.1.2 This application is made for the following activities listed under Schedule 1 of the EP Regulations, and a number of directly associated activities (DAA) associated with the proposed Installation, which are also included in Table 3.1.

Table 3.1: Permitted Activities

Activity Ref	SCHEDULE 1 – PART 2 REFERENCE	DESCRIPTION OF ACTIVITY	LIMITS OF SPECIFIED ACTIVITY	DETAILS OF THE ACTIVITY
A1	Section 4.2, Part A (1)(a)(i): Production of Inorganic Chemicals (Hydrogen) – Phase 1	Operation of a blue hydrogen production facility by means of JM LCH technology (GHR-ATR combination process). Design capacity of 1.2 GWth LHV, across two phases of development (600 Megawatt thermal (MWth) per phase). This equates to the capacity to produce 37.3 t/hr (phase 1 + 2) of hydrogen at peak production, once both phases are operational.	From receipt of natural gas to the discharge of hydrogen product.	Blue hydrogen production process involving the conversion of natural gas feedstock into hydrogen product, using the JM LCH technology (GHR-ATR combination).
A2	Section 4.2, Part A (1)(a)(i): Production of Inorganic Chemicals (Hydrogen) – Phase 2			
A3	Section 6.10 Part A(1): Carbon Capture and Storage	Operation of a blue hydrogen production facility by means of JM LCH technology (GHR-ATR combination process). Carbon capture rate of 95% in accordance with current BAT guidance and has the potential capacity to further increase the capture rate to meet potential future regulatory changes. Capacity to continuously export 2.54 megatonnes (Mt) of CO_2 per year once both phases are operational (100% utilisation).	From receipt of CO_2 process emissions in the CO_2 removal unit to the treatment of CO_2 prior to export from the Installation.	The absorption of CO_2 generated in the hydrogen production process using an amine-based solvent, followed by compression and dehydration of the treated CO_2 for off-site transportation and long-term storage.
A4	Section 1.1 Part A(1)(a): Burning of any fuel in an appliance with a rated thermal input of 50MW or more.	Operation of : • auxiliary steam boilers for each phase. With a capacity of up to 71.87 MW per boiler. • fired startup heaters for each phase with a combined capacity of 36.6MW.	From receipt of fuel gas (natural gas during startup and process tail gas and H_2 rich gas during normal operations) to discharge of exhaust gases.	Auxiliary steam boilers to satisfy the steam demand of the hydrogen production facility. Continuously fired during normal operations by process tail gas and fired by natural gas during startup.

Activity Ref	SCHEDULE 1 – PART 2 REFERENCE	DESCRIPTION OF ACTIVITY	LIMITS OF SPECIFIED ACTIVITY	DETAILS OF THE ACTIVITY
		• Emergency back-up generators for black start with an 8.86 MW input capacity per generator, and diesel driven fire water pumps with a 1.3 MW input capacity per pump.		Fired startup heaters using natural gas to facilitate plant start-up periods only. Boilers are SCR-enabled to abate emissions of oxides of nitrogen (NO_x) to the atmosphere during normal operation.
A5	Section 5.4, Part A (1)(a) (ii) Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving physico-chemical treatment.	Effluent Treatment	From receipt of wastewater to point of discharge to NZT outfall	Onsite treatment of wastewater through effluent treatment plant and offsite discharge to the Tees Bay.
A6	Section 5.4, Part A (1)(a) (i) Recovery of non-hazardous waste with a capacity exceeding 50 tonnes per day involving biological treatment.	Biological Treatment via membrane bioreactor	From receipt of condensate and other effluents through denitification and anionic nitrification stages to recycle treated water back to the raw water treatment plant.	Onsite biological treatment of process condensate and other process wastewaters.
Directly Associated Activities				
A7	Directly associated activity	Raw Water Treatment Plant	From receipt of the incoming water supply through the primary/secondary treatment processes to production of water for use in the hydrogen production facility	Treats supplied water for use in the hydrogen production process.
A8	Directly associated activity	Dewatering of raw water sludge.	From receipt sludge from clarifier to disposal of solids.	Dewatering of clarifier sludge (0.04 m^3/hr) and disposal of the resulting sludge.
A9	Directly associated activity	Demineralisation Plant	From receipt of the treated raw water supply through the reverse osmosis and electro-deionisation	Treats supplied water for use in the hydrogen production process.

Activity Ref	SCHEDULE 1 – PART 2 REFERENCE	DESCRIPTION OF ACTIVITY	LIMITS OF SPECIFIED ACTIVITY	DETAILS OF THE ACTIVITY
			processes to produce DMW for use in the hydrogen production facility	
A10	Directly associated activity	Dewatering of sludges from the MBR or backwashes from the ETP processes.	From receipt of bio-sludges from the membrane bioreactor and backwash from the effluent treatment plant.	Dewatering of biosludges and backwash by dewatering (<0.002 m^3/hr) and subsequent disposal of the resulting sludge.
A11	Directly associated activity	Production of or import of oxygen and nitrogen	Production of oxygen / nitrogen (ASU) and storage onsite prior to use in process or import and storage onsite prior to use	ASU and storage or pipeline for import of oxygen and nitrogen for use in the hydrogen production process.
A12	Directly associated activity	Raw materials handling and storage	From receipt of raw materials to their point of use.	Storage, handling, distribution, and use of raw materials including water, liquid (water treatment chemicals) and gaseous (N_2) materials
A13	Directly associated activity	Process Cooling Plant	From receipt of cooling water to discharge of cooling water blowdown to effluent treatment plant.	Operation of process cooling plant.
A14	Directly associated activity	Surface Water Drainage	From receipt of surface water to point of discharge.	Operation of systems for the collection, reuse, and discharge of uncontaminated surface water.
A15	Directly associated activity	Product storage	From point of hydrogen production to its export	Storage, handling, and export of hydrogen.
A16	Directly associated activity	Process Water Closed Drainage System	Closed drain systems: a) From separate collection of amine drain drum to either reuse or disposal via tankers.	Operation of separate closed drainage system for collection and handling of amine containing process waters and separate closed drainage system of process

Activity Ref	SCHEDULE 1 – PART 2 REFERENCE	DESCRIPTION OF ACTIVITY	LIMITS OF SPECIFIED ACTIVITY	DETAILS OF THE ACTIVITY
			b) From separate collection of process condensate from syngas plant to a closed drain drum to the biological treatment plant and reuse in raw water treatment.	condensate for treatment and reuse in raw water treatment plant.
A17	Directly associated activity	Emergency flare	From receipt of waste gas into the flare to the release of combustion gases	Operation of a flare for the safe disposal of flammable off-gases in startup, shutdown, process upset and emergencies
A18	Directly associated activity	Gas compression	Compression of hydrogen and carbon dioxide gases prior to export.	Operation of the gas compression systems.

4.0 CONDITION OF THE LAND AT PERMIT ISSUE

<table>
<tr>
<td>Environmental setting including:
• Geology
• Hydrogeology
• Surface waters</td>
<td>
4.1 Geology

4.1.1 Defra's MAGIC online map for Agricultural Land Classification (ALC) (see Annex 3) classifies the Installation site as being underlain by urban and non-agricultural soils giving the soils a Low resource value and a negligible impact value (see Figure 10-19 in Annex 3). Ground levels at the Installation site generally slope from the south of the area to the north, towards the North Sea coastline. The centre of the site is slightly undulated with minor changes in ground levels (+5 mAOD to +8mAOD).

4.1.2 Artificial Ground is present at most of the Installation site, and is associated with the long historical industrial use of the site.

4.1.3 The Site is in an area that might not be affected by coal mining based on the information contained in the Groundsure reports (see Annex 3). There is no hazard from non-coal mining at the site according to data provided by the British Geological Survey (BGS). See Figures 10-20 to 10-23 (Annex 3).

4.1.4 The published British Geological Survey 1:50,000 scale maps ((Sheets 33 (BGS,1987) and 34 (BGS,1998)) show the Site to be underlain by three types of superficial deposits: Tidal Flat Deposits, Glaciolacustrine Deposits, and Devensian Till.

4.1.5 The BGS maps show the bedrock geology underlying the Site to be Redcar Mudstone Formation, Penarth Group, and Mercia Mudstone Group.

4.1.6 A summary of the superficial and bedrock deposit underlying the site, in the order of occurrence, is shown below and on Figures 10-1 and 10-3 (Annex 3):

<table>
<tr><th>Superficial Geology</th><th>Bedrock Geology</th></tr>
<tr><td>Tidal Flat Deposits
Glaciolacustrine Deposits
Devensian Till</td><td>Redcar Mudstone Formation (Lias Group)
Penarth Group (Rhaetian)
Mercia Mudstone Group (Triassic)</td></tr>
</table>
4.1.7 There are two historic landfill sites located 105 m and 150 m east of the Site boundary, according to Local Authority (LA) and mapping records dated
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		1952 reported as refuse tips. The latest operator/license holder, as well as the first and last input dates are not supplied. Given the location of the landfill, it is unlikely to have an adverse impact to the Site. No other landfill sites are identified within 250m of the Site. These are shown on Figure 10-6 (Annex 3).
	4.1.8	Other historical land uses in the vicinity of the site are shown Figures 10-7, 10-8a – 10-8e and 10-9 (Annex 3).
	4.1.9	The site is identified as being at negligible risk of ground instability. Refer to Figures 10-18a – 10-18f.
	4.1.10	The Site lies mostly within an area where between 1 and 3 % of homes are at or above the Action Level for radon. Radon protection measures are likely required under this scenario.
	4.1.11	Based upon the Conceptual Site Model (CSM) (Document Reference: 6.4.12 Environmental Statement, Appendix 10B) presented in Annex 3, an evaluation of the risks posed by the identified potential pollutant linkages at the Site has been prepared and is presented in Annex 3.
	4.2	Hydrogeology
	4.2.1	The EA Groundwater Protection Policy adopts aquifer designations consistent with the Water Framework Directive.
	4.2.2	According to this system the Redcar Mudstone Formation is classified as a Secondary (undifferentiated) aquifer. The Mercia Mudstone Group is classified as a Secondary aquifer B. The Penarth Group is classified as a Secondary undifferentiated and Secondary B aquifer. No Principal aquifers underly the site.
	4.2.3	The Superficial Aquifer Designation at the site comprises classification of the Tidal Flat Deposits (sand and silt, eastern half of the site) strata as Secondary Aquifer A, the Glaciolacustrine deposits as Unproductive, and the Till and Tidal Flats Deposits (sand, silt and clay, western half of the site) as Unproductive.

	4.2.4	Environment Agency (EA) Groundwater Maps show that the proposed Installation site falls outside any Groundwater Source Protection Zones.
	4.2.5	The proposed Installation site is identified to be located on a Secondary superficial Aquifer with the groundwater vulnerability classified as medium to high.
	4.2.6	The proposed Installation site is indicated to be outside the Groundwater and Surface water Safeguard Zones for Drinking Water.
	4.2.7	The aquifers, groundwater vulnerability and source protection zones are shown on Figures 10-11 to 10-15 (Annex 3).
	4.3	Hydrology
	4.3.1	The River Tees flows approximately 840 m to the west of the proposed Installation boundary. The River Tees is tidal at the location, with the normal tidal limit approximately 14 km upstream (at the Tees Barrage).
	4.3.2	The North Sea is located approximately 680 m to the north of the proposed Installation.
	4.3.3	There are a number of surface water features in the vicinity of the site, primarily comprising the Dabholm Gut, which flows to the River Tees approximately 0.7 km south of the proposed Installation. The Dabholm Gut is tidal and accepts water from: • the Fleet (that runs from Coatham Marsh, to the west of Redcar); • the Mill Race (from east of the Wilton international complex); and • Dabholm Beck (from the west of the Wilton International complex).
	4.3.4	The Northumbrian Water Bran Sands wastewater treatment works (WwTW) (to the south of the site) discharges into the Dabholm Gut, as does effluent from the Wilton complex.
	4.3.5	The EA 'Flood map for planning' indicates that the whole of the proposed Installation is located within Flood Zone 1 that is defined as, "land having a less than 1 in 1,000 (less than 0.1%) annual probability of river or sea flooding." Further details of this are

		presented in Supporting Statement, Appendix I Flood Risk Assessment (Document Reference: DCO 6.4.9)
	4.3.6	The proposed Installation site is not located within any Groundwater Source Protection Zone.
	4.3.7	Figures in Annex 3 show BGS boreholes (Figure 10-4), discharge consents (Figure 10-11), groundwater abstractions (Figure 10-16) and surface water (Figure 10-17).
Pollution history including: • Pollution incidents that may have affected land • Historical land-uses and associated contaminants • Any visual/olfactory evidence of existing contamination • Evidence of damage to pollution prevention measures	4.4	Pollution History
	4.4.1	The site has been subject to extensive industrial development since before the date of earliest Ordnance Survey map (1854) with potential contaminative uses present up to approximately 2015.
	4.4.2	Contaminative uses included iron and steel works, coking works, railways, tarmacadam / slag works, brine works, cement manufacture, anhydrite mining, landfill and chemical works with associated buildings, plants, production facilities, pavements, services and waste storage and transfer areas.
	4.4.3	The historical development of the Site is discussed in detail and shown on Figures 10-7, 10-8a – 10-8e and 10-9 in Annex 3.
	4.4.4	The BGS Durham and the Tees Valley Mineral Resources and Constraints Report indicated that "the Billingham Anhydrite was extensively mined on Teesside between 1927 and 1971 as a source of sulphur for the manufacture of the fertiliser ammonium sulphate and sulphuric acid. It was reported that "the Boulby Halite formed the basis of the Teesside chemical industry and was still being worked by brine pumping in 2000". Report on Abandoned Mineral Workings and Possible Surface Instability Problems (Morris et al, 1982) indicates that the mine at Billingham (NZ478227) located in the vicinity of the site was operational between 1926 and 1971. Mining ceased due to the decline in use of ammonia sulphate fertiliser and because the Anhydrite Process of sulphuric acid production became uncompetitive with methods using elemental sulphur.

	4.4.5	It is noted that the site falls outside of a Coal Authority Mining Reporting Area and CIRIA C758D indicates that it lies to the north of areas underlain by historic ironstone workings, these being located across the elevated topography of the North Yorkshire Moors.
	4.4.6	Two landfill sites are located within 250 m of the site boundary. These are historical refuse tips located 105 m and 150 m to the east of the site, according to Local Authority/mapping records dated 1952. The latest operator / license holder, and the first and last input dates, are not supplied. Given the location and state of the landfills, they are unlikely to have an adverse impact to the site.
Evidence of historic contamination, for example, historical site investigation, assessment, remediation and verification reports (where available)	4.5	Evidence of Historic Contamination
	4.5.1	Factual ground investigation data and interpretive reports for previous ground investigations undertaken for the site were received from Allied Exploration & Geotechnics Limited and CH2M, and reviewed as part of the desktop assessment. The reports reviewed are listed in Annex 3.
	4.5.2	The review of potential contaminant linkages for the Installation has indicated possible constraints on land use across the Site from contamination that would typically be expected for industrial land. The potential contamination risks identified in the desk study are dependent upon the type of development proposed in addition to the industrial history of the area. Previous assessments have indicated the presence of contaminative substances, including but not limited to, sulphate, metals, polyaromatic hydrocarbons (PAHs), petroleum hydrocarbons and asbestos.
	4.5.3	A conceptual site model (CSM) (Document Reference: 6.4.12 Environmental Statement, Appendix 10B) and a detailed environmental risk assessment (Document Reference: 6.4.13 Environmental Statement, Appendix 10C) for the identified risks has been undertaken for the site and are provided in Annex 3 and Table 5.1. It is understood that the relevant areas of the site will be remediated by the current owner (South Tees

		Development Corporation (STDC)) to the acceptable standards for industrial sites prior to being handed over to the new operator. STDC is responsible for separate applications for these works. It is anticipated that a verification of the site condition will be undertaken to set the baseline for the permit Installation, including identification of residual contamination from historic land use, prior to commissioning of the proposed Installation.
Baseline soil and groundwater reference data	4.6	Baseline Soil and Groundwater Information
	4.6.1	The site and immediate surroundings are currently managed by the STDC, and the relevant areas of the Site which will be developed will be remediated to the acceptable industrial standard, in line with the Local Area Plan for the Redcar area. The relevant areas of the Site which will be within the final permit Installation site boundary will therefore be remediated to this standard prior to be handling it over to H2Teesside Limited, following which the Installation will be constructed.
	4.6.2	Additionally, the proposed Installation is to be installed on concrete hardstanding, with controlled drainage, and will use a limited type and quantity of potentially contaminating raw materials. The raw materials will be stored in appropriately secured and bunded containers, therefore the likelihood of the new operations adversely affecting the surrounding environment is considered to be minimal. Therefore, based on the review of existing ground conditions and proposed Installation operations, it is considered that the proposed activities do not pose a significant risk to the environment.
	4.6.3	As an Industrial Emissions Directive (IED) regulated activity, baseline conditions for the site will be collected as part of the detailed Phase II ground investigation to be undertaken prior to construction of the Installation.
	4.6.4	Indicative potential pollution risks from the proposed operations and associated mitigation measures are shown in Table 5.1
Supporting information	• Annex 3	

5.0 ENVIRONMENTAL RISK ASSESSMENT

5.1 Potentially Hazardous Substances

5.1.1 In accordance with IED requirements, the potentially hazardous substances that may be present on site have been identified and are presented in the table in Annex 2. These materials represent raw materials used and/or products for the site and broadly comprise:

- Process catalysts;
- CO2 absorption solvents;
- Gases including natural gas, H2, O2 and N2;
- Generator and pump fuels;
- Boiler and cooling water treatment chemicals;
- SCR catalyst; and
- Firefighting Foam.

5.1.2 MSDS sheets have been provided separately for these materials.

5.2 Assessment of Relevant Hazardous Substances (RHS)

5.2.1 RHS in relation to IED are defined as:

'*those substances or mixtures defined within Article 3 of Regulations (EC) No1272/2008, which, as a result of their hazardousness, mobility, persistence and biodegradability (as well as other characteristics), are capable of contaminating soil or groundwater and are used, produced and/or released by the installation.*'

5.2.2 The MSDS sheets for the materials on the inventory have been reviewed and we have recorded the hazardous properties where relevant on the inventory table in Annex 2. The RHS for the site based on the assessment are outlined below.

Diesel, and Lubricating Oils

5.2.3 Diesel and lubricating oils are used by the back-up emergency generators and the firewater pumps.

5.2.4 Both are capable of contaminating soil and groundwater should they be released into the environment. These oil-based substances are toxic to the water environment and although they are biodegradable in particular conditions, larger volumes of these substances are likely to be relatively persistent in the environment.

5.2.5 Diesel is stored in sufficiently large quantities to be considered a RHS for the purposes of this assessment.

5.2.6 Lubricating oil will only stored in small quantities on the site and will be brought onto the site as needed for maintenance purposes. Any waste oil generated during

maintenance will be removed from site as it is produced. On this basis lubricating oil and waste lubricating oil have been discounted as RHSs for the purposes of this baseline assessment of soils and groundwater

Process catalysts

5.2.7 Process catalysts are retained on site as catalyst beds within the production processes which are contained. These substances are toxic to the water environment and in larger volumes these substances are likely to be relatively persistent in the environment.

5.2.8 The volumes of the materials held on site are relatively low with the exception of the LTS catalyst which has a volume in the order of 126 m^3. Exposure risk is highest during the time of bed replacement (every 1 – 4 years) which will be undertaken by specialist contractors who will bring the replacement catalyst to site and remove the waste catalyst to an offsite facility for regeneration. Given the potential hazard to the aquatic environment we have classed these materials as RHS.

CO2 Absorption Solvent

5.2.9 This is OASE White which is an amine based solvent used for CO2 capture and which will be stored on site. It is hazardous primarily in relation to human health, and adsorption and mobility in soil is not accepted.

5.2.10 Given the volume to be held on site and the risk to human health, we are treating this as an RHS.

Water treatment Chemicals

5.2.11 Boiler water will be treated via ion exchange, the typical chemicals used are expected to include caustic soda, hydrochloric acid, trisodium phosphate and an oxygen scavenger or similar proprietary boiler water chemicals. Some of these chemicals will be hazardous to the environment, however they be stored and used in very small quantities. As such we don't consider them as RHS at this time although we have included them in the environmental risk assessment in table 5.3 below.

Ammonia

5.2.12 Ammonia solution will be used as a flue gas treatment chemical and is considered a hazardous substance as it is very toxic to aquatic life.

5.2.13 Given its hazardous nature and potential volume stored on site, this is considered as a RHS.

5.3 Environmental Risk Assessment Methodology

5.3.1 The methodology adopted is described in detail in Environment Agency Land contamination risk assessment[1] and relies on the development of a site specific conceptual site model (CSM) consisting of three components:

- A source of contamination, for example due to historical site operations;
- A pathway, a route by which receptors can become exposed to contaminants. Examples include vapour inhalation, soil ingestion and groundwater migration;
- A receptor, a target that may be exposed to contaminants via the identified pathways. Examples include human occupiers/users of the site, controlled water receptors, property or ecosystems.

5.3.2 For a potential risk to either environmental and/or human receptors to exist, a plausible pollutant linkage involving each of these components must exist. If one of the components is absent then a pollutant linkage, and thereby potentially unacceptable risk, is also unlikely to exist. Where all three components are or may be present, a potentially complete pollutant linkage can be considered to exist. This does not automatically imply the presence of unacceptable risk, but further investigation of the potential pollutant linkages is required.

5.3.3 The potential sources of contamination on or in the vicinity of the site, receptors on or near site, and pathways on or near the site are discussed within this section.

Potential Sources of Contamination

5.3.4 Potentially polluting activities are principally the storage and handling of the diesel fuel, raw materials, process gases and natural gas for the combustion plant.

Potential Receptors

5.3.5 The following potential receptors have been identified which would be adversely affected by any contamination at the site:

Table 5.1: Potential Receptors

Potential Receptor	Description
Human Health	• Construction workers, • Future site users; and • Operational staff.
Controlled Waters	• Groundwater within the underlying made ground deposits; • Groundwater within the underlying bedrock; • Tees Estuary
Vegetation	• Vegetation and landscaping in nearby Sites

[1] The Environment Agency, 2020. Land contamination risk assessment.

Potential Pathways

5.3.6 Potential pathways have been identified, which could link the potential sources with the potential receptors. These pathways are discussed by receptor type below in consideration of the redevelopment of the site:

Table 5.2: Potential Receptors

Potential Pathways	Description
Controlled Waters	• Migration across above ground surfaces; • Migration of contaminants with sub-surface infiltration; • Shallow ground water flow
Soil	• Potential for direct contact and potentially contaminated soils during future construction activities

5.4 Assessment of the Likelihood of Land Pollution

5.4.1 An assessment of the potentially polluting substances identified in 5.1.1 taking into consideration the proposed management and control arrangements has been completed and is presented in Table 5.3 on the following page.

Table 5.3. Environmental Risk Assessment for Raw Materials and Wastes at the Proposed Installation

SUBSTANCES	RELEVANT ACTIVITY	POTENTIAL FOR POLLUTION FROM THE RELEVANT ACTIVITY	EXISTENCE OF POLLUTION PREVENTION MEASURES	NATURE OF PRIMARY CONTAINMENT	TESTING AND INSPECTION OF PRIMARY CONTAINMENT	NATURE OF SECONDARY CONTAINMENT	TESTING AND INSPECTION OF SECONDARY CONTAINMENT	NATURE OF TERTIARY CONTAINMENT	TESTING AND INSPECTION OF TERTIARY CONTAINMENT	ADEQUACY OF POLLUTION PREVENTION MEASURES YES/NO	ARE THE PROPOSED INTEGRITY TESTING OF POLLUTION PREVENTION MEASURES ADEQUATE YES/NO	IS THERE AN ADEQUATE DOCUMENTED MANAGEMENT SYSTEM TO DEMONSTRATE OPERATOR MANAGEMENT AND COMPETENCE WITH THE RELEVANT ACTIVITY	LIKELIHOOD OF POLLUTION
Catalysts (various) e.g. for reforming, shift reaction etc. • Katalco 61-2F • Katalco 32-4 • Katalco 79-1 • Katalco 23-4HMQR • Katalco 23-4HMQ • Katalco 23-4HQ • Katalco 28-4Q • Katalco 83-5 • Katalco 89-9GQ • Katalco 83-3X • Katalco 59-4 •	Charged to process vessels and changed every one to four years	Loss on charging or removing spent catalyst from vessels	Yes	Storage of catalyst material will be minimised with catalyst being ordered ahead of change-out events. Catalyst materials loading/removal to be completed by specialist contractor. Placed in vessels under hygiene dust extraction.	Drums of catalyst inspected. Catalyst containing vessels subject to inspection and maintenance	Plant areas containing vessels are concreted. Catalysts are solids and therefore not very mobile on spillage.	Concrete hardstanding is subject to inspection and maintenance / repair if required.	Mixture of concrete and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes	Very low
Proprietary Amine Solvent for CO_2 recovery	Delivery by vehicle to site – once site system is charged the delivery is very infrequent as only to top up system (once per annum)	Spillage during off-loading e.g. flex hose/ connection failure	Yes	Road tanker fitted with dry-break couplings Delivery hoses on a register that covers inspections, change frequency etc. Offloading points plugged or blanked off when not in use. Potential to install non return valve (NRV) to prevent backflow on disconnection.	Visual inspection of road tanker and delivery hoses to be carried out. Deliveries via reputable supplier using vehicles which are fit for purpose.	Concrete hardstanding for delivery vehicle, including kerbed area draining via a blind sump for the collection of spilt materials	Visual inspection of concrete hardstanding, and the blind sump to ensure they are in good working condition. Empty sump of rainwater periodically.	Spill kits to be available on site	Scheduled inspections of spill kits / containment provisions	Yes	Yes	Yes [1]	Very low

SUBSTANCES	RELEVANT ACTIVITY	POTENTIAL FOR POLLUTION FROM THE RELEVANT ACTIVITY	EXISTENCE OF POLLUTION PREVENTION MEASURES	NATURE OF PRIMARY CONTAINMENT	TESTING AND INSPECTION OF PRIMARY CONTAINMENT	NATURE OF SECONDARY CONTAINMENT	TESTING AND INSPECTION OF SECONDARY CONTAINMENT	NATURE OF TERTIARY CONTAINMENT	TESTING AND INSPECTION OF TERTIARY CONTAINMENT	ADEQUACY OF POLLUTION PREVENTION MEASURES YES/NO	ARE THE PROPOSED INTEGRITY TESTING OF POLLUTION PREVENTION MEASURES ADEQUATE YES/NO	IS THERE AN ADEQUATE DOCUMENTED MANAGEMENT SYSTEM TO DEMONSTRATE OPERATOR MANAGEMENT AND COMPETENCE WITH THE RELEVANT ACTIVITY	LIKELIHOOD OF POLLUTION
	Storage	Leak from bulk storage tankage by overfilling or mechanical damage to tank infrastructure (tank, pipelines, pumps)	Yes	2 x 380m^3 above ground bulk storage tanks (one per phase) feeding the process. Tanks fitted with level measurement and alarms to prevent overfilling.	Above ground storage tanks to be situated outdoors. Level detection alarms and trips tested routinely. Will be subject to routine visual checks and inspection in line with manufacturer guidance.	The tank will be installed in a concrete bund in compliance with CIRIA C736 guidelines, with level alarms to identify high levels of accumulated water and / or leakage. Bund capacity 110% of largest tank or 25% of tankage within the bund.	Regular visual inspection of bunding, and testing of alarms. Tank is on a tank inspection and maintenance register, as per industry practice.	Site hardstanding and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes (1)	Very low
Ammonia solution used in SCR abatement for combustion plant	Delivery by vehicle to site	Spillage during off-loading e.g. flex hose/ connection failure	Yes	Road tanker fitted with dry-break couplings Delivery hoses on a register that covers inspections, change frequency etc. Offloading points plugged or blanked off when not in use. Potential to install non return valve (NRV) to prevent backflow on disconnection.	Visual inspection of road tanker and delivery hoses to be carried out. Deliveries via reputable supplier using vehicles which are fit for purpose.	Concrete hardstanding for delivery vehicle including kerbed area draining via a blind sump for the collection of spilt materials	Visual inspection of concrete hardstanding, and the blind sump to ensure they are in good working condition. Empty sump of rainwater periodically.	Spill kits to be available on site	Scheduled inspections of spill kits / containment provisions	Yes	Yes	Yes (1)	Very low
	Storage	Leak from bulk storage tankage by overfilling or mechanical damage to tank infrastructure (tank, pipelines, pumps)	Yes	2 x 20m^3 above ground bulk storage tanks (one per phase) feeding the process. Tanks fitted with level measurement and alarms to prevent overfilling.	Above ground storage tanks to be situated outdoors. Level detection alarms and trips tested routinely. Will be subject to routine visual checks and inspection in line with manufacturer guidance.	The tank will be installed in a concrete bund in compliance with CIRIA C736 guidelines, with level alarms to identify high levels of accumulated water and / or leakage. Bund capacity 110% of largest tank or 25% of tankage within the bund.	Regular visual inspection of bunding, and testing of alarms. Tank is on a tank inspection and maintenance register, as per industry practice.	Site hardstanding and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes (1)	Very low

SUBSTANCES	RELEVANT ACTIVITY	POTENTIAL FOR POLLUTION FROM THE RELEVANT ACTIVITY	EXISTENCE OF POLLUTION PREVENTION MEASURES	NATURE OF PRIMARY CONTAINMENT	TESTING AND INSPECTION OF PRIMARY CONTAINMENT	NATURE OF SECONDARY CONTAINMENT	TESTING AND INSPECTION OF SECONDARY CONTAINMENT	NATURE OF TERTIARY CONTAINMENT	TESTING AND INSPECTION OF TERTIARY CONTAINMENT	ADEQUACY OF POLLUTION PREVENTION MEASURES YES/NO	ARE THE PROPOSED INTEGRITY TESTING OF POLLUTION PREVENTION MEASURES ADEQUATE YES/NO	IS THERE AN ADEQUATE DOCUMENTED MANAGEMENT SYSTEM TO DEMONSTRATE OPERATOR MANAGEMENT AND COMPETENCE WITH THE RELEVANT ACTIVITY	LIKELIHOOD OF POLLUTION
Small quantities of waste chemicals and oils (e.g. fresh lube oils / cleaning solvents)	Generated from maintenance activities, e.g. waste oils / cleaning solvent, or storage. Storage of raw lube oils and cleaning reagents (e.g. solvents)	Leak from storage containers. Not bulk storage but drums and IBC's.	Yes	Dedicated waste containers, with segregated storage of hazardous and non-hazardous waste. Storage quantities to be confirmed during FEED stage. Raw materials in drums and IBC's.	Storage containers will be subject to routine visual checks and inspection.	IBC's and drums will be stored on top of secondary containment bunds, for collection of drips and spills.	Regular visual inspection of storage and bund provisions.	Site hardstanding and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes (1)	Very low
Diesel	Delivery by vehicle to site - once site system is charged the delivery is very infrequent diesel is only used in emergency situations	Spillage during off-loading e.g. flex hose/ connection failure	Yes	Road tanker fitted with dry-break couplings Delivery hoses on a register that covers inspections, change frequency etc. Offloading points plugged or blanked off when not in use. Potential to install non return valve (NRV) to prevent backflow on disconnection.	Visual inspection of road tanker and delivery hoses to be carried out. Deliveries via reputable supplier using vehicles which are fit for purpose.	Concrete hardstanding for delivery vehicle, including kerbed area draining via a blind sump for the collection of spilt materials	Visual inspection of concrete hardstanding, and the blind sump to ensure they are in good working condition. Empty sump of rainwater periodically.	Spill kits to be available on site	Scheduled inspections of spill kits / containment provisions	Yes	Yes	Yes (1)	Very low
	Storage	Leak from bulk storage tankage by overfilling or mechanical damage to tank infrastructure (tank, pipelines, pumps)	Yes	Anticipated to be double skinned tanks (with integral 110% bund). Leak detection within interstitial area between walls (bund). Level measurement to prevent overfilling.	Will be subject to routine visual checks and inspection in line with manufacturer guidance. Level measurement, alarms and trips will be on a routine testing regime.	The tank will be double skinned with integral bunding. The bund will have leak detection.	Regular visual inspection of bunding, and testing of the leak detection system	Site hardstanding and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes (1)	Very low

SUBSTANCES	RELEVANT ACTIVITY	POTENTIAL FOR POLLUTION FROM THE RELEVANT ACTIVITY	EXISTENCE OF POLLUTION PREVENTION MEASURES	NATURE OF PRIMARY CONTAINMENT	TESTING AND INSPECTION OF PRIMARY CONTAINMENT	NATURE OF SECONDARY CONTAINMENT	TESTING AND INSPECTION OF SECONDARY CONTAINMENT	NATURE OF TERTIARY CONTAINMENT	TESTING AND INSPECTION OF TERTIARY CONTAINMENT	ADEQUACY OF POLLUTION PREVENTION MEASURES YES/NO	ARE THE PROPOSED INTEGRITY TESTING OF POLLUTION PREVENTION MEASURES ADEQUATE YES/NO	IS THERE AN ADEQUATE DOCUMENTED MANAGEMENT SYSTEM TO DEMONSTRATE OPERATOR MANAGEMENT AND COMPETENCE WITH THE RELEVANT ACTIVITY	LIKELIHOOD OF POLLUTION
Water treatment chemicals and boiler water treatment chemicals, such as: • Hydrochloric acid • Caustic • Biocides (sodium hypochlorite, bromine water) • Corrosion inhibitors	Storage in drums and IBC's connected to the ancillary process operations (i.e. water preparation, BFW preparation)	Leak from storage containers	Yes	Storage in drums and IBC's. Storage quantities to be confirmed during FEED stage.	Storage containers will be subject to routine visual checks and inspection.	IBC's and drums will be stored on top of secondary containment bunds, for collection of drips and spills.	Regular visual inspection of storage and bund provisions.	Site hardstanding and surface water drainage. Isolation valves in drainage system.	Concrete hardstanding and drainage are subject to scheduled inspection and maintenance / repair if required.	Yes	Yes	Yes (1)	Very low

- Notes: (1) Documented Management System will be developed as part of the FEED activities

6.0 CONCLUSION

6.1.1 As demonstrated in Table 5.3, the activities undertaken at the Installation and the associated pollution prevention and containment measures are considered to represent a very low risk of pollution to the underlying soil and groundwater. The CSM and SCR will be updated at FEED when land contamination condition is better understood, which will inform the collection of baseline data.

6.1.2 The Installation will maintain an incident register throughout the lifetime of the operations which will log any losses of containment or near misses, and record whether the loss was contained to the site systems (as expected) or managed to enter the underlying soil and groundwater, in which case the clean-up and remediation activities undertaken will be recorded.

6.1.3 The Installation will also maintain an infrastructure monitoring log to record the scheduled inspection and maintenance of containment systems e.g. amine tank and bunding, and any significant maintenance or repair activities required. Details of the routine inspection and maintenance activities will be developed prior to commencement of operations.

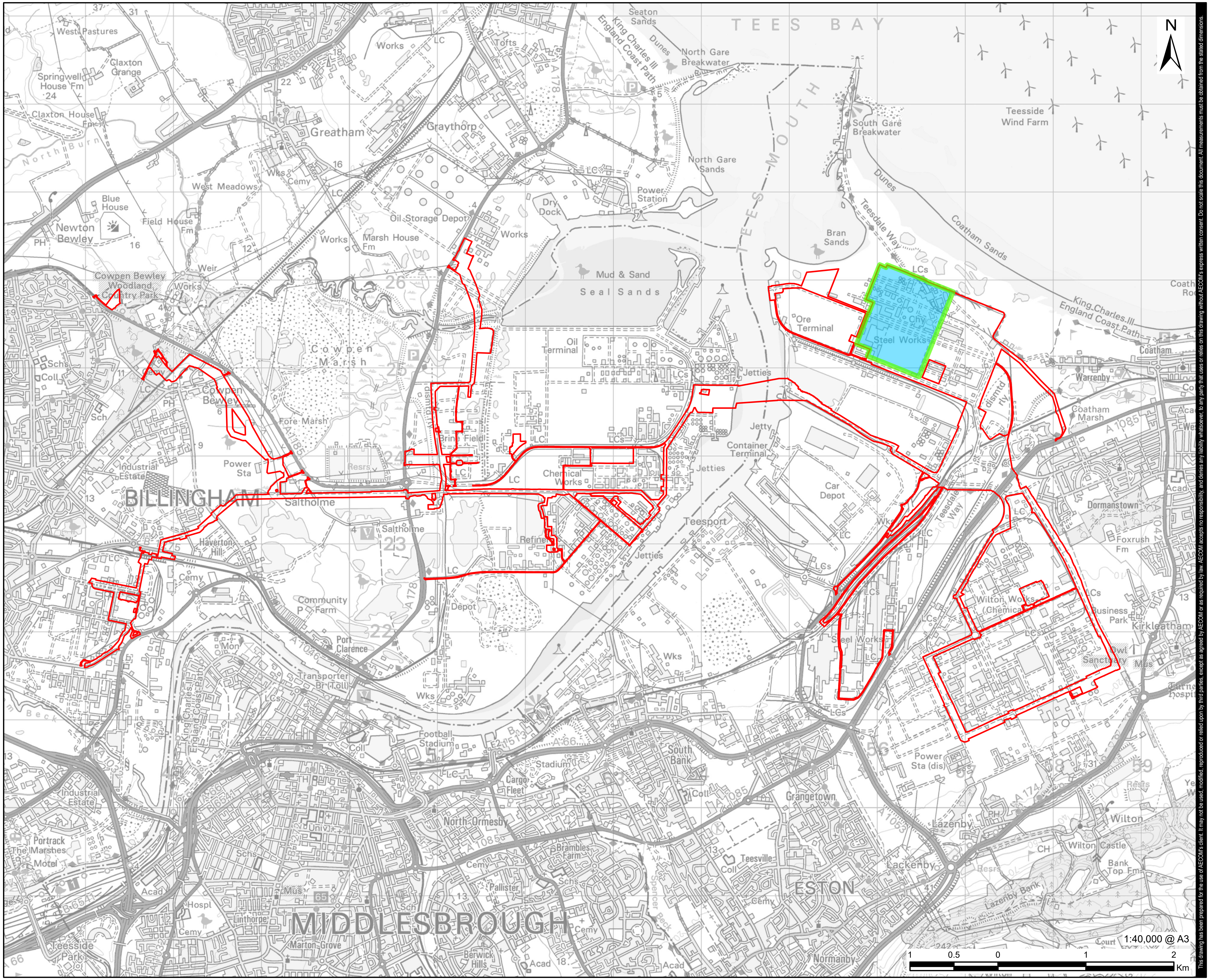
6.1.4 The CSM is provided in Annex 3 which identifies possible risks arising from substances used or deposited at the proposed Installation (i.e Main site), or from other sources of land contamination. Both past and current potentially contaminative land uses have been considered in the site conceptual model in Annex 3.

6.1.5 Gaseous raw materials (e.g. natural gas) and products (e.g. hydrogen) do not pose a risk to land contamination and are excluded from the environmental risk assessment in Table 5.3.

ANNEX 1: FIGURES

- Figure 1 – Site Location Plan
- Figure 2 – Site Layout
- Figure 4 – Drainage Plan

Revision: 0 Drawn: MAB Checked: CC Approved: AG Date: 2024-05-15



AECOM

PROJECT

H2Teesside DCO

APPLICANT

H2 Teesside

CONSULTANT

AECOM Limited
100 Embankment,
Cathedral Approach,
Manchester, M3 7FB
www.aecom.com

LEGEND

- Proposed DCO Development Site
- Carbon Capture Enabled Hydrogen Production Installation
- Proposed Environmental Permit Installation Boundary

NOTES

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ISSUE PURPOSE

Environmental Permit Application

PROJECT NUMBER

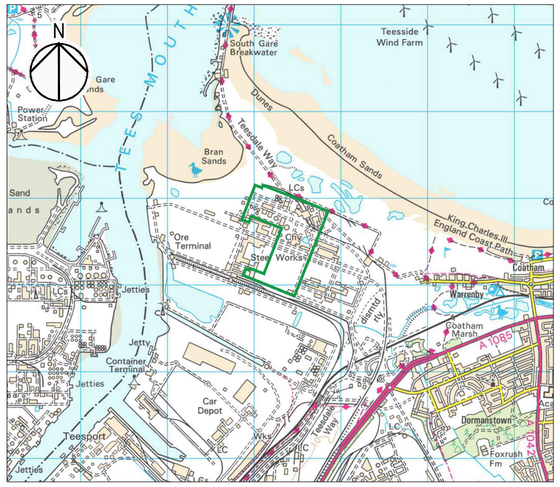
60689030

FIGURE TITLE

Proposed Development Site (including location of the Carbon Capture Enabled Hydrogen Production Installation)

FIGURE NUMBER

Figure 1-1



SITE LOCATION
SCALE 1:50,000

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

KEY

INSTALLATION BOUNDARY

HYGREEN SITE

Revision Details	By / Check	Date	Suffix

Purpose of issue

PERMIT APPLICATION

Client

bp H2 Teesside

Project Title

H2Teesside

Drawing Title

SITE LAYOUT PLAN

Designed	Drawn	Checked	Approved	Date
-	AO	AG	AF	10/24

AECOM Internal Project No.	Suitability
60675797	-
Scale @ A3	Zone
1:5,000	-

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Royal Court, Basil Close
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AECOM

Drawing Number	Rev
FIGURE 2	-

AECOM

PROJECT

H2Teesside DCO

APPLICANT

H2 Teesside

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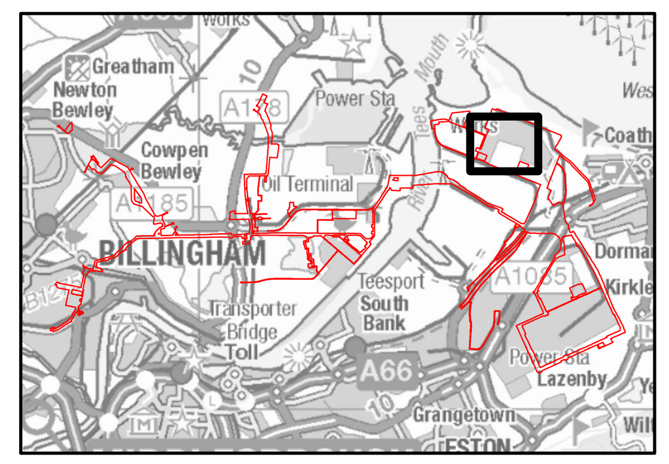
LEGEND

- DCO Limits
- Plot Plan
- Net Zero Teesside Outfall Option (Collect Storm Water and Other Effluents)
- Teesworks Option (Collect Storm Water Only)
- Surface Water Drainage Collection In Storm and Outfall Pond
- Proposed Environmental Permit Installation Boundary

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 5(2)(o).



NOTES

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APPLICATION REFERENCE

H2T_March24_DCO_2.12_Rev0

ISSUE PURPOSE

Environmental Permit Application

PROJECT NUMBER

60689030

FIGURE TITLE

Indicative Drainage Plan

FIGURE NUMBER

Figure 4

Revision: 0

ANNEX 2: RAW MATERIALS

Material	Use on Site	Hazard Properties	Hazard Identification	Annual Usage	Comment
KATALCO™ 61-2F	Hydrodesulphurisation Catalyst	Corrosion Health Hazard Environment	**H318** – Causes serious eye damage. **H334** – May cause allergy or asthma symptoms or breathing difficulties if inhaled. **H317** – May cause an allergic skin reaction. **H341** – Suspected of causing genetic defects **H350i** – May cause cancer by inhalation. **H360** – May damage fertility or the unborn child **H372** – Causes damage to organs (lungs, respiratory tract) through prolonged or repeated inhalation **H411** – Toxic to aquatic life with long lasting effects.	-	Is held in a catalyst bed (26m^3) in production unit with expected lifetime of 4 years
KATALCO 32-4	Desulphurisation Absorbent	Environment	**H400** – Very toxic to aquatic life. **H410** – Very toxic to aquatic life with long lasting effects.	-	Is held in a catalyst bed (43.9m^3) in production unit with expected lifetime of 1 year per bed
KATALCO 79-1	Ultra-Purification	Health Hazard Irritant Environment	**H332** - Harmful if inhaled. **H334** - May cause allergy or asthma symptoms or breathing difficulties if inhaled. **H317** - May cause an allergic skin reaction. **H341**- Suspected of causing genetic defects. **H350i** - May cause cancer by inhalation. **H360D** - May damage the unborn child. **H373** - May cause damage to organs through prolonged or repeated exposure. **H400 -** Very toxic to aquatic life. **H410** - Very toxic to aquatic life with long lasting effects.	-	Is held in a catalyst bed (3.7m^3) in production unit with expected lifetime of 1 year per bed
KATALCO 23-4HMQR	Gas Heated Reformer (GHR) Catalyst	Health Hazard	**H350i** - May cause cancer by inhalation. **H372** – Causes damage to organs (lungs, respiratory tract) through prolonged or repeated inhalation	-	Is held in a catalyst bed (12.9m^3) in production unit with expected lifetime of 4 years
KATALCO 23-4HMQ	Gas Heated Reformer (GHR) Catalyst	Health Hazard	**H350i** - May cause cancer by inhalation.	-	Is held in a catalyst bed (10.3m^3) in

Material	Use on Site	Hazard Properties	Hazard Identification	Annual Usage	Comment
			H372 – Causes damage to organs (lungs, respiratory tract) through prolonged or repeated inhalation		production unit with expected lifetime of 4 years
KATALCO 23-4HQ	Gas Heated Reformer (GHR) Catalyst	Health Hazard	**H350i** - May cause cancer by inhalation. **H372** – Causes damage to organs (lungs) through prolonged or repeated inhalation	-	Is held in a catalyst bed (2.6m^3) in production unit with expected lifetime of 4 years
KATALCO 28-4Q	Autothermal Reformer (ATR) Catalyst	Health Hazard Irritant	**H317** - May cause an allergic skin reaction. **H350i** - May cause cancer by inhalation. **H372** – Causes damage to organs (lungs) through prolonged or repeated inhalation	-	Is held in a catalyst bed (29.4m^3) in production unit with expected lifetime of 4 years
KATALCO 83-5	Isothermal Temperature Shift (ITS) Catalyst	Environmental Hazard	**H400 -** Very toxic to aquatic life. **H410** - Very toxic to aquatic life with long lasting effects.	-	Is held in a catalyst bed (29.4m^3) in production unit with expected lifetime of 4 years
KATALCO 89-9GQ	Autothermal Reformer (ATR) Catalyst	Health Hazard Irritant	**H317** - May cause an allergic skin reaction. **H350i** - May cause cancer by inhalation. **H373** - May cause damage to lungs through prolonged or repeated inhalation.	-	Is held in a catalyst bed (2.3m^3) in production unit with expected lifetime of 4 years
KATALCO 83-3X	Low Temperature Shift (LTS) Catalyst	Environmental Hazard	**H400 -** Very toxic to aquatic life. **H410** - Very toxic to aquatic life with long lasting effects.	-	Is held in a catalyst bed (125.6m^3) in production unit with expected lifetime of 4 years
KATALCO 59-4	Chloride Guard	Environmental Hazard	**H412** – Harmful to aquatic life with long lasting effects.	-	Is held in a catalyst bed (8.7m^3) in production unit with expected lifetime of 1 year per bed
OASE White	CO2 absorption solvent	Health Hazard Corrosive	**H318 –** Causes serious eye damage **H334 –** May cause allergy or asthma symptoms or breathing difficulties if inhaled **H317 –** May cause an allergic skin reaction **H361f –** Suspected of damaging fertility	Amine-based solvent - 6.2 m^3/y	Estimated storage capacity for: Amine-based solvent - 760 m^3 (b)

Material	Use on Site	Hazard Properties	Hazard Identification	Annual Usage	Comment
			H361d – Suspected of damaging the unborn child		
Natural gas	Hydrogen production	Gas cylinder Flame	**H220** – Extremely flammable gas **H280** – Contains gas under pressure; may explode if heated	986,02t/y	Storage not proposed
Nitrogen	Purging equipment to free it from flammable / toxic material; blanketing amine storage and other storage tanks, compressor seals and sump vessels Non-continuous demand for safe shutdown of the plant (non continuous demand will be supplied by on-site liquid N2 storage)	Gas cylinder	**H280** – Contains gas under pressure; may explode if heated	17,520 t/y	-
Oxygen	ATR	Gas cylinder Flame	**H270** – May cause or intensify extremely flammable gas **H280** – Contains gas under pressure; may explode if heated	813,103 t/y	Storage proposed up to 600T per phase if ASU option selected.
Diesel	Emergency diesel generator	Health Hazard Harmful	**H227** – Combustible liquid **H304** – May be fatal when swallowed and enters airways **H315** – Causes skin irritation **H332** – Harmful if inhaled **H351** – Suspected of causing cancer **H373** – May cause damage to organs through prolonged or repeated exposure (bone marrow, liver, thymus)	TBC at FEED	Once site system is charged the delivery is very infrequent diesel is only used in emergency situations
Raw water	Reagent, cooling and steam makeup	-	-	~6 Mt/y (phase 1 + 2)	-
Hydrochloric Acid	Water Treatment Chemicals	Corrosive Irritant	**H290** – May be corrosive to metals **H314** – Causes severe skin burns and eye damage **H335** – May cause respiratory irritation	83 m3/y	-
Caustic	Water Treatment Chemicals	Corrosive	**H314** – Causes severe skin burns and eye damage	TBC	-
Sodium Hypochlorite	Cooling water package	Corrosive Environmental Hazard	**H290** – May be corrosive to metals **H314** – Causes severe skin burns and eye damage **H410** - Very toxic to aquatic life with long lasting effects.	76 m^3/y	-

Material	Use on Site	Hazard Properties	Hazard Identification	Annual Usage	Comment
Bromine water	Cooling water package	Corrosive Harmful Environmental Hazard	**H315** – Causes skin irritation **H318** – Causes serious eye damage **H332** – Harmful if inhaled **H400 -** Very toxic to aquatic life.	6.5 t/y	-
Corrosion inhibitors	Cooling water package	Flammable Health Hazard Corrosive Harmful	**H315** - Causes skin irritation **H319** – Causes serious eye damage or eye irritation **H304** – May be fatal when swallowed and enters airways **H373** - May cause damage to lungs through prolonged or repeated inhalation.	39.2 t/y	-
Foam	Fire system	Harmful	**H315** - Causes skin irritation **H319** – Causes serious eye damage or eye irritation **H412** - Harmful to aquatic life with long lasting effects.	TBC	-
Nalco Elim-Ox	Boiler Water Treatment – O2 scavenger	Corrosive Harmful	**H315** - Causes skin irritation **H319** – Causes serious eye damage or eye irritation **H332** – Harmful if inhaled	TBC at FEED	TBC at FEED
Sodium Phosphate	Boiler Water Treatment Chemicals	Harmful	**H315 -** Causes skin irritation **H319 -** Causes serious eye irritation **H335 -** May cause respiratory irritation	TBC at FEED	TBC at FEED
Nalco Tri-Act 2813	Boiler Water Pump Treatment Chemicals	Corrosive Harmful	**H315** - Causes skin irritation **H319** – Causes serious eye damage or eye irritation	17.3 m^3/y	TBC at FEED
Aqueous ammonia	SCR	Corrosive Harmful Environmental Hazard	**H314** – Causes severe skin burns and eye damage **H318** – Causes serious eye damage **H335** – May cause respiratory irritation **H400 -** Very toxic to aquatic life. **H411 –** Toxic to aquatic life with long lasting effects	600 m3/yr (Phase 1)	TBC at FEED
Scale Inhibitor	Cooling Water Treatment	-	**-**	23.6 t/y	TBC at FEED

(a) All site storage volumes to be confirmed at FEED.
(b) MSDS for water treatment and firefighting systems are linked to the final vendor selected and will be confirmed at final design..
(c) All annual consumption values to be confirmed at FEED – where volumes are provided these are the current estimates.

ANNEX 3: GEOLOGY, HYDROGEOLOGY AND CONTAMINATED LAND

- DCO Environmental Statement, Chapter 10, Geology, Hydrogeology and Contaminated Land
- Summary Report (Document Reference: 6.4.11 Environmental Statement, Appendix 10A)
    - Groundsure Report – Main Site Only (Document Reference 284970768_1_1 – 21/09/2021)
    - Envirocheck Report – Main Site Only(Document Reference: GS-9167761 – 01/11/2022)
    - Site Walkover Survey -Main Site section
    - Previous Reports Summary – Main Site Only
    - Detailed Unexploded Ordnance Desktop Survey – Main Site Only
- Conceptual Site Model - Main Site Sections only (Document Reference: 6.4.12 Environmental Statement, Appendix 10B)
- Contaminated Land Environmental Risk Assessment - Main Site sections only (Document Reference: 6.4.12 Environmental Statement, Appendix 10B)
- Geotechnical Risk Register – Main Site sections only (Document Reference: 6.4.13 Environmental Statement, Appendix 10C)
- Figures and Plans
    - 10-1 Artificial Geology
    - 10-2 Superficial Geology
    - 10-3 Bedrock Geology
    - 10-4 BGS Boreholes
    - 10-5 Faults and Linear Features
    - 10-6 Waste and Landfills
    - 10-7 Hazardous Sites
    - 10-8a – e Historical Industrial Land Uses
    - 10-9 Historical Tanks
    - 10-10 Ecological Designations
    - 10-11 Discharge Consents
    - 10-12 Superficial Aquifers
    - 10-13 Bedrock Aquifers
    - 10-14 Groundwater Vulnerability
    - 10-15 Groundwater Source Protection Zones
    - 10-16 Groundwater Abstractions
    - 10-17 Surface Water Abstractions
    - 10-18a NGS Collapsible Deposits
    - 10-18b NGS Compressible Deposits
    - 10-18c NGS Ground Dissolution of Soluble Rocks
    - 10-18d NGS Landslides
    - 10-18-e NGS Running Sand
    - 10-18f NGS Shrink Swell Clays

- 10-19 Agricultural Land Classification
- 10-20 Brit Pits
- 10-21 Non Coal Minings
- 10-22 Surface Ground Workings
- 10-23 Underground Workings

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Figure 10-1d: Artificial Geology – Water Connection Corridor;

Figure 10-1e: Artificial Geology – Electrical Pipeline Corridor;

Figure 10-1f: Artificial Geology – Hydrogen Pipeline Corridor;

Figure 10-1g: Artificial Geology – Other Gases Connection Corridor;

Figure 10-2a: Superficial Geology – Main Site;

Figure 10-2b: Superficial Geology – Carbon Dioxide Export Corridor;

Figure 10-2c: Superficial Geology – Natural Gas Connection Corridor;

Figure 10-2d: Superficial Geology – Water Connection Corridor;

Figure 10-2e: Superficial Geology – Electrical Pipeline Corridor;

Figure 10-2f: Superficial Geology – Hydrogen Pipeline Corridor;

Figure 10-2g: Superficial Geology – Other Gases Connection Corridor;

Figure 10-3a: Bedrock Geology – Main Site;

Figure 10-3b: Bedrock Geology – Carbon Dioxide Export Corridor;

Figure 10-3c: Bedrock Geology – Natural Gas Connection Corridor;

Figure 10-3d: Bedrock Geology – Water Connection Corridor;

Figure 10-3e: Bedrock Geology – Electrical Pipeline Corridor;

Figure 10-3f: Bedrock Geology – Hydrogen Pipeline Corridor;

Figure 10-3g: Bedrock Geology – Other Gases Connection Corridor;

Figure 10-4: BGS Boreholes;

Figure 10-5: Faults and Linear Features;

Figure 10-6: Waste and Landfills;

Figure 10-7: Hazardous Sites;

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Figure 10-13c: Bedrock Aquifers – Natural Gas Connection Corridor;

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Figure 10-13e: Bedrock Aquifers – Electrical Pipeline Corridor;

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Figure 10-14d: Groundwater Vulnerability – Water Connection Corridor;

Figure 10-14e: Groundwater Vulnerability – Electrical Pipeline Corridor;

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VOLUME III: APPENDICES (ES VOLUME III, EN070009/APP/6.4)

Appendix 10A – Geology, Hydrogeology and Land Contamination Desk Based Summary Report

Appendix 10B – Contaminated Land Conceptual Site Model

Appendix 10C – Contaminated Land Environmental Risk Assessment

Appendix 10D – Geotechnical Risk Register

10.0 GEOLOGY, HYDROGEOLOGY AND CONTAMINATED LAND

10.1 Introduction

10.1.1 This chapter of the Environmental Statement (ES) identifies the potential impacts and effects on geology, hydrogeology and contaminated land that have been considered as part of the Environmental Impact Assessment (EIA) of the Proposed Development. The assessment has been undertaken in accordance with best practice guidance, and consideration has been given to geology: superficial soils and bedrock, geological and hydrogeological designations, soils and Agricultural Land Classification (ALC), land contamination and minerals.

10.2 Legislation, Planning Policy Context and Other Guidance

10.2.1 This section identifies and describes legislation, planning policy and guidance that is of relevance to the assessment of geology, hydrogeology and contaminated land effects.

Planning Policy Context

National Planning Policy

National Policy Statements

10.2.2 The revised National Policy Statements for energy infrastructure were published by the Government on 22 November 2023, following consultation in March 2023, and were designated (i.e. came into force) on 17 January 2024. Therefore, the revised NPSs are relevant policy for applications for development consent submitted and accepted for examination following their designation.

10.2.3 The following recently designated revised energy NPSs are considered of relevance to the Proposed Development:

- the Overarching NPS for Energy (EN-1) (DESNZ, 2023);
- the NPS for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (DESNZ, 2023); and
- the NPS for Electricity Networks Infrastructure (EN-5) (DESNZ, 2023).

Overarching National Policy Statement for Energy (EN-1) (November 2023)

10.2.4 The NPS for Energy (EN-1) (Department for Energy Security and Net Zero, 2023a) was published in November 2023 and is of relevance to the geology, hydrogeology and contaminated land assessment.

10.2.5 Section 4.12 (Pollution control and other environmental regulatory regimes) (Department for Energy Security and Net Zero (DESNZ), 2023a) includes consideration for discharges or emissions and indirect or direct impacts to terrestrial, freshwater, marine, onshore and offshore environments, or which include noise and vibration may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes.

10.2.6 Before consenting any potentially polluting developments it should be confirmed that:

- the relevant pollution control authority is satisfied that potential releases can be adequately regulated under the pollution control framework; and
- the effects of existing sources of pollution in and around the site are not such that the cumulative effects of pollution when the proposed development is added would make that development unacceptable, particularly in relation to statutory environmental quality limits.

10.2.7 The section also refers to pollution from industrial sources is controlled through the Environmental Permitting (England and Wales) Regulations 2016 (EPR) and it is a requirement for industrial facilities to have an environmental permit (EP). There is a requirement for larger industrial facilities undertaking specific types of activities to use Best Available Technology (BAT) to reduce emissions to air, water and land. Other relevant sections include section 5.4 Biodiversity and Geological Conservation, and section 5.16 Water Quality and Resources.

National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (2023)

10.2.8 A revised version of the NPS for Gas Supply Infrastructure and Gas and Oil Pipeline (EN-4) (DECC, 2023b) was published in November 2023. This NPS is of relevance to the geology, hydrogeology and contaminated land assessment as the Proposed Development includes pipeline infrastructure including a natural gas supply pipeline and hydrogen distribution pipelines. The NPS is noted to refer to 'Natural Gas' rather than 'Gas' as within the previous NPS EN-4.

10.2.9 Section 2.3 (Climate change adaptation) details the policy context for mitigating climate change for nationally significant energy infrastructure. Climate change resilience measures should account for increased risk of flooding, effects of rising sea levels and storm surges, higher temperatures, increased risk of earth movement and subsidence and any other increased risks identified in the assessment within the ES.

10.2.10 Section 2.8 (Underground Natural Gas Storage) and 2.9 (Underground Natural Gas Storage: Applicant assessment) sets out the limitations of site selection of underground storage and considerations to geology and aquifers. The Applicant's assessment must give consideration to the long-term integrity of affected strata within the construction, operational and decommissioning phases. The section also identifies non-exhaustive impacts which result from gas storage and supply infrastructure such as gas emissions, water quality and disposal of brine.

10.2.11 Section 2.10 provides details on the mitigation measures for underground natural gas storage including measures to control the abstraction of water including abstraction licences and Environmental Permits. The disposal of brine into an underground reservoir or the sea requires an Environmental Permit or discharge consents.

10.2.12 Section 2.21 (Natural Gas and Oil Pipelines: Applicant assessment) details the importance of understanding pipeline safety, impacts such as water quality and resources, and soils and geology and the potential impact that development might have on these. The section also highlights the effects of hydrostatic testing of pipelines which may take place during commissioning which may affect water quality and abstraction licenses and environmental permits are likely to be required. This includes consideration for proposals of horizontal directional drilling (HDD) and whether the geological conditions are suitable. Paragraph 2.21.49 describes how "*When considering any application where the pipeline goes under a designated area of geological or geomorphological interest, the Applicant should submit details of alternative routes, which either bypass the designated area or reduce the length of pipeline through the designated area to the minimum possible, and the reasons why they were discounted.*"

10.2.13 Section 2.22 (Natural Gas and Oil Pipelines: Mitigation) details mitigation measures for soil and geology including appropriate treatment of soil in line with the principles and practices outlined in the Code of Practice for the Sustainable Management of Soils on Construction Sites. Typical design mitigation measures to protect water quality are also summarised including avoidance of vulnerable groundwater areas, careful storage of excavated material away from watercourses and careful reinstatement of riverbanks and reed beds. The section further details possible appropriate mitigation measures.

10.2.14 Section 2.23 (Natural Gas and Oil Pipelines: Secretary of State decision making) details the requirement to consider the impact to soil and geology. It is noted that the proposed route and other measures (if applicable) eliminates or reduces adverse impacts to an acceptable level, whilst not adversely affecting the integrity of the pipeline. This section also notes that the impacts on water quality and resources should be acceptable.

National Policy Statement for Electricity Networks Infrastructure (EN-5) (2023)

10.2.15 A revised version of the NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2023c) was published in November 2023. This NPS is of relevance to the geology, hydrogeology and contaminated land assessment as the Proposed Development includes electricity grid connection infrastructure.

10.2.16 Section 2.6 (Climate change adaptation and resilience) details the considerations for flooding (particularly of substations vital for the network), effects of adverse weather on overhead lines, effects of increased temperatures, earth movement or subsidence caused by flooding or drought and coastal erosion for the landfall of offshore transmission cables and their associated substations in the inshore and coastal locations, which should be considered within the ES.

10.2.17 Paragraph 2.9.25 details the disruptive effects of undergrounding on the environment, archaeological sites, sensitive habitats, soils and geology and damage heritage assets.

10.2.18 Section 2.9 (Applicant assessment) details the impacts the Applicant should consider. However, it notes that the list is not exhaustive and site-specific

information should also be provided. This section also includes reference to the Horlock Rules, which provide guidance for the design and siting of substations and include consideration for environmental issues from the earliest stage to keep adverse effects to a reasonably practicable minimum. The guidance also refers to internationally and nationally designated areas of amenity, cultural or scientific value; the protection of local amenity value, existing habitats and landscape features including ancient woodland, historic hedgerows, surface and groundwater sources and nature conservation areas; and consider the land use effects.

10.2.19 Section 2.14 (Sulphur Hexafluoride) detail the mitigation measures the Applicant should consider to avoid and minimise the environmental impacts to both onshore and offshore at the early design stage in the development process. This includes consideration of sulphur hexafluoride on the environment.

The National Planning Policy Framework (December, 2023)

10.2.20 The National Planning Policy Framework (NPPF) (Department for Levelling Up, Housing and Communities (DLUHC), December 2023) sets out the government's planning policies for England and how these are expected to be applied. The NPPF contains policies relevant to the geology and soils assessment. The 'Reforms to national planning policy' document has been put forward to the government by the DLUHC with recommendations to the government on the NPPF.

10.2.21 Paragraph 65 states *'Provision of affordable housing should not be sought for residential developments that are not major developments, other than in designated rural areas (where policies may set out a lower threshold of 5 units or fewer). To support the re-use of brownfield land, where vacant buildings are being reused or redeveloped, any affordable housing contribution due should be reduced by a proportionate amount.'*

10.2.22 Paragraph 123 states *'Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.'*

10.2.23 Paragraph 124 c describes how *'Planning policies and decisions should give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.'*

10.2.24 Paragraph 146 a states '*makes as much use as possible of suitable brownfield sites and underutilised land.'*

10.2.25 Paragraph 180 f states '*Planning policies and decisions should contribute to and enhance the natural and local environment by remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.'*

10.2.26 Paragraph 189 states *'Planning policies and decisions should ensure that: a) a site is suitable for its proposed use taking account of ground conditions and any risks*

arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation); b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and adequate site investigation information, prepared by a competent person, is available to inform these assessments.'

10.2.27 Paragraph 190 states *'Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.'*

Planning Practice Guidance (2019)

10.2.28 The guidance was published to provide more in-depth guidance to the NPPF. The Planning Practice Guidance (PPG) of relevance to the geology and soils assessment is Land Affected by Contamination (Ministry of Housing, Communities and Local Government (MHCLG), 2019). The PPG aims to provide guiding principles on how planning can deal with land affected by contamination.

A Green Future: Our 25 Year Plan to Improve the Environment

10.2.29 The 25 Year Environment Plan sets out government action to help the natural world regain and retain good health. It aims to deliver cleaner air and water in our cities and rural landscapes, protect threatened species and provide richer wildlife habitats. It calls for an approach to agriculture, forestry, land use and fishing that puts the environment first.

10.2.30 Policy 3 of Chapter 1 (Using and managing land sustainability) details the aims to *improve soil health and restoring and protecting peatlands*.

10.2.31 Policy 2 of Chapter 4 (Increasing resource efficiency and reducing pollution and waste) details the aims at *reducing pollution including minimising the risk of chemical contamination in our water*.

Environmental Improvement Plan 2023

10.2.32 The Environmental Improvement Plan presents the delivery plan for the environment to building a greener more prosperous country.

10.2.33 The plan aims to deliver on ten environmental goals with an apex goal of thriving plants and wildlife.

10.2.34 Goal four (managing exposure to chemicals and pesticides) includes *support partners to manage waste streams that are contaminated with persistent organic pollutants (POPs) to ensure that they are destroyed at end of life and reduce the levels of POPs entering* by *ensuring chemicals are safely used and managed* the environment.

10.2.35 Goal six (using resources from nature sustainably) includes *improving and protecting soil health*.

10.2.36 Goal ten (enhancing beauty, heritage and engagement with the natural environment) includes *reinforce the natural, geological and cultural heritage of our landscapes*. This includes monitoring and evaluating the *condition of heritage features including geological sites and scheduled monuments*.

10.2.37 The plan discusses the aim of improving our use of resources which will include *publish a baseline map of soil health for England by 2028 and bring at least 40% of England's agricultural soil into sustainable management by 2028*.

Local Planning Policy

South Tees Regeneration Master Plan (2017)

10.2.38 This Master Plan presents the vision, strategy and ideas for the transformational regeneration of the South Tees Development Corporation area into world class employment-generating zone and economic growth enabler for the Tees Valley. The Master Plan presents a summary of the existing ground conditions (Section 2.11.), a Ground Conditions – Potential Major Hazards Zones, understanding ground conditions (Section 13.04.) and states the following relevant constraint:

- *Contamination: The types of use possible across the STDC area will be influenced by ground conditions and ground contamination, as full-scale de-contamination is neither proposed nor financially viable. Residential dwellings would likely be unsuitable for the site.*

Redcar and Cleveland Borough Council Local Plan (2018)

10.2.39 The following policies and statements of the Redcar and Cleveland Borough Council (RCBC) Local Plan and Policies Map (RCBC, 2018a) are relevant to the geology, hydrogeology and contaminated land assessment:

- Paragraph 1.70 – *"Redcar and Cleveland has substantial areas of contaminated land. The Local Plan will support the reclamation of contaminated land to enable the redevelopment of brownfield sites and help shift the perception of South Tees, presenting a cleaner, greener image of industry."*
- Policy SD 2 Locational Policy – *"Wherever possible, priority will be given to the development of brownfield land in sustainable locations, providing it is not of high environmental value, the reuse of existing buildings and limiting development in the countryside."*
- Paragraph 2.14 – *"In seeking to prioritise the re-use of previously developed land, the Council will continue to work with delivery partners including private developers, the Homes and Communities Agency and the Tees Valley Combined Authority which is, among other things, overseeing the preparation of a Brownfield and Surplus Public Sector Land Register, in line with government policy."*
- Paragraph 2.28 – *"Applicants proposing development on or near potentially contaminated land will be required to evidence that risks associated with contamination will be successfully addressed through remediation without undue environmental impact during and following the development in*

accordance with the Model Procedures for the Management of Land Contamination (CLR 11) [replaced by LC:RM (EA, 2021)]*, which have been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination."*

- Policy SD 7 Flood and Water Management – *"Discharge rates into surface water and combined sewers resulting from the redevelopment of brownfield sites will be limited to a maximum of 50% of flows consented for previous uses."*
- Paragraph 6.13 – *"To support these housing delivery aspirations, and in accordance with government policy a brownfield land register is currently being prepared by the Tees Valley Combined Authority in collaboration with the five local authorities."*
- Paragraph 6.26 – *"Prioritising where possible and including in terms of economic viability considerations, the development of previously developed ('brownfield') sites and other available land within existing settlement boundaries."*
- Policy N 4 Biodiversity and Geological Conservation – *"We will protect and enhance the borough's biodiversity and geological resources. Support will be given to high quality schemes that enhance nature conservation and management, preserve the character of the natural environment and maximise opportunities for biodiversity and geological conservation, particularly in or adjacent to, Biodiversity Opportunity Areas in the wider Tees Corridor, Teesmouth, East Cleveland and Middlesbrough Beck Valleys areas."*
  - *"…Priority will be given to protecting our internationally important sites, including the Teesmouth and Cleveland Coast Special Protection Area/Ramsar and European Marine Site, and the North York Moors Special Protection Area and Special Area of Conservation."*
  - *"…Development that is likely to have an adverse impact on nationally important SSSI sites, including broader impacts on the national network and combined effects with other development, will not normally be allowed. Where an adverse effect on the site's notified interest features is likely, an exception will only be made where: c. the benefits of the development, at this site, clearly outweigh both any adverse impact on the features of the site that makes it of special scientific interest, and any broader impacts on the network of SSSIs; d. no reasonable alternatives are available; and e. mitigation, or where necessary compensation, is provided for the impact."*
- Policy LS 4 South Tees Spatial Strategy – *"The strategy includes:*
  - *Wilton International;*
  - *South Tees Development Corporation area, as illustrated on the Policies Map (including current and former steelworks at South Tees and Redcar);*
  - *Teesport; and*
  - *South Tees Industrial Estates and Business Parks."*

10.2.40 The Strategy ensures the Council, and its partners will aim to consider the economy, connectivity and environment as the points detailed within the Strategy to secure decontamination and redevelopment of potentially contaminated land.

Redcar and Cleveland, South Tees Area Supplementary Planning Document (May 2018)

10.2.41 The following policies and statements of the Redcar and Cleveland South Tees Planning Area Supplementary Planning Document (RCBC, 2018b) are relevant to the geology, hydrogeology and contaminated land assessment:

- Development Principle STDC1: Regeneration Principles
  - *"To reduce pollution, contribute to sustainable flood risk management and habitat protection and encourage biodiversity and long term sustainability;*
  - *To support development which makes the best use of available land and existing infrastructure;*
  - *To support development that contributes to the creation of a healthy, active, safe and secure environment; and*
  - *To support the protection of heritage assets and the historic environment and the protection and enhancement of landscape character."*
- Development Principle STDC3: Phasing Strategy
  - Development that can be implemented in the early phases will be supported including areas which require ground remediation and site preparation; and
  - *"The redevelopment of areas requiring more extensive remediation, demolition and / or new or upgraded infrastructure will also be supported, although it is recognised that this is likely to take longer to secure. Development within the more contaminated areas should have regard to Development Principle STDC9 and the forthcoming Ground Remediation Strategy."*
- Development Principle STDC7: Natural Environmental Protection and Enhancement
  - *"The Council will, in partnership with the STDC and investment partners and other key stakeholders, protect and, where appropriate, enhance designated and non-designated sites of biodiversity and geodiversity value and interest within the South Tees Area. The need to remediate known contamination, including to reduce environmental harm, and to redevelop the South Tees Area for productive uses is fully recognised and supported by the Council. In doing so it will be important for all development proposals to be in accordance with the requirements of STDC7 and to respond to their environmental setting, in particular to protect and, where possible enhance, biodiversity and geodiversity interests.;*

- *All proposals will be required to comply with Local Plan Policy N4 Biodiversity and Geological Conservation. Proposals with the potential to affect the Teesmouth and Cleveland Coast SPA should undergo a Habitat Regulations Assessment (HRA) with regard to the conservation objectives of the designation;*
- *The Council will support the delivery of a strategy for the regeneration area which promotes the provision of green infrastructure, in accordance with Local Plan Policy N2, including a series of connected open, private and public spaces, using open space as connectors not barriers to development; and*
- *All proposals will be required to have regard to the forthcoming Environment and Biodiversity and Open Space Strategies and, where appropriate, the Redcar and Cleveland Teesmouth and Cleveland Coast SPA Recreation Management Plan, including in the mitigation of likely cumulative impacts on the natural environment. Net environmental gains should be provided where appropriate and viable, in accordance with Policies N2 and N4."*

- Development Principle STDC9: Site Remediation
  - *"The Council supports the following approach to the remediation of land; Remediation will be proportionate, based on a risk assessment and respond to the development typology and its needs;*
  - *Where appropriate, remediation of the site will provide for environmental betterment;*
  - *The Ground Remediation Strategy will consider opportunities for the area of land identified as the Landfill Zone, subject to other regulatory requirements, to be used to support the remediation of STDC development land in the short term. Once the use of this area is no longer required it must, itself, be the subject of a remediation scheme and may be made available for renewable energy or other appropriate development;*
  - *Development proposals should be in accordance with the forthcoming Ground Remediation Strategy and all remediation activities will be required to avoid adverse effects on the integrity, conservation objectives or qualifying features of the Teesmouth and Cleveland Coast SPA and Ramsar site, in line with Policy N4 of the Local Plan;*
  - *Development proposals and remediation activities will be required to avoid unacceptable impacts on water quality and contamination of the water environment;*
  - *As the site incorporates large areas of previously developed land with a history of industrial uses there will be a requirement to remediate land in advance of development. The approach is one that will match the degree of remediation with end user requirements, to this end, the remediation of the South Tees Area will respond to investment needs and the release of land for development;*

- *It is recognised that areas of land will be subject to different levels of contamination and the approach of the STDC will be to assess the degree of contamination and to adopt a Ground Remediation Strategy in order to deal with that contamination based on site delivery and viability. Wherever possible and following an appraisal of remedial options, remediation of the site will provide a degree of environmental betterment of site conditions. The Ground Remediation Strategy, which is being prepared for the South Tees Area must be the subject of a phasing plan which itself will balance the need to incentivise development to secure early investment in development opportunities;*
- *The area of land currently identified as the Landfill Zone (see Development Principle STDC14 - South Industrial Zone) is one which could be used to offset the costs of remediation of development sites once this site is no longer required, as utilising this area as a repository for residual, unsuitable materials from site preparation will save significant cost over offsite disposal. The site itself may be capped and remediated in accordance with the landscape strategy and is likely to be appropriate for future renewable energy development, or other forms of development, after it is capped. This approach will be considered in the site wide Ground Remediation Strategy; and*
- *Development proposals located in proximity to former landfill sites should be supported by a Gas Risk Assessment and should incorporate any necessary protection measures, such as those to protect buildings from landfill gas migration."*

Stockton-on-Tees Borough Council Local Plan (2019)

10.2.42 The following policies and statements of the Stockton-on-Tees Borough Council (STBC) Local Plan (STBC, 2019) are relevant to the geology, hydrogeology and contaminated land assessment:

- Natural Environment – Paragraph 8.45 – *"The planning system should contribute to and enhance the natural and local environment by:*
  - *protecting and enhancing valued landscapes, geodiversity and soils;*
  - *recognising the wider benefits of ecosystem services;*
  - *minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including the establishment of coherent ecological networks that are more resilient to current and future pressures;*
  - *preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability; and*
  - *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."*

- Policy ENV5 Preserve, Protect and Enhance Ecological Networks, Biodiversity and Geodiversity – *"Development proposals should seek to achieve net gains in biodiversity wherever possible. It will be important for biodiversity and geodiversity to be considered at an early stage in the design process so that harm can be avoided and wherever possible enhancement achieved (this will be of particular importance in the redevelopment of previously developed land where areas of biodiversity should be retained and recreated alongside any remediation of any identified contamination). Detrimental impacts of development on biodiversity and geodiversity, whether individual or cumulative should be avoided."*
- Policy ENV7 Ground, Air, Water, Noise and Light Pollution – *"Where future users or occupiers of a development would be affected by contamination or stability issues, or where contamination may present a risk to the water environment, proposals must demonstrate via site investigation/assessment that:*
  - *a. Any issues will be satisfactorily addressed by appropriate mitigation measures to ensure that the site is suitable for the proposed use, and does not result in unacceptable risks which would adversely impact upon human health and the environment; and*
  - *b. Demonstrate that development will not cause the site or the surrounding environment to become contaminated and / or unstable.*
- *Groundwater and surface water quality will be improved in line with the requirements of the European WFD and its associated legislation and the Northumbria River Basin Management Plan. Development that would adversely affect the quality or quantity of surface or groundwater, flow of groundwater or ability to abstract water will not be permitted unless it can be demonstrated that no significant adverse impact would occur, or mitigation can be put in place to minimise this impact within acceptable levels."*
- Paragraph 8.73 – *"For development to be supported, such assessments will be required and demonstrate that pollution is or can, (through mitigation) be brought within acceptable levels. For the purposes of this policy 'levels' refers to statutory limits (such as those relating to air quality and contaminated land) and the wider consideration of impacts under the Environmental Protection Act (1990)."*
- Paragraph 8.75 – *"Stockton Borough has a legacy of previously developed land which can make an important contribution to its land supply for development. It is the responsibility of the developer and / or landowner to ensure development on site(s) affected by contamination or land stability issues result in a safe development."*
- Paragraph 8.76 – *"Planning applications for new development on sites which are contaminated or are underlain by potentially unstable land must be accompanied by information which shows that investigations have been carried out to determine the nature and extent of any hazard, as well as the possible impact it is likely to have on future users and the environment. Any assessment*

should set out the detailed measures needed to allow the development to proceed safely, including, as appropriate those needed to improve and treat the land, address land stability and any other public safety issues. A Preliminary Risk Assessment should be submitted as a minimum which includes a desk study, conceptual model and initial assessment of risk; this information must satisfactorily demonstrate to the local planning authority that the risk to human health and controlled waters has been fully understood and can be addressed through appropriate measures. After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990. The aim is not to prevent development of the land but to ensure that new development is appropriate for its location and that the physical constraints on the land are taken into account at the planning application stage."

Hartlepool Local Plan (2018)

10.2.43 The following policies and statements of the Hartlepool Borough Council (HBC) Local Plan (HBC, 2018) are relevant to the geology, hydrogeology and contaminated land assessment:

- CC3: *"Renewable and Low Carbon Energy Generation (excluding strategic wind turbines and large scale solar photovoltaic developments) - Where appropriate, developers will need to include a satisfactory scheme to restore the site to a quality of at least its original condition when the development has reached the end of its operational life, including addressing any resultant land contamination issues."*
- Paragraph 9.45 – *"The presence of any contamination on the land must be investigated and any necessary remediation measures put in place."*
- QP6: Technical Matters – *"Point 2) The presence of any contamination on the land must be investigated and any necessary remediation measures put in place."*
- Paragraph 16.36 – *"Aquifers are vulnerable to various forms of pollution. Proposed developments should therefore ensure that suitable pollution prevention measures are in place to protect the water supplies from pollution. In particular, any future development that requires piling, deep foundations or removal of soil and clay cover should be suitably managed so that they do not produce new pathways for contaminants to enter the underlying groundwater. In addition, creation of new pathways which would allow high groundwater to inundate land causing localised groundwater flooding should be prevented."*
- NE1: Natural Environment – *"Point 10) In prioritising the re-development of brownfield land, areas that are important for biodiversity will be retained or recreated within the site, and remediation of contaminated land will be pursued" and "Point 11) The major/principal aquifers underlying Hartlepool along with watercourses and other surface and coastal waters will be protected from over abstraction and contamination from pollutants and saline intrusion resulting from development. Developments will be required to demonstrate*

that they do not impact on the major/principal aquifer underlying Hartlepool, along with watercourses and other surface and coastal waters and they can achieve access to a sustainable water supply prior to approval."

Other Guidance and Legislation

10.2.44 This section covers EU legislation and UK legislation, regulations and applicable guidance.

10.2.45 The UK left the EU on 31 January 2020. The legislation discussed in this section remains applicable to the Geology, Hydrogeology and Contaminated Land chapter.

EU Legislation

The Water Framework Directive (2000/60/EC) (2000)

10.2.46 The Water Framework Directive (WFD) (European Parliament and of the Council, 2000) came into force in 2000. Its primary objective is for all groundwater, surface water and coastal water bodies to achieve 'good' status by 2015 and maintain this status. It includes broader ecological objectives as well as aiming to prevent the deterioration of all water bodies. The framework aims to develop sustainable water use and reduce and eliminate the presence of hazardous substances within water bodies. It must be considered in any development that has the potential to have an impact on any part of the water environment.

Groundwater Daughter Directive (2006/118/EC) (2006)

10.2.47 This Groundwater Daughter Directive (European Environment Agency, 2006) classifies groundwater bodies, establishes pollutant threshold values, and identifies trends and starting points for their reversal. Specific measures to control groundwater pollution are described, including good groundwater chemical status criteria and provisions to control groundwater pollutant inputs. The Directive provides further details on groundwater pollution control that are outlined within the WFD (2000/60/EC).

The Environmental Liability Directive (2004/35/EC) (2004)

10.2.48 This Environmental Liability Directive (European Parliament and of the Council, 2004) relates to the prevention and remedying of environmental damage. The Directive refers to environmental damage to habitats and protected species, water damage (chemical and ecological) and land damage caused by land contamination. In this instance, damage is defined as *"a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly".* It also establishes a framework based on the 'polluter pays' principle to prevent and remedy environmental damage. Operators are therefore liable to the cost of prevention measures and remediation strategies.

Dangerous Substances Directive (2006/11/EC) (2006)

10.2.49 This Dangerous Substances Directive (European Parliament and of the Council, 2006) sets out the measures of pollution caused by certain dangerous substances discharged into the aquatic environment (inland surface water, territorial waters and internal coastal waters). As part of this Directive, List I and List II substances are described,

whereby List I substances should be eradicated, and List II substances should be reduced.

UK Legislation

Environmental Protection Act 1990: Part 2A

10.2.50 The UK's approach to contaminated land management is primarily governed by Part IIA of the Environmental Protection Act 1990 (Part 2A), which came into force in April 2000. This legislation establishes the legal framework for identifying and remediating contaminated land across the UK. Contaminated land is legally defined as land where substances are causing or could cause significant harm to people, property or protected species; and significant pollution of surface waters or groundwater. Enforcing authorities are required to identify and deal with such land.

The Environment Act (1995)

10.2.51 The Environment Act (HM Government, 1995) established the EA and the Scottish Environment Protection Agency corporate bodies. This makes provision with respect to contaminated land and abandoned mines. Further provisions are provided for National Parks, pollution controls, natural resource conservation and environment conservation/enhancement.

The Environment Act (2021)

10.2.52 The Environment Act (HM Government, 2021) makes provision with respect to water (surface and groundwater), waste and improvement of the environment. It provides a legal framework for environmental governance and for specific improvement of the environment, including measures on waste and resource efficiency, air quality and environmental recall, water, nature and biodiversity and nature conservation covenants.

The Water Act (2003)

10.2.53 The Act (HM Government, 2003) provides measures with regards to holding and issuing licences for water abstractions. The four broad aims of the Act are to ensure sustainable use of water resources, to strengthen the voice of consumers, to increase competition and to promote water conservation. This Act also considers controlled water pollution and coal mine water discharges and describes provisions for land drainage and flood defence. This was issued to amend the 1991 Water Resources Act (HM Government, 1991a) and Water Industry Act (HM Government, 1991b).

The Water Act (2014)

10.2.54 The aim of the Act (HM Government, 2014a) was to reform the water industry to make it more innovative and responsive to customers and to increase the resilience of water supplies to natural hazards such as droughts and floods. The Act describes provisions for the following: abstraction water licence modifications, waterworks records, flood insurance for households, internal drainage boards, regulations for the water environment and Regional Flood and Coastal Committees.

The Water Resources Act (1991)

10.2.55 The Act (HM Government, 1991a) gives the EA powers and duties to prevent or remedy the pollution of controlled waters. Previously under the Act and now under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) it is a criminal offence for a person to cause or knowingly permit pollution of controlled waters. Sections within the Act refer to water resources management, pollution of water resources, flood defences, fishery controls, financial provisions, land and works powers and information provisions.

Anti-Pollution Works Regulations (as amended) (1999)

10.2.56 These Regulations (HM Government, 1991) empower the EA to serve a notice to remediate or mitigate on *"any person who has caused or knowingly permitted poisonous, noxious or polluting matter or any solid waste to be present in controlled waters."* The notice will either describe a potential incident and the risk to associated controlled waters, or for a pollution incident that has already occurred, the notice will describe the pollution event. Furthermore, the notice will describe the necessary operations or works which should be carried out.

The Environmental Permitting (England and Wales) Regulations (2016) and The Environmental Permitting (England and Wales) (Amendment) (EU Exit) Regulations (2019)

10.2.57 The Regulations (HM Government, 2016) (HM Government, 2019) set out the measures for those carrying out activities that may cause imminent threats of, or actual 'environmental damage', which require a permit. These Regulations also outline the authorities responsible for enforcing the Regulations. Such Regulations cover environmental permits, discharge into regulated facilities, abstractions of groundwaters, enforcement and offences, public registers and powers/functions of the regulator and authority.

The Environmental Damage (Prevention and Remediation) (England) Regulations (2015)

10.2.58 The Regulations (HM Government, 2015) describe the legal framework for the prevention of environmental damage and the requirements for the remediation of damage when it occurs. It sets out the UK Government's views on how they should be applied and how particular terms should be interpreted.

The Contaminated Land (England) Regulations (2012)

10.2.59 The Contaminated Land Regulations (HM Government, 2012) set out the processes of risk assessment and identification/evaluation of remediation options. This is an amendment of the 2006 Contaminated Land (England) Regulations (HM Government, 2006).

The Waste (England and Wales) (Amendment) Regulations 2014 (as amended)

10.2.60 The Regulations (HM Government, 2014b) out the measures required for the prevention of, production and management of waste. The Regulations describe the purpose of waste prevention programmes with waste prevention measures and

refers to monitoring by appropriate authorities using qualitative or quantitative benchmarks.

10.3 Assessment Methodology and Significance Criteria

Study Area

10.3.1 The study area for this assessment is the area over which the potential direct and indirect effects of the Proposed Development are predicted to occur during the construction, operation (including maintenance as necessary) and decommissioning phases.

10.3.2 The direct effects on geology and hydrogeology are those that may arise during construction, operation (including maintenance) and decommissioning. Effects may occur simultaneously during the period when Phase One is operational and Phase Two is under construction.

10.3.3 The indirect effects involve disturbing the ground in such a way that contaminant linkages (source-pathway-receptor) are created, for example, introducing a new pathway for the migration of flared gas within Made Ground into aquifers or by allowing potentially contaminated dusts, during construction or decommissioning, to migrate offsite to nearby residential or commercial properties.

10.3.4 The study area for geology, hydrogeology and contaminated land is the entirety of the ground within the Proposed Development Site (Figure 4-1, ES Volume II, EN070009/APP/6.3), along with a buffer extending 250 m around the Proposed Development Site to identify potential offsite sources of contamination to inform the baseline condition within and adjacent to the Proposed Development Site. For assessment of effects to controlled waters, designated sites, groundwater abstractions and groundwater source protection zones, a buffer extending 1 km from the Proposed Development Site is considered appropriate.

10.3.5 These study areas are considered to be appropriate for the assessment of geology, hydrogeology and contaminated land in accordance with methodology set out in the Design Manual for Roads and Bridges (DMRB) LA109 Geology and Soils (National Highways, 2019a). The study area distance has been used to identify potential receptors such as designated sites as well as identifying sources such as landfills. The environmental datasets obtained for the site included a 1 km buffer for the Proposed Development Site. The study areas are also based on professional judgement by competent experts with relevant and appropriate experience of assessing land contamination and contamination dispersion.

Impact Assessment Methodology

10.3.6 The geology, hydrogeology and contaminated land assessment considers the following resources:

- geology: artificial ground, superficial deposits and bedrock;
- mineral resources;
- aquifer designations;

- soils and ALC; and
- contamination of soils and groundwater.

10.3.7 A detailed assessment of potential Source-Pathway-Receptor linkages and a risk assessment have been used to develop the Conceptual Site Model (CSM), which is included as part of this chapter within Appendix 10B (ES Volume III, EN070009/APP/6.4).

10.3.8 To facilitate the impact assessment process and ensure consistency in the terminology of effect significance, the standard assessment methodology discussed in Chapter 2: Assessment Methodology (ES Volume I, EN070009/APP/6.2) has been applied.

10.3.9 This methodology is appropriate for assessing the likely significant effects of the Proposed Development on geology, hydrogeology and contaminated land because it follows the standard guidance in DMRB LA109 (National Highways, 2019a), DMRB LA113 (National Highways, 2020), DMRB LA 104 (National Highways, 2020), Land Contamination: Risk Management (EA, 2023) and A New Perspective on Land and Soil in Environmental Impact Assessment (Institute of Environmental Management and Assessment, 2022).

10.3.10 The assessment of receptor value (sensitivity) for geology, soils and controlled waters follows the procedure described in Table 3.11 of the DMRB LA 109 (National Highways, 2019a). The assessment of receptor value (importance) for groundwater resources follows the procedure described in Table 3.70 of the DMRB LA 113, Road Drainage and the Water Environment (National Highways, 2020).

Value/ Sensitivity of Receptors

10.3.11 The value (sensitivity or importance) of a resource, ranges from Very High to Negligible (or Low for groundwater) and is dependent on the assessment area or features of importance and conservation value. The criteria for determining the value of a resource and typical examples for geology, soils, human health and controlled waters are provided in Table 10-1.

Table 10-1: Sensitivity (Value) of Geology, Soil and Water Environment Attributes (Adapted from DMRB LA109 Table 3.11 (National Highways, 2019a) and DMRB LA113 Table 3.70 (National Highways, 2020) Therein)

RECEPTOR VALUE (SENSITIVITY IMPORTANCE)	CRITERIA	ASPECT	TYPICAL EXAMPLES
Very High	Very rare and of international importance with no potential for replacement. Geology meeting international designation citation criteria which is not designated as such.	Geology	UNESCO (United Nations Educational, Scientific and Cultural Organisation) World Heritage Sites, UNESCO, Global Geoparks, Sites of Special Scientific Interest (SSSIs) and Geological Conservation Review sites where citations indicate features of international importance.
	Soil directly supporting an EU designated site.	Soils	Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar Site; and/or ALC Grades 1 and 2 (as defined in Table 10-7).
	Human Health: very high sensitivity land use.	Contamination	Residential or allotments.
	Nationally significant attribute of high importance.	Groundwater	Principal aquifer providing a regionally important resource and/or supporting a site designated under EC and UK legislation. Groundwater locally supports Groundwater Dependent Terrestrial Ecosystems (GWDTE). Source Protection Zone (SPZ1).
High	Rare and of national importance with little potential for replacement.	Geology	Geological SSSIs and National Nature Reserves (NNRs).

RECEPTOR VALUE (SENSITIVITY IMPORTANCE)	CRITERIA	ASPECT	TYPICAL EXAMPLES
	Geology meeting national designation citation criteria which is not designated as such.		
	Soils directly supporting a UK designated site.	Soils	e.g. SSSIs; and/or ALC Grade 3a.
	Human Health: high sensitivity land use.	Contamination	Public Open Space.
	Locally significant attribute of high importance.	Groundwater	Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE or SPZ2.
Medium	Of regional importance with limited potential for replacement. Geology meeting regional designation citation criteria which is not designated as such.	Geology	Regionally Important Geological Sites (RIGS).
	Soils supporting non-statutory designated sites.	Soils	Local Nature Reserves (LNRs), Local Geological Sites (LGS), Sites of Nature Conservation Importance (SNCIs). ALC Grade 3b.
	Human Health: medium sensitivity land use.	Contamination	Commercial or industrial land.
	Of moderate quality and rarity.	Groundwater	Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3.

RECEPTOR VALUE (SENSITIVITY IMPORTANCE)	CRITERIA	ASPECT	TYPICAL EXAMPLES
Low	Of local importance/interest with potential for replacement.	Geology	Non designated geological exposures, former quarries / mining sites.
	Soils supporting non-designated notable or priority habitats.	Soils	ALC Grades 4 and 5.
	Low sensitivity land use	Contamination	Highways and rail.
	Lower quality	Groundwater	Unproductive Strata.
Negligible	No geological exposures, little/no local interest.	Geology	Significant depth of Made Ground.
	Soils: previously developed land formerly in 'hard uses' with little potential to return to agriculture.	Soils	Industrial land/soils not present.
	Human health: undeveloped surplus land, no sensitive land use proposed.	Contamination	Extensive areas of existing hard standing.
	Negligible is not applicable to Groundwater under Table 3.7 of LA 113.	Groundwater	N/A

Magnitude of Impacts

10.3.12 The magnitude of potential impacts upon geology, soils, human health and controlled waters receptors considers the scale of the predicted change to baseline conditions and where there are potential pathways between an impact source / hazard and identified receptors. This takes into account the spatial scale of the impact, as well as its duration and reversibility (e.g. the impact magnitude may be moderated if the impacts are temporary rather than permanent; or are reversible rather than irreversible).

10.3.13 The magnitude of impact on a receptor (geology, soils, human health and controlled waters) ranges from Major to No Change, with additional magnitude descriptions of Minor Beneficial, Moderate Beneficial and Major Beneficial prescribed to groundwater receptors in line with DMRB LA 113 (National Highways, 2020). The criteria for determining the magnitude of impact upon receptors are provided in Table 10-2.

Table 10-2: Magnitude of Impact of a Resource (Adapted from DMRB LA 109 Table 3.12 and Table E/2.1 (National Highways, 2019a) Therein)

MAGNITUDE	CRITERIA	ASPECT	TYPICAL DESCRIPTION
Major Adverse	Result in loss of resource/designation or quality of the resource.	Geology	Loss of geological feature/designation and / or quality and integrity, severe damage to key characteristics, features or elements.
		Soils	Physical removal or permanent sealing of soil resource or agricultural land.
	Human health: significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels – SP1010 (Contaminated Land: Applications in Real Environments (CL:AIRE, 2014)). Potential for significant harm to human health.	Contamination	Contamination heavily restricts future use of land.
	Results in loss of attribute and / or quality and integrity of the attribute.	Groundwater	Loss of, or extensive change to, an aquifer. Loss of regionally important water supply. Calculated risk of pollution from spillages ≥2% annually (Spillage Assessment). Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Groundwater quality and runoff assessment). Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification.

MAGNITUDE	CRITERIA	ASPECT	TYPICAL DESCRIPTION
			Loss or significant damage to major structures through subsidence or similar effects.
Moderate Adverse	Results in partial loss of resource/designation or quality of the resource.	Geology	Partial loss of geological feature/designation, potentially adversely affecting the integrity; partial loss of / damage to key characteristics, features or elements.
		Soils	Permanent loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
	Human health: contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g., category 4 screening levels SP1010). Significant contamination can be present.	Contamination	Control / remediation measures are required to reduce risks to human health / make land suitable for intended use.
	Results in effect on integrity of attribute, or loss of part of attribute.	Groundwater	Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial / industrial / agricultural supplies. Potential medium risk of pollution to groundwater from routine runoff – risk score 150 to 250. Calculated risk of pollution from spillages ≥1% annually and <2% annually.

MAGNITUDE	CRITERIA	ASPECT	TYPICAL DESCRIPTION
			Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification. Damage to major structures through subsidence or similar effects or loss of minor structures.
Minor Adverse	Results in minor measurable change in resource / designation.	Geology	Minor measurable change in geological feature / designation attributes, quality or vulnerability; minor loss of, or alteration to, one (may be more) key characteristics, features or elements.
		Soils	Temporary loss/reduction of one or more soil function(s) and restriction to current or approved future use (e.g., through degradation, compaction, erosion of soil resource).
	Human health: contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels SP1010). Significant contamination is unlikely with a low risk to human health.	Contamination	Best practice measures can be required to minimise risks to human health.
	Results in some measurable change in attributes, quality or vulnerability.	Groundwater	Potential low risk of pollution to groundwater from routine runoff – risk score <150. Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. Minor effects on an aquifer, GWDTEs, abstractions and structures.

MAGNITUDE	CRITERIA	ASPECT	TYPICAL DESCRIPTION
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use and integrity.	Geology	Very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature / designation. Overall integrity of resource not affected.
		Soils	No discernible loss/reduction of soil function(s) that restrict current or approved future use.
	Human health: contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g., category 4 screening levels SP1010).	Contamination	No requirement for control measures to reduce risks to human health/ make land suitable for intended use.
	Results in effect on attribute, but of insufficient magnitude to affect the use and integrity.	Groundwater	No measurable impact upon an aquifer and / or groundwater receptors and risk of pollution from spillages <0.5%.
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring.	Groundwater (only)	Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding.
Moderate Beneficial	Results in moderate improvement of attribute quality.	Groundwater (only)	Contribution to improvement in water body WFD classification. Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification. Support to significant improvements in damaged GWDTE.

MAGNITUDE	CRITERIA	ASPECT	TYPICAL DESCRIPTION
Major Beneficial	Results in major improvement of attribute quality.	Groundwater (only)	Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in water body WFD classification.
No Change	No temporary or permanent loss in resource of designation.	Geology	No temporary or permanent loss/disturbance of characteristics features or elements.
		Soils	No loss/reduction of soil function(s) that restrict current or approved future use.
	Human health: reported contaminant concentrations below background levels.	Contamination	No intervention required.
No Change	No loss or alteration of characteristics, features or elements.	Groundwater	No observable impact in either direction.

Significance Criteria

10.3.14 Once the value (sensitivity) of each resource and the magnitude of the potential impact has been established, the significance (effect) matrix from Table 3.8.1 DMRB LA 104 (National Highways, 2020) has been used to determine the effect significance reproduced in Table 10-3.

10.3.15 Table 10-4 presents the significance of each effect.

Table 10-3: Significance (Effect) Matrix

RECEPTOR VALUE	MAGNITUDE OF IMPACT (DEGREE OF CHANGE)				
	NO CHANGE	NEGLIGIBLE	MINOR	MODERATE	MAJOR
Very High	Neutral	Slight	**Moderate or large**	**Large or very large**	**Very large**
High	Neutral	Slight	**Slight or moderate**	**Moderate or large**	**Large or very large**
Medium	Neutral	Neutral or **slight**	**Slight**	**Moderate**	**Moderate or large**
Low	Neutral	Neutral **or slight**	Neutral **or slight**	**Slight**	**Slight or moderate**
Negligible	Neutral	Neutral	Neutral **or slight**	Neutral **or slight**	**Slight**

Table 10-4: Significance of Effect

EFFECT	SIGNIFICANCE
Very large	**Significant**
Large	**Significant**
Moderate	**Significant**
Slight	**Not significant**
Neutral	**No change, not significant**

Cumulative Geology Effects

10.3.16 An assessment of cumulative geology effects has been undertaken and is detailed within Chapter 23: Cumulative and Combined Effects (ES Volume I, EN070009/APP/6.2).

10.3.17 The assessment of cumulative effects follows the methodology described in Advice Note Seventeen (The Inspectorate, 2019a), for more information refer to Chapter 23: Cumulative and Combined Effects (ES Volume I, EN070009/APP/6.2).

10.3.18 It is important to note that cumulative effects may vary from the effects of the Proposed Development considered in isolation. For example, it is possible for the Proposed Development to have greater effects cumulatively with other planned developments than if it is considered in isolation against the existing baseline reported in Section 10.4.

Sources of Information/ Data

10.3.19 Current baseline conditions have been determined by a desk-based review of available information and relevant available published reports. The full desk-based review is included at Appendix 10A (ES Volume III, EN070009/APP/6.4). The baseline characterisation is considered to be sufficient to inform this assessment.

10.3.20 Confirmatory intrusive ground investigation (GI) will be undertaken to support the assessments and will also be used to inform the Proposed Development Site detailed design.

10.3.21 The scope of the GI will be forwarded to the relevant authorities as appropriate prior to commencing works. This is envisaged to include informing Local Authorities if appropriate for GI associated with pipeline routes. For areas near sensitive ecological receptors relevant stakeholders will be engaged with including obtaining the MMO for the over water GI.

Conceptual Site Model

10.3.22 Appendix 10B: Contaminated Land Conceptual Site Model (CSM) (ES Volume III, EN070009/APP/6.4) has been prepared using a Source-Pathway-Receptor CSM model to identify potential pathways by which sources of contamination may impact on identified receptors. The CSM has been used to inform the assessment of the potential impact of the Proposed Development for geology, soils, hydrogeology and contaminated land receptors in this ES.

Environmental Risk Assessment

10.3.23 Based upon the CSM produced for the Proposed Development Site (Appendix 10B, ES Volume III, EN070009/APP/6.4), an evaluation of the risks posed by the identified potential pollutant linkages at the Proposed Development Site has been prepared and is presented in Appendix 10C: Contaminated Land Environmental Risk Assessment (ES Volume III, EN070009/APP/6.4). The Environmental Risk Assessment has been used to assess the potential impact of the Proposed Development for geology, soils, hydrogeology and contaminated land receptors in this ES.

Geotechnical Risk Register

10.3.24 A Preliminary Engineering Assessment and Geotechnical Risk Register is described in detail within Appendix 10D: Geotechnical Risk Register (ES Volume III, EN070009/APP/6.4).

Summary of Resource Value

10.3.25 This assessment considers the following resources:

- geology; artificial ground, superficial deposits and bedrock;
- minerals;
- hydrogeological aquifer designations;
- soils and agricultural land classification; and
- contamination to soils and groundwater.

Consultation

Scoping Opinion

10.3.26 An EIA Scoping Opinion was requested from the Inspectorate on 6 April 2023. A response was received on 17 May 2023. For the Scoping Opinion and the Applicant's responses to them, refer to Appendix 1E (ES Volume III, EN070009/APP/6.4).

Statutory Consultation

10.3.27 The PEI Report was published for statutory consultation on 14 September 2023 and the consultation period ended on 26 October 2023. A second statutory consultation was held between 13 December 2023 and 23 January 2024, and additional targeted consultation was held between 9 February 2024 and 10 March 2024. The matters raised have been reviewed and an explanation of how the Applicant has had regard to them is set out in the Consultation Report (EN070009/APP/5.1).

10.3.28 Refer to Table 10-5 for a detailed summary of the Statutory Consultation feedback relevant to this chapter from Statutory Environmental Bodies, and the Applicant's responses.

Table 10-5: Responses to the Statutory Consultation Feedback

CONSULTEE	DATE AND METHOD OF CONSULTATION	SUMMARY OF CONSULTEE COMMENTS	SUMMARY OF RESPONSE/ HOW COMMENTS HAVE BEEN ADDRESSED
Natural England	20/10/23	Natural England's comments relating to the Public Consultation and the Preliminary Environmental Information Report (PEIR) are given below: **Soils and Best and best and most versatile land** Natural England notes the submitted information detailing agricultural land classification (ALC) for land affected by the development. We acknowledge the predominantly lower grades of, and non-agricultural, land recorded within the development site. In addition to best and most versatile land considerations for the identified Grade 3 land north of the R.Tees we would emphasise the important need for conservation of soil resources more generally. We therefore note and welcome reference to the Code of Practice for the Sustainable Management of Soils on Construction Sites, for example in respect of proposals for horizontal directional drilling (HDD) beneath the R.Tees and Greatham Crook.	**Soils and Best and best and most versatile land** The assessment reflects the importance of soil as a resource with reference to the Code of Practice for the Sustainable Management of Soils on Construction Sites.
Environment Agency	26/10/23	**Groundwater** The information within the Preliminary Environmental Information Report (PEIR) appears robust, follows appropriate guidance and assessment methodologies	**Groundwater** Table 10-10 in Chapter 10: Geology, Hydrogeology and Contaminated Land (ES Volume I, EN070009/APP/6.2) has been

CONSULTEE	DATE AND METHOD OF CONSULTATION	SUMMARY OF CONSULTEE COMMENTS	SUMMARY OF RESPONSE/ HOW COMMENTS HAVE BEEN ADDRESSED
		and considers the mitigation requirements should any adverse effect be found. The Sherwood Sandstone principal aquifer should be included as a receptor within PEIR Chapter 10 Table 10-10. This receptor has been omitted from this table, but is referred to elsewhere, specifically within the proposed area of the hydrogen corridor.	updated to include the Sherwood Sandstone Principal Aquifer.

Use of the Rochdale Envelope

10.3.29 In order to ensure a robust assessment of the likely significance of the environmental effects of the Proposed Development, the EIA is being undertaken adopting the principles of the 'Rochdale Envelope' approach where appropriate in line with the Planning Inspectorate's ('the Inspectorate's') Advice Note 9 (The Inspectorate, 2018). This involves assessing the maximum (or where relevant, minimum)/ realistic worst-case parameters (e.g. for construction activities, whole development footprint) for the elements where flexibility needs to be retained (building dimensions or operational modes for example).

10.3.30 The construction of the development will be undertaken in two phases, Phase 1 and Phase 2 with a potential overlap of the phases anticipated, where Phase 1 of the Hydrogen Production Facility may become operational whilst Phase 2 is under construction. The assessment presented in this chapter has taken this into account by considering the introduction of industrial workers to the operational Phase 1 area whilst construction work is undertaken in the Phase 2 area. Human receptors during the construction works in the Phase 1 area are expected to be limited to construction workers. Construction workers will be protected through embedded mitigation of compliance with the requirements of the Construction, Design and Management Regulations 2015.

10.3.31 Given the above, this assessment presents a reasonable 'worst-case' approach.

Assumptions and Limitations

10.3.32 The assessment has been undertaken based on the following assumptions:

- The assessment undertaken is based on the collation and evaluation of available information obtained from the EA, BGS, Groundsure Reports and other sources made available.
- A confirmatory GI will be undertaken to support geotechnical aspects and therefore detailed, design. Subsequent risk assessments will inform decisions about whether remediation works by the Applicant are necessary to supplement (or replace) remediation by STDC as described in 10.5.7. Timing implications are discussed in 10.5.7.
- In the absence of confirmatory GI data, the assessment undertaken has been conservative.

10.4 Baseline Conditions

Existing Baseline

10.4.1 The baseline conditions relevant to geology, hydrogeology and contaminated land includes a detailed desk-based assessment of geological and hydrogeological conditions across the Proposed Development Site, a CSM, and an initial assessment of potential risks to human health and controlled waters (Appendix 10A to 10C, ES Volume III, EN070009/APP/6.4).

10.4.2 Confirmatory GI will be undertaken to confirm ground conditions and chemical status. The data will be used to undertake risk assessments to inform detailed design of the Proposed Development Site and to support mitigation measures as described in 10.5.7.

Ecological Designations

10.4.3 Ecological designations are considered relevant to understanding the baseline conditions to geology, hydrogeology and contaminated land because the Teesmouth and Cleveland Coast SSSI, SPA and Ramsar are all designated as such in part due to the underlying geology present, specifically the mudflats, marshes and dunes. Ecological designations within the Proposed Development Site are summarised in Table 10-6 and are shown on Figure 10-10a to 10-10g (ES Volume II, EN070009/APP/6.3).

Table 10-6: Ecological Designations

SITE/RELEVANT FEATURE	DESCRIPTION
Main Site	No ecological designations are located within the Main Site. Teesmouth and Cleveland Coast SSSI directly north.
CO_2 Export Corridor	No ecological designations are located within the CO_2 Export Corridor. Teesmouth and Cleveland Coast SSSI directly north.
Natural Gas Connection Corridor	No ecological designations are located within the Natural Gas Connection Corridor. Teesmouth and Cleveland Coast SSSI directly north.
Water Connection Corridor	No ecological designations are located within the Water Connection Corridor. Teesmouth and Cleveland Coast SSSI directly north.
Electrical Connection Corridor	No ecological designations are located within the Electrical Connection Corridor. Teesmouth and Cleveland Coast SSSI directly north.
Hydrogen Pipeline Corridor	Ramsar Site (majority of corridor north of river Tees): Teesmouth And Cleveland Coast Reference: UK11068
	SSSI: Teesmouth And Cleveland Coast Reference: 1000263
	SPA (as Ramsar Site above): Teesmouth And Cleveland Coast

SITE/RELEVANT FEATURE	DESCRIPTION
	Reference: UK9006061
	Local Nature Reserve: Cowpen Bewley Woodland Park
Other Gases Connection Corridor	No areas of sensitive land use are located within Other Gases Connection Corridor.

Soils – Agricultural Land Classification

10.4.4 Information is provided on DEFRA's interactive MAGIC online map (DEFRA, n.d.) for ALC in the form of Provisional ALC and Post 1988 ALC maps. The Provisional ALC data covers the entire study area, whereas the Post 1988 ALC data shows a localised area in greater detail. Figure 10-19a to 10-19g (ES Volume II, EN070009/APP/6.3) presents Provisional ALC data of the Proposed Development Site. ALC definitions (provided by Natural England) are presented in Table 10-7. ALC grades 1, 2 and 3a are deemed to be Best and most Versatile (BMV) agricultural soils and ALC information for each part of the Proposed Development Site is presented in Table 10-8.

Table 10-7: Agricultural Land Classification Definitions

AGRICULTURAL LAND CLASSIFICATION	AGRICULTURAL LAND CLASSIFICATION DEFINITION
Urban Land	Outside classification
Non-Agricultural Land	Outside classification
Grade 5 – Very Poor Quality	Land with very severe limitations that restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.
Grade 4 – Poor Quality	Land with severe limitations which significantly restrict the range of crops or level of yields. It is mainly suited to grass with occasional arable crops (for example cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties using the land. The grade also includes arable land that is very dry because of drought.
Subgrade 3b – Moderate Quality	Land capable of producing moderate yields of a narrow range of crops.
Subgrade 3a – Good Quality	Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of crops.

AGRICULTURAL LAND CLASSIFICATION	AGRICULTURAL LAND CLASSIFICATION DEFINITION
Grade 3 – Good to Moderate Quality	Land with moderate limitations that affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in grades 1 and 2.
Grade 2 – Very Good Quality	Land with minor limitations that affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown. On some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops, such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than grade 1.
Grade 1 – Excellent Quality	Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of crops.

Table 10-8: Agricultural Land Classification Definitions

PART OF THE PROPOSED DEVELOPMENT SITE	AGRICULTURAL LAND CLASSIFICATION
Main Site	**Urban** and **Non-Agricultural** – Entirety of Main Site.
CO_2 Export Corridor	**Urban** and **Non-Agricultural** – Entirety of the Corridor.
Natural Gas Connection Corridor	**Urban** and **Non-Agricultural** – Entirety of the Corridor.
Water Connection Corridor	**Urban** and **Non-Agricultural** – Entirety of the Corridor.
Electrical Connection Corridor	**Urban** and **Non-Agricultural** – Entirety of the Corridor.
Hydrogen Pipeline Corridor, North Of River Tees	**Urban** – Adjacent to the river Tees up to the start of Greatham Creek and then followed south. Including the far west of the Corridor from Cowpen Bewley Road, encompassing the CF Fertiliser Site and surrounding area. Urban also located north of Greatham Creek.

PART OF THE PROPOSED DEVELOPMENT SITE	AGRICULTURAL LAND CLASSIFICATION
	Grade 5 – Adjacent to the end of the Urban Classification from the end of Greatham Creek and moving west to encompass, Swallow Fleet, Holme Fleet and Greatham Creek, and the surrounding land. **Grade 4** – Adjacent to the Grade 5 Classification and encompassing Cowpen Bewley Woodland Park and the A1185 Road. **Grade 3** – Parcel of land approximately 2ha in size for Cowpen Bewley Replacement Land. As a worst case scenario this has been assumed to be Grade 3a. N.B – a small portion of the northern extent of the Hydrogen Pipeline Corridor falls within Grade 3 land adjacent to Billingham Cemetery, However, it is noted that this area of land comprises a road. Therefore, is not considered further in this assessment.
Hydrogen Pipeline Corridor, South Of River Tees	**Urban** and **Non-Agricultural** – Entirety of the Corridor. N.B There is a low likelihood that Grade 2 ALC encroaches onto the east side of the southeastern extent at Lackenby industrial works area. However, it is considered that this is most likely to be a mapping overlay error as the area is already in industrial use, comprising a pipeline network. Therefore, it is not considered further in this assessment.
Other Gases Connection Corridor	**Urban** and **Non-Agricultural** – Entirety of the Corridor.

Geology

10.4.5 The geology beneath the Proposed Development Site is shown on British Geological Survey (BGS) 1:50,000 Sheet 33 Stockton (BGS, 1987) and Sheet 34 Guisborough (BGS, 1998). It is also shown on extracts of the BGS 1:50,000 Digital Geological Map of Great Britain that were obtained as part of the Groundsure Reports.

10.4.6 BGS 1:50,000 scale mapping reproduced from the BGS digital data is shown on Figure 10-1a to 10-1g: Artificial Geology, Figure 10-2a to 10-2g: Superficial Geology and Figure 10-3a to 10-3g: Bedrock Geology (ES Volume II, EN070009/APP/6.3).

10.4.7 Note: BGS 1:10,000 Sheet NZ52NE (Warrenby) does not show the full extent of the superficial geology at the Proposed Development Site and the straight line shown on other maps is an artifact noting the historical extent of geological mapping undertaken by the BGS (NZ52NE (BGS, 2006)).

10.4.8 A summary of the geology of the Proposed Development Site is provided in Table 10-9.

Table 10-9: Summary of Geology at the Proposal Development Site

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
Main Site	Present – most of the Main Site, apart from the north-eastern corner.	**Tidal Flat Deposits:** BGS geological mapping anticipates that the Tidal Flat Deposits underlie the entirety of the Main Site. The BGS has provided two different layer types for these deposits; Sand and Silt and Sand, Silt and Clay, respectively, depending on which 1:50,000 geological map Sheet covers the area of interest. Across land covered by the Stockton sheet (Sheet 33) (BGS, 1987), the deposits are indicated to comprise Sand, Silt and Clay whilst further east on the Guisborough sheet (Sheet 34) (BGS, 1998) they are reported to comprise of Sand and Silt. **Glaciolacustrine Deposits:** It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. **Till, Devensian:** It is anticipated that Glacial Till Deposits will underlie the Tidal Flat Deposits and Glaciolacustrine Deposits.	**Redcar Mudstone Formation (Lias Group):** The south-east corner is anticipated to be underlain by the Redcar Mudstone Formation. **Penarth Group (Rhaetian):** A thin strip of land through the centre of the Main Site, and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (Triassic):** The north-west extent and the Penarth Group are anticipated to be overlain by the Mercia Mudstone Group.
CO_2 Export Corridor	Present – most of Corridor, apart from north-western corner	**Blown Sand:** The north-east corner is underlain by Blown Sand Deposits. **Tidal Flat Deposits:** The remainder of the Corridor, and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits.	**Redcar Mudstone Formation (Lias Group):** The Redcar Mudstone Formation is anticipated to underlie most of the Corridor, apart from a small parcel of land in the north-west and south-west corner.

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits in places. **Till, Devensian:** It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	**Penarth Group (Rhaetian):** The north-west corner and far south-west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (Triassic):** The Mercia Mudstone Group underlies the Penarth Group.
Natural Gas Connection Corridor	Present – most of the Corridor, apart from a small parcel of land to the north.	**Blown Sand:** The north extent is anticipated to be underlain by Blown Sands. **Tidal Flat Deposits:** The remainder of the Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. **Glaciolacustrine Deposits:** It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. **Till, Devensian:** It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	**Redcar Mudstone Formation (Lias Group):** The Redcar Mudstone Formation is anticipated to underlie most of the Corridor, apart from a small parcel of land in the far west. **Penarth Group (Rhaetian):** The west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (New Red Sandstone Supergroup):** The Mercia Mudstone Group is anticipated to underlie the Penarth Group.
Water Connection Corridor	Present – western extent of the Corridor.	**Blown Sand**: The central area of the Corridor is anticipated to be underlain by Blown Sands. **Tidal Flat Deposits:** The remainder of the Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits.	**Redcar Mudstone Formation (Lower Lias):** The Redcar Mudstone Formation is anticipated to underlie most of the Corridor, apart from a small parcel of land in the north-west and south-west corner. **Penarth Group (Rhaetian):** The north-west corner, south-west corner and the Redcar Mudstone

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. **Till, Devensian:** It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (New Red Sandstone Supergroup):** The Mercia Mudstone Group is anticipated to underlie a small parcel of land in the north-west corner and the Penarth Group.
Electrical Connection Corridor	Present – most of the Corridor, apart from small parcels of land in the north-west and along eastern boundary.	**Blown Sand:** It is anticipated that a thin strip of land along the eastern boundary will be underlain by Blown Sand Deposits. **Tidal Flat Deposits**: The remainder of the Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. **Glaciolacustrine Deposits**: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. **Till, Devensian**: It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	**Redcar Mudstone Formation (Lower Lias):** The Redcar Mudstone Formation is anticipated to underlie most of the Corridor, apart from a small parcel of land in the north-west and far south-west corner. **Penarth Group (Rhaetian):** The north-west corner, south-west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (New Red Sandstone Supergroup):** The Mercia Mudstone Group is anticipated to a small parcel of land in the north-west corner and underlie the Penarth Group.
Hydrogen Pipeline Corridor	Present – central and western extent east of the river Tees and eastern extent and localised areas west of the river Tees	**Blown Sand:** It is anticipated that a thin strip of land in the north-eastern extent of the Corridor to the east of the river Tees will be underlain by Blown Sand.	**Redcar Mudstone Formation (Lower Lias):** The eastern and south-eastern extent (east of the river Tees) is underlain by the Redcar Mudstone Formation. **Penarth Group (Rhaetian):** The western and south-western extent (east of the river Tees) and the

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Peat: A small area of Peat encroaches on the central extent of the Corridor (west of the river Tees). **Alluvium:** Alluvium Deposits are anticipated to underlie the far north-western extent of the Corridor (west of the river Tees). **Tidal Flat Deposits:** The Blown Sand Deposits, Peat Deposits, the north-eastern extent (east of the river Tees) and central extent (west of the river Tees) as well as small parcels of land in the far western extent are anticipated to be underlain by Tidal Flat Deposits. **Glaciolacustrine Deposits:** The south-eastern extent (east of the river Tees) and south-western extent (west of the river Tees), and the Tidal Flat Deposits are anticipated to be underlain by Glaciolacustrine Deposits. **Till, Devensian:** The far south-western extent (east of the river Tees) and the Glaciolacustrine Deposits are anticipated to be underlain by Glacial Till Deposits.	Redcar Mudstone Formation is underlain by the Penarth Group. **Mercia Mudstone Group (New Red Sandstone Supergroup):** The far western and south-western extent (east of the river Tees), the eastern area (west of the river Tees) and the Penarth Group are anticipated to be underlain by the Mercia Mudstone Group. **Sherwood Sandstone Group (New Red Sandstone Supergroup):** The western extent (west of the river Tees) and the Mercia Mudstone Group is underlain by the Sherwood Sandstone Group.
Other Gases Connection Corridor	Present – most of the Corridor, apart from a small parcel of land in the north-east corner.	**Blown Sand**: It is anticipated that Blown Sand will underlie a small parcel of land in the north-east corner of the Corridor.	**Redcar Mudstone Formation (Lower Lias):** The Redcar Mudstone Formation is anticipated to underlie most of the Corridor, apart from a small parcel of land in the north-west corner.

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Tidal Flat Deposits: The remainder of the Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. **Glaciolacustrine Deposits**: Based on the mapping it is expected that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. **Till, Devensian:** Based on the mapping it is expected that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	**Penarth Group (Rhaetian):** The north-west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. **Mercia Mudstone Group (New Red Sandstone Supergroup):** The Mercia Mudstone Group is anticipated to underlie the Penarth Group.

Geological Features and Minerals

10.4.9 There are no recorded RIGS or Locally Important Geological Sites on or within 1 km of the Proposed Development Site.

10.4.10 The Tees Valley has a long history of mineral extraction, the specialist nature of which supported the development of the chemical and steel making industries on the Tees. However, the range of current primary mineral extraction is limited to crushed rock and sand and gravel with some brine extraction at Seal Sands and small-scale clay extraction at Cowpen Bewley. The Tees Valley has relatively few remaining minerals operations.

10.4.11 In taking forward minerals development in the plan area, and particularly along the river corridor and the River Tees, any proposals will need to demonstrate that there will be no adverse impact on the integrity of the Teesmouth and Cleveland Coast SPA and Ramsar Site.

10.4.12 There is one brinefield, for salt production, currently active in the study area which is near Seal Sands in Stockton-on-Tees. Two further brinefields in the Seal Sands area have existing planning permissions and two brinefield cavities at Wilton in Redcar and Cleveland have existing permission for extraction under an 'Instrument of Consent'. The Wilton cavities are presently used for gas storage rather than extraction. Information from the BGS indicates brine extraction has limited viability itself, but it is acknowledged that there may be future interest to create storage caverns for gas and other fluids.

10.4.13 Anhydrite was formerly mined by ICI for use in the chemical industry at Billingham. Production ceased in 1971 and the mine closed in 1978 when the shaft was capped[1]. The capped shaft is located approximately 160 m to the east of the Hydrogen Distribution Network Corridor at Haverton Hill.

10.4.14 Permission was granted in 2009 for the extraction of natural gas at Kirkleatham from a Permian limestone reservoir. Permission also exists for the extraction of anhydrite from the deep mine at Billingham (Stockton-on-Tees), although the mine has not been worked since 1971 and the shaft is capped.

10.4.15 Ten dormant minerals sites were identified in the Tees Valley, one of which has had new conditions approved for minerals extraction (the anhydrite mine at Billingham). Of the remaining nine it is now considered that seven of these sites are highly unlikely to ever resume extraction due to recent development, designations or proposed allocations for other uses. Land at the remaining sites at Low Middlesfield Farm and Eaglescliffe Brickworks (Stockton-on-Tees) may require new planning permissions to be approved before they could be reopened.

10.4.16 The sterilisation of minerals occurs when other non-minerals developments take place on, or close to, mineral deposits and render them incapable of being extracted. Minerals Policy Statement 1 states inter alia that minerals safeguarding areas should be identified in Development Plan Documents (DPDs) to avoid such sterilisation. Sand and gravel, limestone, potash, salt, gypsum/anhydrite and coal

[1] Mindat (n.d.)

are widespread across the Tees Valley. Whilst the extraction of these resources may not be currently viable for reasons of price, geology, quality and previous extractive work, this situation may change, and they may be required at some point in the future. The spatial extent of these deep and shallow resources, excluding certain areas of constraint, are identified as safeguarding areas on the plans of the Tees Valley Joint Minerals (Stockton-on-Tees, 2011a) and Waste Core Strategy DPD (Stockton-on-Tees, 2011b) in Appendix A and the appropriate areas will be shown on each of the individual planning authority's adopted proposals maps.

10.4.17 Appendix C of the Tees Valley Joint Minerals (Stockton-on-Tees, 2011a) and Waste Core Strategy DPD (Stockton-on-Tees, 2011b) indicates Safeguarded Minerals (deep, salt and gypsum) extending below the whole of the Proposed Development Site (including service corridors). The MSA for gypsum (anhydrite) covers the whole of the Tees Valley plan area.

10.4.18 Safeguarded marine dredged sand and gravel (shallow resources) are present locally at Tees Dock. Tees Dock is also identified as a Safeguarded Wharf. Billingham Reach Industrial Estate is identified as a Safeguarded Wharf.

Natural Ground Hazards

10.4.19 Groundsure GIS data was used to present the Natural Ground Hazards for the Proposed Development on Figures 10-18a to 10-18f (ES Volume II, EN070009/APP/6.3). A summary of the Natural Ground Hazards at the Main Site and associated Connection Corridors is presented in the Summary Report.

Hydrogeology

10.4.20 The following WFD Groundwater Bodies are present within the Proposed Development Site:

- Tees Sherwood Sandstone, Good chemical rating and Good quantitative rating (2019); and
- Tees Mercia Mudstone, Poor chemical rating and Good quantitative rating (2019).

10.4.21 Figure 10-12a to 10-12g and Figure 10-13a to 10-13g (ES Volume II, EN070009/APP/6.3) present the designated superficial and bedrock aquifers within the Proposed Development Site.

10.4.22 Figure 10-14a to 10-14g presents the Groundwater Vulnerability classification for the Proposed Development Site.

10.4.23 Figure 10-15 presents the Groundwater Source Protection Zones for the Proposed Development Site.

10.4.24 Figure 10-16 presents the Groundwater Abstractions location at and within 1 km of the Proposed Development Site.

10.4.25 Hydrogeological classifications for each area of the Proposed Development Site are summarised in Table 10-10.

10.4.26 It should be noted that the Tidal Flat Deposits are designated as two separate aquifers on the DEFRA Magic Maps (DEFRA, n.d.), which are based on Environment Agency data. On the DEFRA mapping the two aquifers are split by an artificial line orientated north to south crossing the Main Site, see Figure 10-12a to 10-12b (ES Volume II, EN070009/APP/6.3). Tidal Flat Deposits – Sand and Silt (BGS) are designated as Secondary A within the majority of the Main Site and to the east, whilst Tidal Flat Deposits – Sand, Silt and Clay (BGS) are designated Secondary Undifferentiated within the minority of the Main Site and to the west. This split is artificial and appears to relate to BGS 1:10,000 Sheet NZ52NE (Warrenby) not showing the full extent of the superficial geology at the Main Site and the artificial straight line shown on this mapping appears to be an artifact noting the extent of mapping undertaken by the BGS (NZ52NE (BGS, 2006)).

10.4.27 There are no Groundwater Dependent Terrestrial Ecosystems (GWDTEs) or Source Protection Zone (SPZs) (SPZ 1 to 3) within 1 km of the Proposed Development Site. There are no Drinking Water Groundwater Safeguard Zone (SgZs) within 1 km of the Proposed Development Site.

Table 10-10: Hydrogeology of the Proposed Development Site

RELEVANT HYDROGEOLOGICAL FEATURE	DESIGNATION	STRATA
Main Site		
Superficial Aquifer	• Secondary A • Unproductive • Secondary Undifferentiated	• Tidal Flat Deposits – Sand and Silt (eastern half of the Main Site) • Glaciolacustrine Deposits (silt/clay) • Till and Tidal Flat Deposits – Sand, Silt and Clay (western half of the Main Site)
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated / Secondary B • Secondary Undifferentiated • Principal Aquifer	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	High (Secondary Superficial)	-

RELEVANT HYDROGEOLOGICAL FEATURE	DESIGNATION	STRATA
Source Protection Zone	None within 1 km	-
CO_2 Export Corridor		
Superficial Aquifer	• Secondary A • Secondary A • Secondary Undifferentiated • Unproductive	• Tidal Flat Deposits – Sand and Silt • Blown Sand • Glacial Till • Glaciolacustrine Deposits - clay
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	High (Secondary Superficial)	-
Source Protection Zone	None within 1 km	-
Natural Gas Connection Corridor		
Superficial Aquifer	• Secondary A • Secondary A • Secondary Undifferentiated • Unproductive	• Tidal Flat Deposits – Sand and Silt • Blown Sand • Till • Glaciolacustrine Deposits - clay
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	High (Secondary Superficial)	-

RELEVANT HYDROGEOLOGICAL FEATURE	DESIGNATION	STRATA
Source Protection Zone	None within 1 km	-
Water Connection Corridor		
Superficial Aquifer	• Secondary A • Secondary A • Secondary Undifferentiated • Unproductive	• Tidal Flat Deposits – Sand and Silt • Blown Sand • Till • Glaciolacustrine Deposits - clay
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	• High (Secondary Superficial) • Medium (Secondary Superficial) • Low (Secondary Superficial) • Medium (Secondary Bedrock) • Low (Secondary Bedrock)	-
Source Protection Zone	None within 1km	-
Electrical Connection Corridor		
Superficial Aquifer	• Secondary A • Secondary A • Secondary Undifferentiated	• Tidal Flat Deposits – Sand and Silt (north-eastern extent of the Corridor) • Blown Sand

RELEVANT HYDROGEOLOGICAL FEATURE	DESIGNATION	STRATA
	• Unproductive	• Till and Tidal Flat Deposits – Sand, Silt and Clay (for north-western and southern extend of the Corridor) • Glaciolacustrine Deposits - clay
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	• High (Secondary Superficial) • Medium (Secondary Superficial) • Medium (Secondary Bedrock) • Low (Secondary Bedrock)	-
Source Protection Zone	None within 1km	-
Hydrogen Pipeline Corridor		
Superficial Aquifer	• Secondary A • Secondary Undifferentiated • Unproductive	• Tidal Flat Deposits – Sand and Silt (north-eastern extent of the Corridor) • Blown Sand • Alluvium • Till and Tidal Flat Deposits – Sand, Silt and Clay (north-west and south-west extent of the Corridor) • Glaciolacustrine Deposits–- clay
Bedrock Aquifer	• Secondary B	• Mercia Mudstone • Penarth Group

RELEVANT HYDROGEOLOGICAL FEATURE	DESIGNATION	STRATA
	• Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	• High (Secondary Superficial) • Medium (Secondary Superficial) • Medium (Secondary Bedrock) • Low (Secondary Bedrock)	-
Source Protection Zone	None within 1 km	-
Other Gases Connection Corridor		
Superficial Aquifer	• Secondary A • Secondary A • Secondary A	• Tidal Flat Deposits – Sand and Silt (most of the Corridor) • Blown Sand • Tidal Flat Deposits – Sand, Silt and Clay (far western and southernmost extend)
Bedrock Aquifer	• Secondary B • Secondary Undifferentiated /B • Secondary Undifferentiated • Principal	• Mercia Mudstone • Penarth Group • Redcar Mudstone • Sherwood Sandstone
Groundwater Vulnerability	High (Secondary Superficial)	-
Source Protection Zone	None within 1 km	-

Historical Development

10.4.28 The Main Site has been subject to extensive industrial development since before the date of earliest Ordnance Survey map (1854), with potential contaminative uses present to the current day.

10.4.29 The historical development of the Proposed Development Site is discussed in detail in Appendix 10A (ES Volume III, EN070009/APP/6.4).

10.4.30 Possible historical industrial contaminative uses within 250 m of the Proposed Development Site include:

- unspecified heaps;
- tramway sidings;
- unspecified tanks;
- refuse heaps;
- unspecified works;
- slag and tarmacadam works;
- railway sidings;
- unspecified commercial / industrial;
- sand pits;
- unspecified ground workings;
- iron and steel works;
- railways building;
- slag works;
- iron works;
- pumping stations;
- oxygen works;
- unspecified warehouses;
- corporation yards;
- unspecified pits;
- unspecified factories;
- chimneys;
- old clay pits;
- cuttings;
- brick works;
- electricity substations;

- salt works;
- power stations;
- engine sheds;
- a fire station;
- a mortuary;
- disused brine wells;
- an oil storage depot;
- a cemetery;
- a smithy;
- a bedding works;
- rifle ranges;
- telephone exchange;
- electricity switch house;
- gas handling station;
- tunnel;
- oil refinery;
- oil terminal;
- oil supply terminal;
- slag wool works;
- dock;
- transit shed; and
- terminal.

10.4.31 Historical land uses are provided on the following figures (ES Volume II, EN070009/APP/6.3):

- Figure 10-6: Waste and Landfills;
- Figure 10-7: Hazardous Sites;
- Figure 10-8a to 10-8g: Historical Industrial Land Uses;
- Figure 10-9 Historical Tanks; and
- Figure 10-11: Discharge Consents.

Future Baseline

10.4.32 Future ground conditions on the Main Site may be improved relative to the existing baseline conditions, where existing made ground is remediated by STDC under a

separate planning application prior to commencement of the Proposed Development Site or by the Applicant pursuant to this DCO .

10.5 Proposed Development Design and Impact Avoidance

10.5.1 The EIA process aims to avoid, prevent, reduce or offset potential environmental effects through design and / or management measures. These are measures that are inherent in the design and construction of the Proposed Development (also known as embedded measures). Some embedded measures are required as a result of legislative requirements and / or standard sectoral practices. Some of these embedded mitigation measures as applicable to the geology, hydrogeology and contaminated land assessment are described.

10.5.2 Embedded measures are taken into account prior to the assessment of effects in order to avoid considering assessment scenarios that are unrealistic in practice. These have then been followed through the assessment to ensure that realistic likely environmental effects are identified.

10.5.3 The following impact avoidance measures have either been incorporated into the design or are standard construction or operational practices. These measures have, therefore, been taken into account during the impact assessment and will be secured through a Requirement of the Draft DCO (EN070009/APP/4.1).

Construction

10.5.4 The Framework Construction Environmental Management Plan (CEMP) (EN070009/APP/5.12) sets out the key measures to be employed during the construction of the Proposed Development, to control and minimise the impacts on the environment. The Framework CEMP will set out how impacts upon geology, hydrogeology and contaminated land will be managed during construction. The Final CEMP(s) will be prepared by the construction contractor in accordance with the Framework CEMP prior to construction. The submission, approval, and implementation of the Final CEMP(s) will be secured by a Requirement of the Draft DCO (EN070009/APP/4.1).

10.5.5 In order to manage and monitor waste generated on the Proposed Development Site during construction, an Outline Site Waste Management Plan (SWMP) has been developed as part of the Framework CEMP which will allow for waste streams to be estimated and monitored and goals set with regards to the waste produced. The Outline SWMP will require that the construction contractor segregates waste streams on-site, prior to them being taken to a waste facility for recycling, disposal or reuse in accordance with appropriate permit. All waste removal from the Proposed Development Site will be undertaken by fully licensed waste carriers and taken to permitted waste facilities. In addition, the Final CEMP(s) will also include a Material Management Plan (MMP) following guidance in DoWCoP (CL:AIRE, 2011) and a Hazardous Materials Management Plan including an Asbestos Management Plan (AMP). It is envisaged that a Deposit for Recovery Permit will be obtained to allow specifically itemised volumes of made ground materials which will be excavated at the Main Site to be recovered.

10.5.6 Rainfall runoff from areas where there is a risk of contamination will be managed using temporary drainage systems and or tankered offsite for treatment (including settlement of suspended solids and or oil interceptors) prior to discharge to local watercourses with the approval of the Environment Agency pursuant to a discharge licence. The drainage systems will incorporate pollution control systems designed in line with the Control of Water Pollution from Construction Sites – Guidance for consultants and contractors C532 (CIRIA, 2001) or as agreed with the relevant authorities. Surface watercourses and waterbodies near worksites will be regularly inspected for signs of siltation or other forms of pollution in line with CIRIA Environmental Good Practice on Site Guide C741 (CIRIA, 2015), whilst pumped groundwater, process effluents and construction site runoff will be tested to ensure compliance with discharge consent requirements – these measures are detailed in the Framework CEMP (Volume III, EN070009/APP/6.4) and will be set out in the Final CEMP(s).

10.5.7 Rainfall runoff from areas of low contamination risk will be captured and stored in settlement ponds for reuse where reasonably practicable to reduce consumptive water use (e.g. to supply wheel wash facilities or for dust suppression).

10.5.8 The Proposed Development Site design will take into account existing ground conditions and the potential constraints that they pose. Prior to the design and construction of the Proposed Development on the Main Site, confirmatory GI will be undertaken which will include assessing whether and to what extent contamination is present at the Main Site. The GI will be specified in accordance with the UK Specification for Ground Investigation (Site Investigation Steering Group, 2012) and carried out in accordance with British Standards Institute (BSI) BS EN 1997-2:2007 (BSI, 2007), BS5930:2015+A1:2020 (BSI, 2020) and BS10175:2011+A2:2017 (BSI, 2017). GI will also be undertaken as required, dependant on the depth of construction, where below ground works are to be completed along the Connection Corridors. This is secured under a Requirement of the Draft DCO (EN070009/APP/4.1).

10.5.9 The GI findings will feed into the detailed design process so that appropriate measures can be taken. Specific measures include building and foundation design. In addition, existing pipeline infrastructure will be used where possible, running along existing pipe racking and using existing culverts and overbridges, to minimise impacts upon the ground and groundwater.

10.5.10 The results of the GI may indicate the need to undertake a further risk-based assessment to develop the current CSM that has been produced. This will also involve further assessment of the contamination sources, receptors, and plausible pollutant linkages at the Proposed Development Site, in accordance with government guidance and the UK framework for the assessment of risk arising from contaminated land. The assessment will use principles adopted by the EA in Land Contamination: Risk Management (2023). The significance of impacts will take into account the principles of assessment identified in CIRIA Report C552, (CIRIA, 2001) and EAs guiding principles for land contamination in assessing risks to controlled

waters (EA, 2010). Any such risk-based assessment may indicate the need for mitigation measures additional to those as detailed herein.

10.5.11 STDC are currently completing site clearance in central and southern areas of the Main Site and impacts from this activity have not been included in this assessment.

10.5.12 It is currently anticipated that STDC will complete remediation works required to create a suitable development area before the Applicant's commencement of the construction of the Proposed Development. The scope of STDCs remedial works will include mitigation of any identified risks to controlled waters and / or human health, with STDC to obtain all necessary consents and permits for the works.

10.5.13 In particular, the Applicant understands that STDC are to submit reserved matters approval applications for remedial works in central and southern areas of the Main Site, under their existing outline planning approval for the Foundry site. It is currently anticipated that STDC would submit additional reserved matters approval, or planning applications, for further site clearance and remedial works, if the Applicant proposed construction in the north-west or north-east of Main Site for Phase 2 of the Proposed Development, in accordance with STDCs stated aim to redevelop and regenerate the larger South Tees Development Corporation (STDC) site. If, for any reason, STDC do not bring forward these reserved matters planning applications, or the remediation works are not undertaken in the timescales required, the Applicant would undertake remedial activities required for the development, and this has been assumed as a worst-case assumption for the purposes of the ES. As such, references to start of construction in this ES should be considered to include such works.

10.5.14 The Applicant will also review the scope of any remedial measures considered to be required following the completion of (referred to herein as 'Additional'), or in place of, the remedial works undertaken by STDC. Additional remedial measures before or during construction, could include measures such as a discovery strategy for unexpected contamination, and will be reviewed following review of both GI and relevant remediation specifications and verification reports from STDC. The process for securing the delivery of these remedial measures including the Additional measures is secured by DCO Requirement.

10.5.15 Estimates of waste from the Proposed Development Site in Chapter 21: Materials and Waste Management (ES Volume I, EN070009/APP/6.2), conservatively assume that some hazardous and non-hazardous material generated during any Applicant remediation works before or during construction activities, could require disposal from the Proposed Development Site, with recovery of some soil materials under appropriate permitting. The volumes assume that stockpiled made ground materials specifically included within a Deposit for Recovery Permit are able to be recovered, and do not require disposal. The volume estimates will be further refined following both GI and relevant remediation specifications and verification reports from STDC (if taken forward by them) but it is not anticipated that there would be significant changes that would materially increase the HGV movements required.

10.5.16 If piling is required, a piling risk assessment will be carried out to reduce as far as reasonably practicable the risk of development of preferential pathways (e.g. groundwater flow) between the Made Ground present and the underlying Secondary 'A' or 'B' Aquifers. The assessment will be in accordance with the EA's guidance documents including, piling into contaminated sites (EA, 2001) and will determine the risk to receptors through potential pollution scenarios considering the scope of STDC remedial works and any remediation measures proposed by the Applicant, this is secured pursuant to a Requirement of the Draft DCO (EN070009/APP/4.1).

10.5.17 If any contamination is found during the construction of the Proposed Development, which has not been previously identified, an appropriate risk assessment will be prepared. Any actions/remedial measures resulting from the risk assessment will be agreed with the Local Planning Authorities (LPAs) and in consultation with the EA where risks to controlled waters are identified, pursuant to DCO Requirement. The contamination assessment will be conducted in accordance with CIRIA C552 - Contamination Land Risk Assessment, A Guide to Good Practice and Land Contamination: Risk Management (EA, 2023). Any required remedial measures will be adopted as part of the Proposed Development Site.

10.5.18 The Proposed Development Site design is actively working towards a net cut and fill balance of zero. The suitability of excavated materials for potential recovery, and / or any permitting required to recover excavated materials, will be assessed following confirmatory GI works, and with consideration to STDC remedial works. It is envisaged that a Deposit for Recovery Permit will be obtained to allow specifically itemised volumes made ground materials which will be excavated at the Main Site to be recovered. All earthwork operations will need to be undertaken in accordance with BS6031:2009 (BSI, 2009) and applicable guidelines, including the Manual for Contract Documents for Highway Works (MCHW) Series 600 'Earthworks' (National Highways, 2017).

10.5.19 Construction phase mitigation measures in relation to the geological and hydrogeological environment are summarised here and presented in the Framework Construction Environmental Management Plan (EN070009/APP/5.12):

- Best practice will be adopted during construction to prevent or reduce as far as reasonably practicable spillage risk and spillage effects by adhering to the Framework CEMP. Such measures are set out in the Framework CEMP (EN070009/APP/5.12). The Final CEMP(s) will address the management of concrete batching, concrete usage and accidental spillage relating to foundation and building construction.
- Soil resources will be protected and conserved where possible through adherence to best practice guidance such as DEFRA's 2009 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' (DEFRA, 2009).

- An AMP will be required prior to the start of construction as part of the Final CEMP(s). Particular emphasis is placed on this with regards to the development of the Main Site.
- Land disturbance will be reduced as far as is reasonably practicable and disturbed areas outside the development footprint will be revegetated as soon as possible after construction. Soil excavation will be undertaken with consideration given to the prevailing ground and weather conditions when programming the execution of the works to reduce the potential for mobilisation of exposed soil and / or sediment. Although not anticipated to be widely present across the majority of the Proposed Development Site, if encountered, topsoil and subsoil will be kept separately during excavation.
- Stockpiled excavation material will be kept to a minimum as far as is reasonably practicable and stored away from watercourses to prevent surface water entering or leaving the stockpile area.
- All areas of stockpiled material may be reseeded or otherwise covered temporarily until restoration activities commence. All areas of unused and exposed soil following reinstatement of the Proposed Development Site will be reseeded or otherwise covered as soon as possible. Erosion protection matting may also be used to reduce as far as is reasonably practicable sediment being entrained by water flow or becoming entrained by the wind if allowed to dry out.
- Temporary construction compound areas will be located away from all significant surface water bodies where possible. If the buffer zone has to be reduced to a minimum of 8m from the top of the bank of a main river or 16m for a tidal main river, impermeable liners and bunds will be used to prevent materials entering watercourses.
- Washing out of vehicles or equipment will only take place in controlled areas.
- Suitable areas for specific construction activities will be identified within the Final CEMP(s) and consultation with the EA will take place before construction commences.

10.5.20 Various fuels, oils and chemicals will be required during the construction of the Proposed Development Site. Measures to reduce potential effects associated with these substances during construction will include:

- The preparation of a map that highlights all potential contamination sources, which will be included as part of the Final CEMP(s), SWMP, MMP, and a Hazardous Materials Management Plan (including an AMP).
- The preparation of an inventory of all chemicals, fuels and oils will be kept up to date and be available on-site. Spill contingency plans will be created for each of the items on the inventory. These will be supported by warning notices and appropriate spillage containment equipment and materials at key locations.

- Chemicals, fuels and oils will be stored in secure and designated storage areas in accordance with the appropriate regulatory requirements, including the Control of Pollution (Oil Storage) (England) Regulations 2001 (HM Government, 2001) and Control of Substance Hazardous to Health (COSHH) Regulations 2002 (Health and Safety Executive, 2002). Storage areas will need to be located on hardstanding areas to prevent the possible infiltration of contaminants into soils.
- Re-fuelling of plant will take place in appropriate areas to be agreed in the Final CEMP(s) i.e. in locations with an impervious base and are bunded or provided with interceptor drains. Spill kits will be kept with all vehicles on-site and all bowsers are to be double skinned or have a bund. Vehicles and equipment will not be left unattended during re-fuelling. To prevent materials leaking from static plant, such as pumps and generators, static plant will be placed on drip trays wherever practicable.
- All pumps, generators and similarly fuelled equipment will be placed on drip trays or in a bunded area, and no vehicles or equipment will be allowed to enter any watercourses at any stage. Refuelling areas will be positioned a minimum of 50 m away from any watercourse or drain. All vehicles, generators and similarly fuelled equipment will be maintained to a high standard to reduce as far as is reasonably practicable potential pollution incidents.
- All valves, hoses and associated re-fuelling equipment will be regularly inspected to ensure that they are still in a suitable condition. This equipment will be protected from vandalism and unauthorised interference and will be turned off and securely locked when not in use.
- All storage of drums containing hazardous material will be located within the Main Site temporary construction compound. Any spillages or leaks will be dealt with promptly and all waste disposed of in an appropriate manner. All tanks, drums and other containers will be clearly marked as to their contents. Before any tank is removed or perforated, all contents and residues will be emptied by a competent operator for safe disposal.
- All bunds will have a capacity of at least 110% of the storage volume and will be covered where practical to prevent the collection of rainwater.
- Any staff involved in fuel handling will be given appropriate training, and site-specific procedures will be developed for all staff. Workers will be made aware of their statutory responsibility under section 85 of the Water Resources Act 1991 (HM Government, 1991a) not to 'cause or knowingly permit' water pollution. In addition, they will be made aware of their statutory responsibility under Regulations 38(1) and 12(1) of the Environmental Permitting Regulations 2019 (HM Government, 2019) not to 'cause or knowingly permit' a water discharge activity or groundwater activity without an environmental permit.
- Reference should also be made to the controlled water mitigation measures as detailed in Chapter 9: Surface Water, Flood Risk and Water Resource (ES Volume I, EN070009/APP/6.2).

10.5.21 The H2Teesside project considers the use of trenchless techniques, including Horizontal Directional Drilling (HDD), for major crossings beneath the Teesmouth and SPA and Ramsar site to be a form of mitigation against habitat loss. However, it is noted the potential also exists for habitat loss to occur as a result of HDD collapse or leakage of drilling fluid to the surface, known as breakout. There are standard measures which are included in the design and performance of the HDD which are considered sufficient to avoid the risk of habitat loss. These include:

- Before drilling:
  - Undertaking a ground investigation
  - Detailed design of the launch point or landfill of the HDD, showing geological layers and the intended drill path which has sufficient depth below surface for the expected ground conditions to minimise risk of failure/collapse
  - Undertaking a hydraulic fracture analysis
- During drilling:
  - Ensure drilling fluid is of sufficient viscosity and properties for the ground being drilled
  - Have lost circulation cleanup materials on site to seal any breakout
  - Use casing through weaker cohesive layers near the ground surface if necessary
  - Removal of poor ground / ground stabilisation prior to drilling
  - Monitoring of drilling fluid returns and volumes during drilling to warn of inadequate hole cleaning
  - Monitoring downhole annular pressure (set by fracture analysis) in real time to warn of over pressurising by drilling fluid

10.5.22 In addition the H2Teesside framework CEMP includes[*] the following commitments:

- A commitment to producing a Code of Construction Practice which would specify measures designed to minimise the risk of collapse of any HDD crossing;
- A requirement for the contractor's drilling method statement to form the basis of contingency plans which provide details of specific clean-up and pollution control measures which would be used in the event of an accidental spillage.
- Natural England, and any landowner of land crossed by the HDD, would be consulted on the effectiveness of the proposed measures in reducing effects on designated sites; and
- A requirement for the contractor's drilling method statement to include pollution prevention measures that would be used to minimise the risk of accidental spillage.

Operation

10.5.23 The Hydrogen Production Facility will require an Environmental Permit and will comply with this under the Environmental Permitting (England and Wales) Regulations 2016 (HM Government, 2016).

10.5.24 Prevention of contamination will be a specific requirement of the Environmental Permit for the operation of the Proposed Development Site. Therefore, it will be designed so that it will not create any new areas of ground contamination or pathways to receptors as a result of both construction and operation. The Applicant has also begun engagement with the Environment Agency under the enhanced pre-application scheme and is finalising an application for an Environmental Permit anticipated to be submitted in 2024.

10.5.25 The Proposed Development Site will be operated in line with appropriate standards, whilst the operator will implement and maintain an Environment Management System (EMS) which will be attested to International Standards Organisation (ISO) 14001. The EMS will outline requirements and procedures required to ensure that the Proposed Development Site is operating to the appropriate standard.

10.5.26 An Indicative Surface Water Drainage Plan has been produced for the DCO Application (EN070009/APP/2.12), which details the operational drainage systems to be implemented to control potential impacts from pollution to surface watercourses.

10.5.27 Mitigation measures proposed during the operation of the Proposed Development Site include:

- the implementation of standard industry practices to mitigate potential impacts from accidental spills or leaks to comply with industry best practice;
- the storage and handling of processed chemicals will be undertaken in properly surfaced and bunded areas depending on the findings of the risk assessment that would support the environment permit application and permit conditions set by the regulator;
- implementation of rapid spill response planning and training depending on the findings of the risk assessment that would support the environment permit application and permit conditions set by the regulator; and
- the preparation of a groundwater quality monitoring plan depending on the findings of the controlled waters risk assessment (to be undertaken based on ground investigation data) that would support the environment permit application and permit conditions set by the regulator.

The Applicant has also begun engagement with the Environment Agency under the enhanced pre-application scheme and is finalising an application for an Environmental Permit anticipated to be submitted in 2024.

Decommissioning

10.5.28 A Decommissioning Environmental Management Plan (DEMP) would be produced pursuant to a DCO Requirement. The DEMP would consider in detail all potential

environmental risks on the Proposed Development Site and contain guidance on how risks can be removed or mitigated. This will include details of how geology, hydrogeology and contaminated land should be managed during decommissioning and demolition. The DEMP would be secured by a Requirement of the Draft DCO (EN070009/APP/4.1).

10.5.29 The Proposed Development Site has a long design life and as such it is not considered possible to reliably forecast decommissioning requirements and infrastructure far in the future.

10.5.30 The decommissioning phase is anticipated to involve the removal of all above surface structures. It is assumed that all underground infrastructure would remain in-situ; however, all connection and access points would be sealed or grouted to ensure disconnection.

10.5.31 Potential environmental effects during the decommissioning phase would be broadly similar to those during the construction phase, although there would be a need to address impacts from the production of bulk wastes from demolition of buildings and hardstanding to be recycled for re-use.

10.5.32 Decommissioning activities would be conducted in accordance with the appropriate guidance and legislation at the time of the Proposed Development Site's closure. It is anticipated that a large proportion of the materials resulting from the demolition would be recycled and a record kept to demonstrate that the maximum level of recycling and reuse has been achieved as part of the DEMP.

10.5.33 Upon completion of the decommissioning programme, including any remediation works that might be required, the EA will be invited to witness a post-decommissioning inspection by site staff.

10.6 Impacts and Likely Significant Effects

10.6.1 The Proposed Development and the Connection Corridors have the potential to cause adverse effects to the geology, hydrogeology and contaminated land during construction and operation phases in the absence of impact avoidance measures described in Section 10.5.

10.6.2 The majority of the impacts relating to geology, hydrogeology and contaminated land that are expected to arise as a result of the Proposed Development are anticipated to occur during the construction works.

10.6.3 Table 10-11 summarises the resource value (sensitivity) of the identified receptors within the Proposed Development Site.

10.6.4 A summary of effects during Proposed Development Site construction, operation and decommissioning (taking into account the mitigation measures) is presented in Table 10-12. Where the significance of effects are considered to be **not significant** (inclusive of embedded mitigation), further mitigation is recommended in the form of GI to confirm assessment.

Table 10-11: Resource Value (Sensitivity)

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
Geology – See Figure 10-3a to 10-3g – Bedrock Geology				
Geology Bedrock	Sherwood Sandstone Group – Sandstone	Hydrogen Pipeline Corridor	Medium	The Sherwood Sandstone is not a designated RIGS, geological unit, however considered medium due to aquifer designation described below.
Geology Bedrock	Mercia Mudstone Group – Mudstone	Entirety of the Proposed Development Site	Low	The Mercia Mudstone is a non-designated geological exposure.
Geology Bedrock	Penarth Group – Mudstone	Entirety of the Proposed Development Site	Low	The Penarth Group is a non-designated geological exposure.
Geology Bedrock	Redcar Mudstone Formation – Mudstone	Entirety of the Proposed Development Site	Low	The Redcar Mudstone is a non-designated geological exposure.
Geology Minerals	Concealed Permian Formations – Salt and Gypsum (Anhydrite)	Entirety of the Proposed Development Site	Medium	There is one brinefield reported in the Tees Value Minerals Core Strategy to be active near Seal Sands (Stockton-on-Tees), although the BGS have suggested this ceased operation in 2002. Two further brinefields in the Seal Sands area have existing planning permissions and two brinefield cavities

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
				at Wilton (Redcar and Cleveland) have existing permission for extraction under an 'Instrument of Consent'. Permission also exists for the extraction of anhydrite from a deep mine at Billingham (Stockton-on-Tees) although the mine has not been worked since 1971 and the shaft was capped in 1978.
Soils – See Figure 10-19a to 10-19g - Agricultural Land				
Soils (ALC)	Agricultural Land Value (measured using the ALC)	Main Site CO_2 Export Corridor Natural Gas Connection Corridor Water Connection Corridor Electricity Connection Corridor Hydrogen Pipeline Corridor Other Gases Connection Corridor	Low	Soils are recorded as non-agricultural/urban.

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
Soils (ALC)	Agricultural Land Value (measured using the ALC)	Hydrogen Pipeline Corridor	Grade 3 – High	Areas of Grade 3 soil are located in the western extent of the Hydrogen Pipeline Corridor north of the River Tees (Cowpen Bewley Replacement Land). The land is not subdivided into Grade 3a or 3b, therefore, a worst-case assessment assuming Grade 3a land has been adopted.
Soils (ALC)	Agricultural Land Value (measured using the ALC)	Hydrogen Pipeline Corridor	Grade 5 – Low Grade 4 – Low	Areas of Grade 4 (Poor) and 5 (Very Poor) north of the River Tees.
Soils – See Figure 10-1a to 10-1g – Artificial Geology and 10-2a to 102g – Superficial Geology				
Soils	Blown Sand	CO_2 Export Corridor Natural Gas Connection Corridor Water Connection Corridor Electrical Connection Corridor Hydrogen Pipeline Corridor Other Gases Connection Corridor	High	Soils in sensitive environmental designations (Teesmouth and Cleveland Coast SPA, Ramsar Site and SSSI).

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
Soils	Tidal Flat Deposits – Sand and Silt Tidal Flat Deposits – Sand, Silt and Clay Till, Devensian – Diamicton	Entirety of the Proposed Development Site	Low	Soils supporting non-designated notable or priority habitats. The majority of the Tidal Flat Deposits are exposed south-west of the coastline and along the margins of the river Tees. Inland these soils are already overlain by Artificial Ground/Made Ground.
Soils	Glaciolacustrine Deposits, Clay and Silt Glaciolacustrine Deposits, Sand Glaciofluvial Deposits – Sand and Gravel Alluvium	Entirety of the Proposed Development Site	Low	Soils supporting non-designated notable or priority habitats.
Groundwater – See Figure 10-13a to 10-13g – Bedrock Aquifers				
Groundwater Contamination (Bedrock)	**Principal Aquifer** Sherwood Sandstone Group – Sandstone	Entirety of the Proposed Development Site	High	Area is outside of any designated SPZ. The Principal Aquifer is of Low Vulnerability because at subcrop it is overlain by a thick cover of low permeability superficial deposits, and to the east of its subcrop it is overlain by low permeability mudrocks of the

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
				Mercia Mudstone Group and / or Penarth Group and / or Redcar Mudstone Formation.
Groundwater Contamination (Bedrock)	**Secondary Aquifer – B** Mercia Mudstone Formation - Mudstone	Entirety of the Proposed Development Site	Medium	Area is outside of any designated SPZ. Secondary Aquifer – B.
Groundwater Contamination (Bedrock)	**Secondary Aquifer – Undifferentiated** Penarth Group - Mudstone	Entirety of the Proposed Development Site	Medium	Area is outside of any designated SPZ. Secondary Aquifer – Undifferentiated/Secondary B.
Groundwater Contamination (Bedrock)	**Secondary Aquifer – Undifferentiated** Redcar Mudstone Formation - Mudstone	Entirety of the Proposed Development Site	Medium	Area is outside of any designated SPZ. Secondary Aquifer – Undifferentiated.
Groundwater – See Figure 10-12a to 10-12g Superficial Geology				
Groundwater Contamination (superficial)	**Secondary Aquifer - A** Blown Sand Tidal Flat Deposits – Sand and Silt	Main Site CO_2 Export Corridor Natural Gas Connection Corridor Water Connection Corridor	**High**	Area is outside of any designated SPZ. Secondary Aquifer – A.

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
		Electrical Connection Corridor Hydrogen Connection Corridor		
Groundwater Contamination (superficial)	**Secondary Aquifer – Undifferentiated** Tidal Flat Deposits – Sand, Silt and Clay Till, Devensian – Diamicton	Entirety of the Proposed Development Site	**Medium**	Area is outside of any designated SPZ. Secondary Aquifer – Undifferentiated.
Groundwater Contamination (superficial)	**Unproductive Strata** Glaciolacustrine Deposits, Clay and Silt Glaciolacustrine Deposits – Sand Glaciofluvial Deposits – Sand and Gravel Alluvium	Entirety of the Proposed Development Site	**Low**	Area is outside of any designated SPZ. Unproductive Strata.
Contamination (Soils)				
Contamination (Soils)	Blown Sand Tidal Flat Deposits – Sand and Silt	Entirety of the Proposed Development Site	**Low**	Extensive existing Highways, Rail and Industrial Land Use. The majority of the Tidal Flat Deposits are exposed south-west of the

ASPECT/ CRITERIA	RESOURCE/ RECEPTOR	PART OF THE PROPOSED DEVELOPMENT SITE	RESOURCE VALUE/ SENSITIVITY	JUSTIFICATION
	Tidal Flat Deposits – Sand, Silt and Clay Till, Devensian – Diamicton Glaciolacustrine Deposits, Clay and Silt. Glaciofluvial Deposits, Sand and Gravel. Glacial Till, Devensian – Diamicton			coastline or along the margins of the river Tees. Inland these soils are already overlain by Artificial Ground / Made Ground.

Table 10-12: Summary of Geology, Hydrogeology and Contaminated Land Effects for the Proposed Development Site

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Construction				
Geology Sherwood Sandstone Group – Sandstone	Sherwood Sandstone Group – Sandstone: **Medium**	**Minor** (From Foundations, e.g. creation of new contaminant linkages (e.g. pile foundation construction through existing Made Ground into underlying natural soils or bedrock,	Sherwood Sandstone Group – Sandstone: **Slight Adverse (Not Significant)** Mercia Mudstone Group - Mudstone, Penarth Group – Mudstone and Redcar	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Mercia Mudstone Group - Mudstone Penarth Group – Mudstone Redcar Mudstone Formation - Mudstone	Mercia Mudstone Group - Mudstone, Penarth Group – Mudstone and Redcar Mudstone Formation – Mudstone: **Low**	pile foundation construction or excavation through an existing aquiclude (impermeable fine / cohesive soils) into an aquifer (comprised of coarse or sandy soils)) Main Site	Mudstone Formation – Mudstone: **Slight Adverse (Not Significant)**	
Geology Mercia Mudstone Group - Mudstone Penarth Group – Mudstone Redcar Mudstone Formation -	**Low**	**Minor** (From Directional drilling through mudstones to form crossing below the river Tees. Spoil generated from construction) Hydrogen Pipeline Corridor	**Slight Adverse (Not Significant)**	T
Minerals Deep Resources Salt and Gypsum	**Medium**	**Minor** (from sterilisation of minerals. Non-minerals developments take place on, or close to, mineral deposits	**Slight Adverse (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
		and render them incapable of being extracted. Development to take place across an area defined in the Tees Valley Joint Minerals and Waste Development Plan Core Strategy as protected to allow for future Gypsum and Salt extraction) Proposed Development Site		
Minerals Shallow Resources Marine dredge Sand and Gravel	**Medium**	**Minor** (Safeguarded under the Tees Valley Joint Minerals and Waste Development Minerals and Waste Core Strategy DPD) Proposed Development Site	**Slight Adverse (Not Significant)**	T
Soils Agricultural Land Classification	**Low**	**Negligible** (From extraction / removal of soils) Proposed Development Site	**Slight Adverse (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Soils Agricultural Land Classification	**High**	**Not Discernible** (From extraction / removal of soils – Physical removal or permanent sealing of <1ha of agricultural land is reported as not discernible based on LA109) Hydrogen Pipeline Corridor	**N/A**	P
Soils General	**Medium**	**Minor** (From spoil resulting from excavations and earthworks) Proposed Development Site	**Slight Adverse (Not Significant)**	T
Groundwater (Bedrock Contamination) Principal Aquifer Sherwood Sandstone	**High**	**Minor** (from changes to hydrogeological regime due to potential mobilisation of any existing contamination during construction) Proposed Development Site	**Slight Adverse (Not Significant)**	P/T
Groundwater (Bedrock Contamination) Secondary Aquifer	**Medium**	**Minor** (from changes to hydrogeological regime due to potential mobilisation of any existing contamination during construction)	**Slight Adverse (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
– B Mercia Mudstone Group – Mudstone and Penarth Group – Mudstone Secondary Undifferentiated Redcar Mudstone Formation – Mudstone		Proposed Development Site		
Groundwater – (Soil Contamination) Secondary Aquifer – A Blown Sand Beach and Tidal Flat Deposits	**Medium**	**Minor** (from potential mobilisation of any potential existing contamination during construction. New contaminant pathways or mobilisation of existing contaminants may result from exposure of soils/increase in rainwater infiltration through changes in ground cover/in excavations) Proposed Development Site	**Slight Adverse (Not Significant)**	T

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Groundwater – (Soil Contamination) Secondary Aquifer – Undifferentiated Tidal Flat Deposits – Sand and Silt Tidal Flat Deposits – Sand, Silt and Clay	**Medium**	**Minor** (from potential mobilisation of any existing contamination during construction. New contaminant pathways or mobilisation of existing contaminants may result from exposure of soils/increases in rainwater infiltration through changes in ground cover/in excavations) Proposed Development Site	**Slight Adverse (Not Significant)**	T
Contamination (Soils) Blown Sand Tidal Flat Deposits	**High**	**Minor** (potential contaminant pathways may be reduced or removed by remedial works including clean cover or capping layer as well as through construction of new structures, hardstanding, pavements over existing contaminated soils. Infiltration pathways may be reduced).	**Slight Beneficial (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
		Main Site		
Contamination (Soils) Blown Sand Tidal Flat Deposits - Sand and Silt Tidal Flat Deposits – Sand, Silt and Clay Glaciolacustrine Deposits, Clay and Silt. Glaciofluvial Deposits, Sand and Gravel.	**Low**	**Minor** (potential contaminant pathways may be reduced or removed by remedial works including clean cover or capping layer as well as through construction of new structures, hardstanding, pavements over existing contaminated soils. Infiltration pathways may be reduced). Main Site	**Slight Beneficial (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Glacial Till, Devensian – Diamicton				
Operational				
Contamination (Soils) Blown Sand Tidal Flat Deposits	**High**	**Minor** (from impacts on soil quality which could potentially occur during operation caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids) Proposed Development Site	**Slight Adverse (Not Significant)**	P
Groundwater (Bedrock Contamination) Principal Aquifer Secondary B Aquifers	**Medium / High**	**Minor** (Impacts on groundwater could potentially occur during operation caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids) Proposed Development Site	**Slight Adverse (Not Significant)**	P

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Secondary Undifferentiated				
Decommissioning				
Contamination (Soils)	**Medium**	**Minor** (from excavation of materials/soil removal. Demolition workers exposed to historic and current potentially contaminated soil sources on Site) Proposed Development Site	**Slight Adverse (Not Significant)**	T
Contamination (Soils)	**Medium**	**Minor** (from accidental spills. Impacts on soil quality could potentially occur during decommissioning caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids) Proposed Development Site	**Slight Adverse (Not Significant)**	T

RESOURCE/ RECEPTOR	VALUE/ SENSITIVITY	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT (WITH EMBEDDED MITIGATION)	NATURE OF EFFECT (PERMANENT OR TEMPORARY)
Groundwater (Bedrock Contamination) Principal Aquifer Secondary A Secondary Undifferentiated	**Medium / High**	**Minor** (from impacts on groundwater and watercourses could potentially occur during decommissioning caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids) Proposed Development Site	**Slight Adverse (Not Significant)**	T
Soils (General)	**Medium**	**Minor** (from export, excavation, stockpiling, redistribution and / or removal of the Made Ground) Main Site	**Slight Adverse (Not Significant)**	T

Note: P = permanent, T = temporary

Construction

10.6.5 The Proposed Development Site may require supporting infrastructure which may impact the geology, hydrogeology and contaminated land. This may include foundation construction (e.g. piled foundations, strip and pad footings), earthworks and excavations (foundations and service conduits).

10.6.6 Most of the impacts relating to geology, hydrogeology and contaminated land that are expected to arise as a result of the Proposed Development are anticipated to occur during construction.

10.6.7 Activities that may result in potential impacts to ground and groundwater at the Proposed Development Site include the following:

- creation of new contaminant linkages (e.g. pile foundation construction through existing Made Ground into underlying natural soils or bedrock, pile foundation construction or excavation through an existing aquiclude (impermeable fine / cohesive soils) into an aquifer (comprised of coarse or sandy soils);
- the potential mobilisation of any existing contamination via the exposure of soils / increases in rainwater infiltration through changes in ground cover / in excavations or bulk earthworks;
- changes to the hydrogeological regime (e.g. dewatering activities) may impact groundwater;
- activities relating to foundation construction, earthworks and excavations and associated transportation activities have the potential to expose construction workers to potentially contaminated dust;
- on site construction traffic, through compaction of the existing soils, could increase the speed of surface water run-off and increase the potential for erosion and transportation of sediment; and
- potential temporary impacts may result from the accidental leak of fuels and oils from vehicular plant or from stored liquids. Other temporary impacts may also result from the use of materials and substances polluting potential (e.g. concrete, fuel, oils and soil) which have the potential to be mobilised to ground or controlled waters.

10.6.8 Potential impacts associated with risks of major accidents and disasters (by leaks or spillages for example) are assessed in Chapter 20: Major Accidents and Disasters (ES Volume I, EN070009/APP/6.2).

10.6.9 There may also be beneficial effects if any previously unidentified contaminated soil is identified and remediated.

Geology

10.6.10 There are no bedrock exposures or outcrops present within the Proposed Development Site. Potential impacts upon the underlying geology are primarily related to the potential risk of creating a new Source-Pathway-Receptor linkage.

10.6.11 As indicated in in Table 10-12, geological effects during the construction of the Proposed Development (taking into account the mitigation measures as detailed in Section 10.5) would be no worse than **Slight Adverse (Not Significant).**

Mineral Resources

10.6.12 Mineral resources are present at depth below the Proposed Development Site and are already primarily covered by existing industrial development at the Main Site. The mineral resources at Proposed Development Site would not be sterilised by the development or render the sites inaccessible for future use.

10.6.13 As indicated in Table 10-12, effects upon mineral resources during Proposed Development Site construction (taking into account the mitigation measures as detailed in Section 10.5) would be no worse than **Slight Adverse (Not Significant).**

Potential Soil Resource and Agricultural Land Quality

10.6.14 The Proposed Development Site is largely already covered in Made Ground or in industrial land use. Soils are predominantly recorded as Grade 4 or 5 and are Non-Agricultural / Urban. Therefore, the magnitude of impact associated with the loss of such soils (Low value) during the construction of the Proposed Development would be considered Negligible, resulting in **Slight Adverse (Not Significant)** effects.

10.6.15 Presumed Grade 3a soils at the Cowpen Bewley Replacement Land have been classed as High value. However, the works are anticipated to be minor and may include tree planting to create open space and join it up with the existing woodland park. It is not expected that there will be physical removal or permanent sealing of agricultural land. However, the assessment has allowed for a conservative <1ha removal or permanent sealing. Based on DMRB LA109 (National Highways, 2019a), physical removal or permanent sealing of <1ha of agricultural land should be reported as not discernible. Therefore, a significance of effect is not applicable.

10.6.16 Soils would be stockpiled for re-use onsite where possible.

Hydrogeology – Changes to Hydrogeological Regime

10.6.17 Excavations and foundations have the potential to disrupt shallow groundwater. Temporary groundwater controls such as dewatering or physical cut-offs may be required to prevent the excavations filling with water, which would be likely to result in the lowering of groundwater levels in the immediate area of the excavation. Service trenches can also provide preferential flow pathways for groundwater. Dewatering of excavations could result in an adverse risk to groundwater and could also draw contaminated groundwater on site, should any be present. The potential effect to Proposed Development Site is considered to be **Slight Adverse (Not Significant**) following the implementation of development design and impact avoidance mitigation as detailed in Section 10.5.

10.6.18 With appropriate design of Proposed Development Site construction activities and the implementation of the measures included in the Framework CEMP as described in Section 10.5, it is anticipated that impacts would be no worse than Minor, resulting in effects no greater than **Slight Adverse (Not Significant).**

Controlled Waters – Contamination

10.6.19 The Proposed Development Site construction works have the potential to impact upon controlled water – pathways (without mitigation) include the following:

- Potential effects upon groundwater could arise from contamination of the Principal, Secondary 'A' Aquifers, Secondary 'B' and Secondary Undifferentiated Aquifers. Disturbance and / or removal of the ground and groundwater could potentially remove, relocate or mobilise potential contaminants e.g., during foundation construction, earthworks and excavations. The potential effect of the Proposed Development Site is considered to be **Slight Adverse (Not Significant**) following the implementation of development design and impact avoidance mitigation as detailed in Section 10.5.
- Pollution of groundwater (and surface water) could result from concrete, fuel, oil and hydrocarbon spillages. The risk of pollution is greater near to excavations where higher permeability strata are exposed i.e., close to the river Tees within the Tidal Flat Deposits or across Connection Corridors that extend through the Blown Sands. The potential effect of the Proposed Development Site is considered to be **Slight Adverse (Not Significant)** following the implementation of development design and impact avoidance mitigation as detailed in Section 10.5.
- Creation of new potential contaminant linkages e.g., pile foundation construction through existing Made Ground into underlying natural soils or bedrock, or pile foundation construction or excavation through an existing aquiclude (impermeable fine / cohesive soils) into an aquifer (comprised of coarse or sandy soils). The potential effect of the Proposed Development Site is considered to be **Slight Adverse (Not Significant)** following the implementation of development design and impact avoidance mitigation as detailed in Section 10.5. Furthermore, a Piling Risk Assessment will be undertaken to mitigate the risks from foundation construction.
- Creation of new potential contaminant linkages or potential mobilisation of any existing contamination may result from exposure of soils / increases in rainwater infiltration through changes in ground cover / in excavations or bulk earthworks. The potential effect of the Proposed Development Site is considered to be **Slight Adverse (Not Significant)** following the implementation of development design and impact avoidance mitigation as detailed in Section 10.5.
- Surface water quantity and quality changes during construction (and decommissioning) and potential effects on surface water supplies, surface water run-off and drainage quantity and quality e.g., during bulk earthworks.

10.6.20 All works must comply with a Water Management Plan as well as any abstraction/ discharge permits required pursuant of the Environmental Permitting Regulations (2016). The Applicant has also begun engagement with the Environment Agency under the enhanced pre-application scheme and is finalising an application for an Environmental Permit anticipated to be submitted in 2024. An Outline Water

Management Plan is presented as part of the Framework CEMP (EN070009/APP/5.12) and updated prior to construction as part of the Final CEMP(s). With appropriate design of the Proposed Development Site construction activities and the implementation of the measures included in the Final CEMP(s), it is anticipated that effects would be no worse than Minor, resulting in effects no more than **Slight Adverse (Not Significant).**

Soils – Contamination

10.6.21 Remediation of potentially contaminated soils has the potential to have a beneficial significance of effect as potential contaminant pathways are reduced by construction of remedial works including clean cover or capping layer as well as through construction of new structures, hardstanding, pavements over existing contaminated soils. Infiltration and pathways can also be reduced. The magnitude of impact to the reduced or removal of contaminated soils is considered to be **Minor** with a **Slight Beneficial (Not Significant)** effect.

Operation

10.6.22 The operational impacts of the Proposed Development Site on geology, hydrogeology and contaminated land are associated with the permanent site infrastructure which includes plant and buildings, roadways, service corridors and areas of hardstanding.

10.6.23 The potential impacts (without mitigation) that could arise during the operational phase of the Proposed Development include:

- Impacts to soil quality, groundwater and watercourses could potentially occur during operation as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals and process liquids. The potential effects of the Proposed Development Site is considered to be **Slight Adverse (Not Significant).**

10.6.24 Environmental Permit will be required for the operation of the Proposed Development Site. The Applicant has also begun engagement with the Environment Agency under the enhanced pre-application scheme and is finalising an application for an Environmental Permit anticipated to be submitted in 2024. With appropriate operational management of the Proposed Development Site in accordance with the Environmental Permit, it is anticipated that impacts would be **Minor**, resulting in effects no more than **Slight Adverse (Not Significant).**

Decommissioning

10.6.25 At the end of its design life, decommissioning of the Proposed Development Site is anticipated to involve the removal of all above ground equipment down to ground level. It is assumed that all underground infrastructure will remain in-situ; however, all connection and access points will be sealed or grouted to ensure disconnection.

10.6.26 As detailed in Section 10.5, a DEMP would be prepared and implemented that would consider potential environmental risks on the Proposed Development Site and contain guidance on how risks can be removed or mitigated. With the

implementation of the DEMP, it is assumed that decommissioning impacts would be similar to those experienced during construction as discussed above.

10.6.27 As such, with the implementation of the measures as detailed in the DEMP, effects on geology, soils and hydrogeology are anticipated to be no worse than **Slight Adverse (Not Significant).**

10.7 Essential Mitigation and Enhancement Measures

10.7.1 Section 10.6 indicates that with the implementation of the proposed development design and impact avoidance measures (embedded mitigation) as detailed in Section 10.5, significant effects associated with geology, hydrogeology and contaminated land are anticipated to be avoided and thus additional mitigation measures are not anticipated to be required.

Construction

10.7.2 No further measures are considered for the construction phase outside of the Proposed Development Design and Impact Avoidance / Embedded Mitigation.

Operation

10.7.3 No further measures are considered for the Operation Phase outside of the Proposed Development Design and Impact Avoidance / Embedded Mitigation.

Decommissioning

10.7.4 No further measures are considered for the Decommissioning Phase outside of the Proposed Development Design and Impact Avoidance / Embedded Mitigation.

10.8 Residual Effects and Conclusions

10.8.1 The effects of the Proposed Development Site following the implementation of essential mitigation and enhancement measures are known as 'residual effects.' No additional essential mitigation and enhancement measures have been identified outside of the proposed development design and impact avoidance embedded mitigation measures. Therefore, the residual effects are considered the same and range between **Slight Beneficial (Not Significant)** and **Slight Adverse (Not Significant)** for the Proposed Development Site during the construction, operation (including maintenance) and decommissioning phases as presented in Tables 10-15, 10-16 and 10-17 respectively.

10.9 Summary of Residual Effects

10.9.1 There are not considered to be any residual significant effects associated with the construction, operation and decommissioning of the Proposed Development. A summary of the residual effects are presented in Tables 10-13, 10-14 and 10-15 respectively.

Table 10-13: Summary of Residual Effects During Construction

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Geology Sherwood Sandstone Group – Sandstone Mercia Mudstone Group - Mudstone Penarth Group – Mudstone Redcar Mudstone Formation - Mudstone	Sherwood Sandstone Group – Sandstone: **Medium** Mercia Mudstone Group - Mudstone, Penarth Group – Mudstone and Redcar Mudstone Formation – Mudstone: **Low**	**Minor** (From Foundations)	Sherwood Sandstone Group – Sandstone: **Slight Adverse (Not Significant)** Mercia Mudstone Group - Mudstone, Penarth Group – Mudstone and Redcar Mudstone Formation – Mudstone: **Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Geology Mercia Mudstone Group - Mudstone	**Low**	**Minor** (From Directional drilling through mudstones to form crossing below the river Tees. Spoil generated from construction)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Penarth Group – Mudstone Redcar Mudstone Formation -				Mudstone / sandstone will not be reused across the Proposed Development Site due to geotechnical unsuitability (both) and high sulphate content (mudstone) which will erode / degrade reinforced concrete structures. Encountered mudstone / sandstone will be removed from the Proposed Development Site.	
Minerals Deep Resources Salt and Gypsum	**Medium**	**Minor** (from sterilisation of minerals. Non-minerals developments take place on, or close to, mineral deposits and render them incapable of being extracted. Development to take place across an area defined in the Tees Valley Joint Minerals and Waste Development Plan Core Strategy as protected to allow for future Gypsum and Salt extraction)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation). Minerals are at depth and are already primarily covered by existing development. The Proposed Development Site does not preclude the future extraction of these minerals.	**Slight Adverse (Not Significant)**
Minerals Shallow Resources	**Medium**	**Minor** (Safeguarded under the Tees Valley Joint Minerals and Waste Development	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Marine dredge Sand and Gravel		Minerals and Waste Core Strategy DPD)		Minerals are at depth and are already primarily covered by existing development. The Proposed Development Site does not preclude the future extraction of these minerals.	**(Not Significant)**
Soils Agricultural Land Classification	**Low**	**Negligible** (From extraction / removal)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Soils Agricultural Land Classification	**High**	**Not Discernible** (From extraction / removal/physical sealing)	**N/A**	N/A	**N/A**
Soils General	**Medium**	**Minor** (From spoil resulting from excavations and earthworks)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Groundwater (Bedrock Contamination)	**High**	**Minor** (from changes to hydrogeological regime. Potential mobilisation of any existing contamination during construction)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation). Construction of piled foundations or deep excavations resulting in disturbance of the	**Slight Adverse (Not Significant)**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Principal Aquifer Sherwood Sandstone				Sherwood Sandstone are not anticipated over the length of the Hydrogen Pipeline Corridor.	
Groundwater (Bedrock Contamination) Secondary Aquifer – B Mercia Mudstone Group – Mudstone and Penarth Group – Mudstone Secondary Undifferentiated Redcar Mudstone Formation – Mudstone	**Medium**	**Minor** (from changes to hydrogeological regime. Potential mobilisation of any existing contamination during construction)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Groundwater – (Soil Contamination) Secondary Aquifer – A Blown Sand Beach and Tidal Flat Deposits	**Medium**	**Minor** (from potential mobilisation of any existing contamination during construction. New contaminant pathways or mobilisation of existing contaminants may result from exposure of soils/increase in rainwater infiltration through changes in ground cover/in excavations)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse** (Not Significant)
Groundwater – (Soil Contamination) Secondary Aquifer – Undifferentiated Tidal Flat Deposits – Sand and Silt	**Medium**	**Minor** (from potential mobilisation of any existing contamination during construction. New contaminant pathways or mobilisation of existing contaminants may result from exposure of soils/increases in rainwater infiltration through changes	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Tidal Flat Deposits – Sand, Silt and Clay		in ground cover/in excavations)			
Contamination (Soils) Blown Sand Tidal Flat Deposits	**High**	**Minor** (from potential contaminant pathways are reduced or removed by construction of remedial works including clean cover or capping layer as well as through construction of new structures, hardstanding, pavements over existing contaminated soils. Infiltration and pathways are reduced)	**Slight Beneficial (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation). Note DMRB LA104 (National Highways, 2019c), does not include for a magnitude category 'Beneficial' category. However, any remedial works such as placement of clean cover, soil treatment, soil stabilisation, removal of localised 'hotspots' of identified contamination would provide improvement to the existing condition.	**Slight Beneficial (Not Significant)**
Contamination (Soils) Blown Sand Tidal Flat Deposits	**Low**	**Minor** (from potential contaminant pathways are reduced or removed by construction of remedial works including clean cover or capping layer as well as through construction of new	**Slight Beneficial (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation). Note DMRB LA 104 (National Highways, 2019c) does not include for a magnitude category 'Beneficial' category. However, any remedial works	**Slight Beneficial (Not Significant)**

RECEPTOR/ RESOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
- Sand and Silt Tidal Flat Deposits – Sand, Silt and Clay Glaciolacustrine Deposits, Clay and Silt. Glaciofluvial Deposits, Sand and Gravel. Glacial Till, Devensian – Diamicton		structures, hardstanding, pavements over existing contaminated soils. Infiltration and pathways are reduced)		such as placement of clean cover, soil treatment, soil stabilisation, removal of localised 'hotspots' of identified contamination would provide improvement to the existing condition.	

Table 10-14: Summary of Residual Effects During Operation

RECEPTOR/ RECOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Contamination (Soils) Blown Sand Tidal Flat Deposits	**High**	**Minor** (from impacts on soil quality could potentially occur during operation caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Groundwater (Bedrock Contamination) Principal Aquifer Secondary B Aquifers Secondary Undifferentiated	**Medium / High**	**Minor** (Impacts on groundwater and watercourses could potentially occur during operation caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

Table 10-15: Summary of Residual Effects During Decommissioning

RECEPTOR/ RECOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Contamination (Soils)	**Medium**	**Minor** (from excavation of materials/soil removal Demolition workers exposed to historic and current potentially contaminated soil sources on Site)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Contamination (Soils)	**Medium**	**Minor** (from accidental spills. Impacts on soil quality could potentially occur during decommissioning caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**
Groundwater (Bedrock Contamination) Principal Aquifer Secondary A Secondary Undifferentiated	**Medium / High**	**Minor** (from impacts on groundwater and watercourses could potentially occur during decommissioning caused by accidental spills resulting from handling or leakage of fuels, lubricants, stored chemicals and processed liquids)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

RECEPTOR/ RECOURCE	IMPORTANCE AND VALUE/ SENSITIVITY	MAGNITUDE OF IMPACTS	LIKELY SIGNIFICANT EFFECTS	ADDITIONAL MITIGATION / EHANCEMENT MEASURES	RESIDUAL EFFECTS
Soils (General)	**Medium**	**Minor** (from export, excavation, stockpiling, redistribution and / or removal of the Made Ground)	**Slight Adverse (Not Significant)**	No additional mitigation measures required outside of proposed development design and impact avoidance (embedded mitigation).	**Slight Adverse (Not Significant)**

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H2Teesside Project

Environmental Statement

Volume III – Appendices

Appendix 10A: Geology, Hydrogeology and Contaminated Land Desk Based Summary Report

Document Reference: 6.4.11

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(a)

Rev: 0

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TABLES

10A.0 GEOLOGY, HYDROGEOLOGY AND CONTAMINATED LAND DESK BASED SUMMARY REPORT

10A.1 Introduction

10A.1.1 The Proposed Development comprises the construction, operation (including maintenance where relevant) and decommissioning of an approximately 1.2-Gigawatt Thermal (GWth) Lower Heating Value (LHV) Carbon Capture and Storage (CCS) enabled Hydrogen Production Facility (the 'Hydrogen Production Facility') located in Teesside, along with the pipeline infrastructure required to supply hydrogen (H_2) to offtakers (customers) and the necessary utility connections. Carbon captured by the Proposed Development will be transported by pipeline to the separately consented Northern Endurance Partnership (NEP) infrastructure on the adjacent Net Zero Teesside site for high-pressure compression and offshore transport and underground storage.

10A.1.2 The Hydrogen Production Facility at the Main Site will need a Hydrogen Pipeline Corridor to transport the H_2 produced to potential industrial off-takers around Teesside as well as a CO_2 Export Corridor and other Connection Corridors including natural gas, water and electricity.

10A.1.3 The proposed capture technology uses an amine-based solvent to absorb CO_2 produced by the H_2 production process, with an anticipated design carbon capture rate in excess of 95%. This process is also known as 'pre-combustion amine-based absorption regeneration'. The design capture rate will be defined in the Environmental Permit that will be required to operate the Proposed Development. The Hydrogen Production Facility will connect via a short CO_2 export connection to the NEP compression and pipeline infrastructure on the adjacent Net Zero Teesside (NZT) site. Based on current projections, the Proposed Development will have the capacity to continuously export approximately 1.4 megatonnes (Mt) of dehydrated and compressed CO_2 per year per phase or use up to approximately 2.8 Mt/year once both phases are operational (100% utilisation) to NEP for offshore underground storage with no temporary CO_2 storage required on site.

10A.1.4 In summary, the Proposed Development comprises the following elements:

- a low carbon H_2 production plant of up to approximately 1.2 GWth capacity to be developed in two phases, each up to 600 MW;
- Hydrogen Pipeline Corridor to supply H_2 to various offtakers on Teesside and within the surrounding area, such pipelines to be utilised in association with the H_2 production plant;
- an Air Separation Unit (ASU) to supply O_2 for the H_2 production process;
- an supply pipeline (as an alternative to the ASU) to supply O_2 and N_2 for the H_2 production process;
- carbon capture and compression facilities and a connection to the NEP high pressure compression facilities and CO_2 Export Pipeline on the adjacent NZT site;

- a Natural Gas Connection Corridor for the supply of gas to the H_2 production plant;
- an Electrical Connection Corridor to provide power to the Proposed Development;
- Water Connections Corridor to supply water to and from the Proposed Development;
- wastewater treatment and disposal infrastructure; and
- other utilities connections, telecommunications, and other associated and ancillary infrastructure.

Proposed Development Details

10A.1.5 The Proposed Development is shown on Figure 1-1 (Environmental Statement (ES) Volume II, EN070009/APP/6.3). The Proposed Development is separated into a number of different elements and areas as shown on Figures 4-1 to 4-8 (ES Volume II, EN070009/APP/6.3) and as described in the following sections.

10A.1.6 These different elements and areas will be used as the basis of the descriptions provided in this Summary Report.

10A.1.7 The location of the Hydrogen Production Facility at the Main Site is shown on Figure 4-2 (ES Volume II, EN070009/APP/6.3).

10A.1.8 A summary of the process infrastructure of the Hydrogen Production Facility, as well as details of the associated Connection Corridors is presented in Chapter 4: Proposed Development (ES Volume I, EN070009/APP/6.2). This includes details of the components and facilities that have been incorporated into the layout of the Main Site.

10A.1.9 Details of the construction programme of the Proposed Development and its subsequent management are provided in Chapter 5: Construction and Programme Management (ES Volume I, EN070009/APP/6.2).

Objectives of the Report

10A.1.10 The purpose of this Report is to collate baseline geotechnical and geo-environmental information for the Proposed Development, present a summary of that information and identify possible geotechnical and geo-environmental development constraints as supporting information for Chapter 10: Geology, Hydrogeology and Contaminated Land (ES Volume I, EN070009/APP/6.2).

10A.1.11 The primary objectives of this Report are to:

- determine whether potentially contaminative uses have taken place within, or in close proximity to, the Proposed Development Site which could have led to the contamination of underlying soils or groundwater; and
- to understand the effects of the geological conditions and Site activities on the geotechnical properties for Site redevelopment.

10A.1.12 This Report has been prepared in accordance with the technical guidance and procedures described in the UK Government guidance Land Contamination: Risk Management (2021), British Standard (BS) 5930:2015+A1:2020 (as amended) Code of Practice for Site Investigations (BSI, 2020), BS:EN 1997 Eurocode 7 – Geotechnical Design (BSI, 1997) and BS 10175:2011+A2:2017 (as amended) Investigation of Potentially Contaminated Sites – Code of Practice (BSI, 2017), to:

- describe the geology, hydrology and shallow mining potential;
- describe the environmental setting / sensitivity and current / historical land use of the Proposed Development Site;
- describe the findings of site reconnaissance visits undertaken in available areas of the Proposed Development Site;
- summarise the history of the Proposed Development Site;
- summarise the underlying geology and hydrogeology;
- summarise the findings of any historical ground investigation work; and
- provide the necessary information to inform the Appendix 10B Contaminated Land – Conceptual Site Model (CSM), Appendix 10C Contaminated Land – Environmental Risk Assessment and Appendix 10D Geotechnical Risk Register (ES Volume III, EN070009/APP/6.4) for the prevailing ground conditions.

Limitations and Exceptions to the Report

10A.1.13 Any risks identified in this Report are perceived risks, based on the information reviewed during the Report and therefore partially based on conjecture from available information. The Report is limited by the non-intrusive nature of the work and actual risks can only be assessed following a physical investigation of the Proposed Development Site.

10A.1.14 The opinions expressed in this Report and the comments given are based on a desk assessment of readily available information. Intrusive investigations will be undertaken at the Proposed Development Site to confirm actual ground and groundwater conditions and to provide data for an assessment of the geotechnical and geo-environmental status of the Proposed Development Site.

10A.1.15 Reference to historical Ordnance Survey (OS) maps and / or data provides invaluable information regarding the land use history of a site. However, it should be noted that historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps and / or data. Selected features from data supplied by Groundsure have been presented on constraints maps (Figures 10-1a to 10-23) (ES Volume II, EN070009/APP/6.3), however as these do not capture every feature, reference should be made to the original historical mapping supplied in the Groundsure Reports for detailed design.

Sources of Information

10A.1.16 Sources of information have been obtained as part of this study are summarised in Table 10A-1.

Table 10A-1: Sources of Information.

SOURCE	TYPE OF INFORMATION
British Geological Survey (BGS)	1:50,000 scale BGS online Onshore GeoIndex (undated)
BGS	1:50,000 scale BGS Geological Map Sheet 33, Solid and Drift Edition – Stockton (1987). 1:50,000 scale BGS Geological Map Sheet 34, Solid and Drift Edition – Guisborough (1998).
BGS	1:10,000 BGS Geological Map Sheet NZ42SE (1984). 1:10,000 BGS Geological Map Sheet NZ42NE (1997). 1:10,000 BGS Geological Map Sheet NZ52NE (2006). 1:10,000 BGS Geological Map Sheet NZ52NW (1995). 1:10,000 BGS Geological Map Sheet NZ52SW (1984). 1;10,560 County Series Geological Map, Yorkshire, Sheet 7 FS (1881).
BGS	Triassic Sandstones of the Vale of York, Baseline Series Report, Report CR/02/102N, 2002.
BGS	Geological Memoir: Frost, DV (1998). Geology of the country around Northallerton. Memoir of the British Geological Survey, Sheet 42 (England and Wales). Mineral Resources: Highley, DE, Lawrence, DJD, Young, B, Harrison, DJ, Cameron, DG, Holloway, S, Lott, GK and Bloodworth, AJ (2000). Mineral Resource Information for Development Plans: Phase One County Durham and the Tees Valley: Resources and Constraints (Co Durham, Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland, and Stockton-on-Tees): Resources and Constraints. British Geological Survey Technical Report WF/00/6 ISBN 0 85272 368 7.
BGS	BGS Boreholes BGS 1:50,000 Digital Mapping Web Mapping Service Streamed into ArcGIS
Coal Authority	The Coal Authority Interactive Map Viewer
Environment Agency	The Environment Agency Catchment Data Explorer “Protect Groundwater and Prevent Groundwater Pollution,” March 2017.
Department of Environment	Industry Profiles, “CL:AIRE,”. “Nitrate Vulnerable Zones,” September 2021.

SOURCE	TYPE OF INFORMATION
Groundsure / Envirocheck (Annex A)	Envirocheck – 284970768_1_1 – 21/09/2021 (Main Site) Envirocheck – 233803971_1_1 – 10/02/2020 (Main Site and All Connection Corridors) GISP-2022-13154-11993 – 05/12/2022 (Hydrogen Pipeline Corridor) GSIP-2023-13293-12624_A_1 to G_1 – 06/12/2022 (Hydrogen Pipeline Corridor) GS-9167762 – 01/11/2022 (Main Site and All Connection Corridors) GS-9167693 – 01/11/2022 (Hydrogen Pipeline Corridor) GS-9167761 – 01/11/2022 (Main Site)GS-9167761 – 01/11/2022 (Hydrogen Pipeline Corridor) GS-9167787 – 01/11/2022 (Hydrogen Pipeline Corridor and Electrical Connection Corridor) GS-9167692 – 01/11/2022 (Hydrogen Pipeline Corridor) GS-9167765 – 01/11/2022 (Hydrogen Pipeline Corridor) GS-9167694 – 01/11/2022 (Main Site and All Connection Corridors) GS-9366848 – 20/02/2023 (The Main Site and Hydrogen Pipeline Corridor) GS-9167696 01/11/2022 (Hydrogen Pipeline Corridor) Groundsure Associated GIS Mapping
Historic England	“Aerial Photo Explorer,” 12 November 2015.
Landis	Cranfield Soil and Agrifood Institute Soilscapes.
Natural England	Natural England Agricultural Land Classification. “Agricultural Land Classification (ACL) Grades – Post 1988 Survey (Polygons)” December 2021. “Special Protection Areas (England)” March 2022. “Ramsar (England)” December 2021.
Department for Environment, Food and Rural Affairs (Defra)	DEFRA’s MAGIC Map Application.
Open Street Map	“Britain From Above” 1924.
Ordnance Survey	“Old Maps Online” 1893.
Previous Desk Study Reports	CH2M (2017), SSI1 Redcar Works – Phase 1 Geo-Environmental Desk Study, Report Reference: 678079_SSI1_001 . CH2M (2017), SSI2 Redcar Works – Phase 1 Geo-Environmental Desk Study, Report Reference: 678079_SSI2_001 Arcadis (2015) Phase 1 Environmental Assessment, Land West of Warrenby, Teesworks

SOURCE	TYPE OF INFORMATION
	Arcadis (2022) Land West of Warrenby, Teesworks, Redcar, South Tees Development Corporation, REPORT NO. 10035117-AUK-XX-XX-RP-ZZ-0417-05-Rem_Strat_LwoW Arcadis (2022) Land West of Warrenby, Teesworks, Redcar, Site Condition Report, Generic Quantitative Risk Assessment and Detailed Quantitative Risk Assessment, South Tees Development Corporation, REPORT NO: 10035117-AUK-XX-XX-RP-ZZ-0428-03-LwoW_DQRA Arcadis (2018), Site Condition Report, Report No. Redcar Steelworks-AUK-XX-XX-RP-GE-0001-02-SSI1_SSI2A_GI_SCR. Arcadis (2018), Geotechnical Risk Assessment Report, Report No. Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI1_SSI2A_GI_GRA Arcadis (2018), Ground Remediation Options Appraisal Report, Report No. Redcar Steelworks-AUK-XX-XX-RP-GE-0001-02-SSI1_SSI2A_GI_ROA.
Previous Ground Investigation Factual Reports	Allied Exploration & Geotechnics Limited, "Ground Investigation Contract, Reference – Priority Areas within SSI Landholdings Contract 1 and Contract 2 (Area A): 4153 & 4154," 2018. Allied Exploration and Geotechnics ltd, "(2018a). Former SSI Steelworks Redcar – Advance Boreholes in SSI1, Areas C & D, Final Factual Report" 2018. CH2M, SSI Redcar – SSSI, Factual Report – Initial Trial Pitting, South Tees Site Company, November 2017 CH2M, SSI Redcar – SSSI, Factual Report – Initial Trial Pitting, South Tees Site Company, November 2017
Previous GI Interpretative Reports	CH2M, Former SSI Steelworks, Redcar – Initial Ground Investigation Works – Geoenvironmental Summary, South Tees Site Company Ltd. May, 2018.
Zetica	Unexploded Ordnance (UXO) Risk Maps.

Field Studies

Site Walkover

10A.1.17 A site walkover of the Main Site was undertaken on the 17 November 2022. The details of the findings of the walkover is presented in Annex B.

Geomorphological / Geological Mapping

10A.1.18 No development specific mapping undertaken. Outside of scope of works.

Probing, Pitting and Testing

10A.1.19 None reviewed or undertaken for this report. Outside of scope of works.

Drainage / Hydrogeological Mapping

10A.1.20 None reviewed or undertaken. Outside of scope of works.

Geophysical Surveys

10A.1.21 None reviewed or undertaken. Outside of scope of works.

Previous Assessments / Ground Investigations

10A.1.22 A summary of the previous assessments and ground investigations associated with the Proposed Development are presented in Annex C.

10A.2 Baseline Conditions

10A.2.1 This section describes the baseline conditions at the Proposed Development Site. The study area is as follows:

- Topography – Proposed Development Site Boundary
- Geology and Soils – Proposed Development Site Boundary and within 250m
- Landfills – Proposed Development Site Boundary and within 250m
- Natural Ground Hazards – Proposed Development Site Boundary and within 500m
- Hydrology – Proposed Development Site Boundary and within 1 km
- Hydrogeology – Proposed Development Site Boundary and within 1 km
- Historical Development – Proposed Development Site Boundary and within 500m
- Land Use – Proposed Development Site Boundary and within 250m
- Current Industrial Land Use – Proposed Development Site Boundary and within 250m
- Regulatory Information – Proposed Development Site Boundary and within 250m
- Sensitive Land Use – Proposed Development Site Boundary and within 1 km
- Radon – Proposed Development Site
- UXO – Proposed Development Site

Site Description

Main Site

10A.2.2 The location of the Hydrogen Production Facility at the Main Site is shown on Figure 1-1 (ES Volume II, EN070009/APP/6.3).

10A.2.3 The Main Site covers approximately 86 hectares (ha). The elevation varies between approximately 5 m and 7 m above ordnance datum (AOD). A number of raised areas are observed at approximately 11 m AOD, notably in the central area of the Main Site. Variations in elevation can be attributed to roads and railway lines sitting at a

slightly higher elevation compared to the rest of the Main Site. The Main Site is located on approximate grid reference 456208E, 525535N.

10A.2.4 The Main Site comprises remaining industrial infrastructure associated with the historical use of the site as Redcar Steelworks. A site walkover was undertaken on the 17 November 2022, a summary of the findings is presented in Annex B. The South Tees Development Corporation (STDC) site is undergoing a phase of demolition.

10A.2.5 The relevant features immediately surrounding the Main Site are summarised in Table 10A-2.

Table 10A-2: Features Surrounding the Main Site.

DIRECTION	SUMMARY
North	The Main Site is bound immediately by an unnamed road, with Teesmouth and Cleveland Coast, a Site of Specific Scientific Interest (SSSI), beyond. The coastline to the North Sea is approximately 600 m north at its closest.
South	The Main Site is bound immediately by other land formerly part of Redcar Steelworks, which is owned by South Tees Development Corporation (STDC) and is now derelict and undergoing demolition and remediation. There is a plot of reclaimed land approximately 280 m south and Northumbrian Water Facility 420 m south-east. Dabholm Cut, which discharges to the River Tees is situated 775 m south of Main Site.
East	The Main Site is immediately bound by other land formerly part of Redcar Steelworks, which is owned by South Tees Development Corporation (STDC) and is now derelict and undergoing demolition and remediation. There is a 66KV substation approximately 400 m east and several unnamed roads associated with the South Tees Development Corporation (STDC) site. The Applicant is aware that this is the site of the future Net Zero Teesside facility.
West	The Main Site is bounded immediately to the north-west by land formerly part of Redcar Steelworks, which is now derelict industrial land owned by South Tees Development Corporation (STDC). Red Car Bulk Terminal and associated bulk material storage area is situated immediately west of this. Bran Sands Lagoon is situated approximately 380 m south-west of the Main Site. Beyond this is the River Tees (approximately 800 m west).

CO_2 Export Corridor

10A.1.1 The CO_2 Export Corridor is located within the wider South Tees Development Corporation (STDC) site, off Trunk Road, Redcar, TS10 5QW. The Corridor section is centred on approximate grid reference 456945E, 5252905N.

10A.1.2 The location of the CO_2 Export Corridor is shown on Figure 4-3 (ES Volume II, EN070009/APP/6.3).

10A.2.6 The CO_2 Export Corridor is located within the wider South Tees Development Corporation (STDC) site to the east of the Main Site. The CO_2 Export Corridor is intersected by various roads running north to south and east to west, with a historical railway track likely to be present in the south. Previous infrastructure associated with the historical use of the site, as an iron and steel works, may still be present including conveyors. The South Tees Development Corporation (STDC) site is undergoing a phase of demolition.

10A.2.7 The relevant features immediately surrounding the CO_2 Export Corridor are summarised in Table 10A-3.

Table 10A-3: Features Surrounding the CO_2 Export Corridor

DIRECTION	SUMMARY
North	The CO_2 Export Corridor is bound immediately by South Gare road, with Teesmouth and Cleveland Coast, a SSSI, beyond. The coastline to the North Sea is approximately 600 m north at its closest. The western portion of the CO_2 Export Corridor is bound by the Main Site to the north-west.
South	The CO_2 Export Corridor is bound immediately by other land formerly part of Redcar Steelworks, which is owned by South Tees Development Corporation (STDC) and is now derelict and undergoing demolition and remediation. There is a plot of reclaimed land approximately 280m south and Northumbrian Water Facility 420 m south-east know as Dabholm Gut, which discharges to the River Tees.
East	The east of the CO_2 Export Corridor comprises a road network, open industrial land and Warrenby.
West	The CO_2 Export Corridor is bounded immediately to the west by Main Site, which is undergoing demolition and remediation, beyond which land formerly part of Redcar Iron and Steelworks. The River Tees is approximately 1.8 km west.

Natural Gas Connection Corridor

10A.2.8 The Natural Gas Connection Corridor is located within the wider South Tees Development Corporation (STDC) Site, off Trunk Road, Redcar, TS10 5QW. The Natural Gas Connection Corridor crosses over the boundary of Main Site along its southern boundary and to the south of the NZT site area. The Natural Gas Connection Corridor is centred on approximate grid reference 456930E, 524698N.

10A.2.9 The Natural Gas Connection Corridor is intersected by various roads running north to south and east to west. A historical railway track is likely present along the southern boundary. Previous infrastructure associated with the historical use of the site as a steelworks may still be present including conveyors. However, it is understood that the South Tees Development Corporation (STDC) site is undergoing a phase of demolition and so it is likely that some of these features are no longer present. Bran Sands Landfill encroaches on the western boundary towards the

south of the Natural Gas Connection Corridor and continues off-site towards the west.

10A.2.10 The relevant features immediately surrounding the Natural Gas Connection Corridor are summarised in Table 10A-4.

Table 10A-4: Features Surrounding the Natural Gas Connection Corridor

DIRECTION	SUMMARY
North	The Main Site and the NZT site is located to the north of the Natural Gas Connection Corridor, beyond which other land formerly part of Redcar Steelworks and Teesmouth and Cleveland Coast SSSI.
South	Immediately to the south of the Natural Gas Connection Corridor is a disused railway track likely to be present and a vacant area of land associated with the former site use. Beyond this is the Bran Sands Effluent Treatment Works.
East	Immediately to the east of the Natural Gas Connection Corridor is an access road leading to the wider South Tees Development Corporation (STDC) site and a possible pipe network, beyond which is a vacant area of land and a the Teesmouth and Cleveland Coast SSSI.
West	Immediately adjacent to the western boundary of the Natural Gas Connection Corridor is the Main Site is other land formerly part of Redcar Steelworks.

Water Connection Corridor

10A.2.11 The north of the Water Connection Corridor is located within the wider South Tees Development Corporation (STDC) site, off Trunk Road, Redcar, TS10 5QW. The Water Connection Corridor crosses over the boundary of the Main Site in the south-eastern corner. The Water Connection Corridor is centred on approximate grid reference 456992E, 525304N. The location and layout of the Water Connection Corridor is presented on Figure 4-7 (ES Volume II, EN070009/APP/6.3).

10A.2.12 The Water Connection Corridor extends into the wider South Tees Development Corporation (STDC) site in the north and comprises the southern and south-eastern extent of the Main Site. Infrastructure including conveyors and tanks are expected to be present within this area. Moving south, the Water Connection Corridor encompasses a thin strip of land parallel to the eastern boundary of the planned Net Zero Teesside Facility. The Water Connection Corridor extends towards the south-east through the Coatham Marsh site approximately 295 m north-east of Steel House buildings. The Water Connection Corridor is intersected by various roads, railway tracks and pipelines including pipe gantries. Infrastructure associated with historical site uses may be present including various works, pylons, electricity sub stations, tanks and travelling cranes.

10A.2.13 The relevant features immediately surrounding the Water Connection Corridor are summarised in Table 10A-5.

Table 10A-5: Features Surrounding the Water Connection Corridor

DIRECTION	SUMMARY
North	The Water Connection Corridor is bound immediately by the Main Site in the western half and Teesmouth and Cleveland Coast, a SSSI in the eastern half and the coastline of the North Sea beyond. Vacant marshland is located adjacent to the north-east boundary of the Water Connection Corridor. Commercial and industrial properties are located approximately 315 m north-east.
South	The southern extent of the Water Connection Corridor is bounded by the former Redcar Steelworks / Redcar Bulk Terminal and the remainder of the Coatham Marsh site. Industrial buildings associated with British Steel Lackenby is located approximately 1 km south from the central extent of the Water Connection Corridor. Commercial and industrial properties are located approximately 1 km south. Residential properties within Dormanstown are located between approximately 275 m south-east and 770 m south-east, beyond which the land use comprises undeveloped agricultural fields. The Northumbrian Water Facility (sewage works) are located approximately 280 m south from the Water Connection Corridor. Dabholm Gut is present approximately 800 m south.
East	The Water Connection Corridor is bounded immediately by vacant marshland associated with Coatham Marsh in the north-east. Residential properties associated with Dormanstown are located approximately 300 m from the eastern boundary of the Water Connection Corridor.
West	The Water Connection Corridor is bounded immediately by the Main Site, the former Redcar Steelworks, now derelict industrial land which is owned by South Tees Development Corporation (STDC) beyond which is the River Tees (approximately 1.1 km west). Redcar Bulk Terminal and associated bulk material storage area is situated approximately 200 m west from the Water Connection Corridor.

Electrical Connection Corridor

10A.2.14 The Electrical Connection Corridor is centred on approximate grid reference 457085E 523464N. The north and north-western section of the Electrical Connection Corridor is located within the wider South Tees Development Corporation (STDC) Site, off Trunk Road, Redcar, TS10 5QW. The western section of the Electrical Connection Corridor crosses the southern boundary of the Main Site. The Electrical Connection Corridor extends in an easterly direction to encompass land between South Tees Development Corporation (STDC) Steel House Gate and Trunk Road south to the A1053.

10A.2.15 The land required for the Electrical Connection Corridor is shown on Figure 4-6: (ES Volume II, EN070009/APP/6.3).

10A.2.16 The Electrical Connection Corridor extends from the south of the NZT site, and moving south, includes the area to the east of Northumbrian Water and to the west of Trunk Road, to include the South Tees Development Corporation (STDC) Steel House Gate, with various unnamed roads intersecting the area and a railway track which runs north-east to south-west. Bran Sands Landfill encroaches on the western boundary towards the south of the Electrical Connection Corridor and continues off-site towards the west.

10A.2.17 The relevant features immediately surrounding the Electrical Connection Corridor are summarised in Table 10A-6.

Table 10A-6: Features Surrounding the Electrical Connection Corridor

DIRECTION	SUMMARY
North	Immediately bounding the north of the Electrical Connection Corridor is the Main Site and Teesmouth and Cleveland Coast SSSI. The coastline to the North Sea is located approximately 445 m north.
South	A series of pipelines orientated east to west are located immediately to the south of the Electrical Connection Corridor is Greystone Road, Broadway Trunk Road and the A66. A vacant parcel of land within the British Steel Lackenby site is located approximately 180 m south. Trunk Road is located approximately 150 m south-east, beyond which the land use comprises industrial and commercial properties within Wilton Works approximately 645 m south-east.
East	To the north-east is the Teesmouth and Cleveland Coast SSSI. The area to the east comprises vacant industrial land and Coatham Marsh. Steelhouse is located approximately 340 m east, beyond which the land use comprises of Dormanstown Industrial Estate approximately 440 m east. Residential properties within Dormanstown are located approximately 580 m east.
West	To the west on the eastern extent of the Electrical Connection Corridor is Redcar Bulk Terminal. The southern extent of the Electrical Connection Corridor is immediately bound to the west by the Northumbrian Water Effluent Treatment Works and Dabholm Gut. Bran Sands Lagoon is located approximately 1.3 km west. The River Tees is located approximately 1 km west.

Hydrogen Pipeline Corridor

10A.2.18 The Corridor crosses the River Tees at the Dabholm Gut area. For the purposes of this report, the Pipeline Corridor is referred to in two sections, the section to the north of the River Tees and the section to the south of the River Tees.

10A.2.19 The land take required for the Hydrogen Pipeline Corridor is presented on Figure 4-4: Hydrogen Pipeline Corridor (ES Volume II, EN070009/APP/6.3).

10A.2.20 To the south of the River Tees, the Corridor extends from the south of the Main Site, along the southern boundary of the NZT site and the area to the south that surrounds including the eastern boundary of the Bran Sands Landfill which extends off-site towards the west. The Corridor diverts to the west along Damholm Gut to the south of the Northumbrian Water Sewage Treatment Works and towards the River Tees. The Corridor runs to the south-east around the industrial and commercial works of the Wilton Works site.

10A.2.21 To the north of the River Tees, the Corridor follows from the River Tees inland to the west through a vacant parcel of land and along existing pipelines within the Seal Sands industrial estate. There are two spurs where the corridor runs northwards to the east of Seaton Carew Rd and Tees Road comprising open fields, roads, Greatham Creek, towards industrial infrastructure within the Venator site. The Corridor diverts through open fields to the west to the A1185 roads leading to Cowpen Bewley Woodland Park. The Corridor continues to the south-east along existing pipelines within an area of industrial development within Haverton Hill.

10A.2.22 Due to the size of the Hydrogen Pipeline Corridor, the features surrounding the Corridor has been divided into two tables, with Table 10A 7relating to the area to the north of the River Tees and the area to the south of the River, noted in Table 10A 8.

Table 10A-7: Features Surrounding the Hydrogen Pipeline Corridor, North of the River Tees

DIRECTION	SUMMARY
North	To the north of the Corridor on the Northern side of the River Tees is the following: - Seal Sands industrial estate (directly) - Holding lagoons (directly) - Teesmouth National Nature Reserve (125 m NE) and Teesmouth and Cleveland Coast RAMSAR site (700 m N) - Industrial works of Billingham industrial area (directly) - Open fields, shrubland, woodland (directly) - Cowpen Bewley Woodland Park (directly)
South	To the south of the Corridor on the Northern side of the River Tees is the following: - Seal Sands industrial estate (directly) - Teesmouth and Cleveland Coast RAMSAR site (directly) - Industrial works of Billingham industrial area (directly) - Open fields, shrubland, woodland (directly)
East	To the east of the Corridor on the Northern side of the River Tees is the following: - Seal Sands industrial estate (directly) - Teesmouth National Nature Reserve (85 m E) and Teesmouth and Cleveland Coast RAMSAR site (Directly)

DIRECTION	SUMMARY
	- Industrial works of Billingham industrial area (directly) - Open fields, shrubland, woodland (directly) - Cowpen Bewley Woodland Park (directly) - Various railway lines and pipeline bound the east of the Corridor.
West	To the east of the Corridor on the Northern side of the River Tees is the following: - Seal Sands industrial estate (directly) - Teesmouth and Cleveland Coast RAMSAR site (Directly) - Industrial works of Billingham industrial area (directly) - Open fields, shrubland, woodland (directly) - Cowpen Bewley Woodland Park (directly) Various railway lines and pipeline bound the east of the Corridor. Adjacent to the River Tees, the Corridor encompasses areas of the Seal Sands industrial estate. The Corridor is understood to entirely bound SSSI and RAMSAR sites associated with the Teesmouth and Cleveland Coast within the east and centre. To the west the Corridor encompasses various areas of agricultural land, Saltholme Brine Reservoirs, and a landfill (Cowpen Bewley Landfill Site).

Table 10A-8: Features Surrounding the Hydrogen Pipeline Corridor, South of the River Tees

DIRECTION	SUMMARY
North	The north of the Corridor is bounded by the Main Site and the former Redcar Iron and Steelworks, beyond which is Teesmouth and Cleveland Coast (SSSI). Directly adjacent to the northern boundary is infrastructure associated with the former steelworks such as conveyors (above ground and below ground) and various access roads.
South	The British Steel Lackenby site is present adjacent to the south of the central extent of the Corridor. To the south-east is the industrial area within the Wilton Works site area with various associated infrastructure present including cooling towers, tanks, pipelines and various warehouse units. The area to the south of Dabholm Gut comprises industrial port infrastructure and depots.
East	Agricultural fields and residential properties within Dormanstown are located to the east of the Corridor. An industrial estate is also located approximately 260 m NE.
West	To the north-east, the Corridor entirely circles the Bran Sands Landfill and various ports and container terminals. The British Steel Lackenby site is located to the west and south-west of the Corridor. Bran Sands Landfill continues off-site towards the west.

Other Gases Connection Corridor

10A.2.23 The Other Gases Connection Corridor is centred on grid reference 457068N 524481N. The north and north-western section of the Other Gases Connection Corridor is located within the wider South Tees Development Corporation (STDC) Site, off Trunk Road, Redcar, TS10 5QW. The southern section of the Other Gases Connection Corridor follows to the south adjacent to the east of the British Steel Lackenby Site.

10A.2.24 The Other Gases Connection Corridor extends from the south of the Main Site and is intersected by an unnamed road to the east. Infrastructure associated with the previous site use may be present within the boundary including conveyors, pipe gantries and tanks. The Other Gases Connection Corridor moves south adjacent to the Northumbrian Water site and the South Tees Development Corporation (STDC) Steel Gate House, along a railway track, which terminates along an unnamed road. Bran Sands Landfill encroaches on the western boundary towards the south of the Other Gases Connection Corridor and continues off-site towards the west.

10A.2.25 The relevant features immediately surrounding the Other Gases Connection Corridor are summarised in Table 10A-9.

Table 10A-9: Features Surrounding the Other Gases Connection Corridor

DIRECTION	SUMMARY
North	To the north-west moving north-east is the Main Site, NZT site and part of the former Redcar Steelworks, beyond which is Teesmouth and Cleveland Coast SSSI approximately 1 km north. Directly adjacent to the northern boundary is infrastructure associated with the former steelworks such as conveyors (above ground and below ground) and various access roads.
South	Access roads and railway lines are located to the south of the Other Gases Connection Corridor. The British Steel Lackenby site is located approximately 200 m south.
East	In the northern extent of the Other Gases Connection Corridor, the land use to the east comprises vacant industrial land, railway lines, access roads and Coatham Marsh. South Tees Development Corporation (STDC) Gatehouse is located approximately 565 m east. The British Steel Lackenby site is located approximately 190 m south-east.
West	To the west of the Other Gases Connection Corridor is the Northumbrian Water site and beyond which is Dabholm Gut and Bran Sands Lagoon. Works are located immediately south-west from the Other Gases Connection Corridor. South-west of the Other Gases Connection Corridor are various commercial warehouses between 590 m and 1.5 km west and docks approximately 1.8 km west.

Topography

10A.2.26 A summary of the topography at the Main Site and associated corridors is presented in Table 10A-10.

Table 10A-10: Summary of Topography

SITE	TOPOGRAPHY SUMMARY
Main Site	The overall topography is varied across the site but typically sits between approximately 5 – 8 m AOD. Several areas such as the roads and railway lines sit at a slightly higher elevation compared to the rest of the site due to embankments. Most notably a raised area in the north-eastern area of the site sits at approximately 10 m AOD.
CO_2 Export Corridor	Ground levels across the wider site generally slope from the south to the north, towards the North Sea Coastline, generally between 6 – 10 m AOD with only minor changes in topography.
Natural Gas Connection Corridor	The topography is the Corridor is generally flat between 6 – 7 m AOD along the north-western extent and 5 – 8 m AOD along the southern extent. Slightly higher elevations between 7 – 10 m AOD are located along the northern extent of the Corridor.
Water Connection Corridor	The Corridor has a varied topography, with a general overall decline to the north, towards the North Sea. Most variations in topography come from roads, railways and buildings which are present across the Corridor, causing the elevation to be higher in some places. In the areas of existing pipeline corridors, a drop in elevation is observed (approximately 4 m AOD). The typical elevation across the site is between 4 and 11 m AOD, with 6 – 10 m AOD in the north and west and 5 - 11 m AOD in the eastern area.
Electrical Connection Corridor	The topography is varied across the entirety of the Corridor but typically follows the general trend of declining from south to north, with an overall range across the site between approximately 4 and 12 m AOD. In the south-east, the topography is typically higher between 8 – 12 m AOD in the surrounding area to railway lines and the existing Tod Point Sub Station. The topography is noted to be varied in the north and west between 5 – 10 m AOD, and generally the lowest in the north-east area between 5 – 7 m AOD.
Hydrogen Pipeline Corridor	The Corridor follows a general trend of falling in elevation towards the River Tees and Teesmouth. To the south of the River Tees, the topography varies between 1 m AOD parallel to Dabholm Cut and up to 18 m AOD towards the south within the Wilton site. To the north of the River Tees, the topography varies between 0 m AOD adjacent to Seal Sands and up to 17 m AOD in the south adjacent to Billingham. The topography generally increases towards to the south. In the areas where the Corridor crosses over the River Tees, the topography is likely to change based on the tidal regime, with neap tides

SITE	TOPOGRAPHY SUMMARY
	from -0.85 m to +1.45 m AOD and spring tides between -1.95 and +2.70 m AOD.
Other Gases Connection Corridor	The topography along the north-western extent is mostly between 6 – 7 m AOD, although the elevation in the north-east corner is approximately 10 m AOD. Along the southern extent, the topography varies between 4 – 8 m AOD.

Geology and Soils

Introduction

10A.2.27 The geology beneath the Proposed Development Site is shown on BGS 1:50,000 Sheet 33 Stockton (1987) and Sheet 34 Guisborough (1998), 1:10,000 BGS Geological Map Sheet NZ42SE (1984), 1:10,000 BGS Geological Map Sheet NZ42NE (1997), 1:10,000 BGS Geological Map Sheet NZ52NE (1995), 1:10,000 BGS Geological Map Sheet NZ52NW (1995), 1:10,000 BGS Geological Map Sheet NZ52SW (1984) and 1;10,560 County Series Geological Map, Yorkshire, Sheet 7 FS (1881) and extracts of the BGS 1:50,000 mapping obtained as part of the Groundsure GIS Mapping.

10A.2.28 BGS 1:50,000 scale mapping reproduced from the Groundsure Reports (Annex A) and associated GIS Mapping is presented on Figures 10-1a to 10-1g to 10-3a to 10-3g (ES Volume II, EN070009/APP/6.3).

10A.2.29 Artificial Ground (Made Ground), superficial geology (recent and drift soils) and bedrock geology mapped across individual work areas of the Proposed Development Site is summarised in Table 10A-11.

10A.2.30 Table 10A-11 is based on GIS data layers of 1:50,000 digital BGS mapping obtained as part of the Groundsure Reports (Annex A) and associated GIS Mapping.

Table 10A-11: Geology

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
Main Site	Present – most of the Main Site, apart from the northeastern corner.	Tidal Flat Deposits: BGS geological mapping anticipates that the Tidal Flat Deposits underlies the entirety of the Main Site. The BGS has provided two different layer types for these deposits; Sand and Silt and Sand, Silt and Clay, respectively, depending on which 1:50,000 geological map sheet covers the area of interest. Across land covered by the Stockton sheet (Sheet 33) (BGS, 1987), the deposits are indicated to comprise Sand, Silt and Clay whilst further east on the Guisborough sheet (Sheet 34) (BGS, 1998) they are reported to comprise of Sand and Silt. Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Redcar Mudstone Formation (Lower Lais): The south-east corner is anticipated to be underlain by the Redcar Mudstone Formation. Penarth Group (Rhaetic): A thin strip of land through the centre of the Main Site, and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The north-west extent and the Penarth Group are anticipated to be underlain by the Mercia Mudstone Group.
CO_2 Export Corridor	Present – most of the CO_2 Export Corridor, apart from northwestern corner	Blown Sand: The northeast corner is underlain by Blown Sand Deposits. Tidal Flat Deposits: The remainder of the CO_2 Export Corridor, and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits.	Redcar Mudstone Formation (Lower Lais): The Redcar Mudstone Formation is anticipated to underlie most of the CO_2 Export Corridor, apart from a small parcel of land in the north-west and south-west corner. Penarth Group (Rhaetic): The northwest corner and far south-west corner and the Redcar

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The Mercia Mudstone Group is anticipated to underlie the Penarth Group.
Natural Gas Connection Corridor	Present – most of the Natural Gas Connection Corridor, apart from a small parcel of land to the north.	Blown Sand: The north extent is anticipated to be underlain by Blown Sands. Tidal Flat Deposits: The remainder of the Natural Gas Connection Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Redcar Mudstone Formation (Lower Lais): The Redcar Mudstone Formation is anticipated to underlie most of the Natural Gas Connection Corridor, apart from a small parcel of land in the far west. Penarth Group (Rhaetic): The west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The Mercia Mudstone Group is anticipated to underlie the Penarth Group.
Water Connection Corridor	Present – western extent of the Water Connection Corridor.	Blown Sand: The central area of the Water Connection Corridor is anticipated to be underlain by Blown Sands. Tidal Flat Deposits: The remainder of the Water Connection Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits.	Redcar Mudstone Formation (Lower Lais): The Redcar Mudstone Formation is anticipated to underlie most of the Water Connection Corridor, apart from a small parcel of land in the north-west and south-west corner. Penarth Group (Rhaetic): The north-west corner, south-west corner and the Redcar

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The Mercia Mudstone Group is anticipated to underlie a small parcel of land in the north-west corner and the Penarth Group.
Electrical Connection Corridor	Present – most of the Electrical Connection Corridor, apart from small parcels of land in the north-west and along eastern boundary.	Blown Sand: It is anticipated that a thin strip of land along the eastern boundary will be underlain by Blown Sand Deposits. Tidal Flat Deposits: The remainder of the Electrical Connection Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Redcar Mudstone Formation (Lower Lais): The Redcar Mudstone Formation is anticipated to underlie most of the Electrical Connection Corridor, apart from a small parcel of land in the north-west and far south-west corner. Penarth Group (Rhaetic): The north-west corner, south-west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The Mercia Mudstone Group is anticipated to a small parcel of land in the north-west corner and underlie the Penarth Group.
Hydrogen Pipeline Corridor	Present – central and western extent east of the River Tees and eastern	Blown Sand: It is anticipated that a thin strip of land in the north-eastern extent of the Hydrogen Pipeline Corridor to the east of the River Tees will be underlain by Blown Sand.	Redcar Mudstone Formation (Lower Lais): The eastern and south-eastern extent (east of the River Tees) is underlain by the Redcar Mudstone Formation.

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
	extent and localised areas west of the River Tees	Peat: A small area of Peat encroaches on the central extent of the Hydrogen Pipeline Corridor (west of the River Tees). Alluvium: Alluvium Deposits are anticipated to underlie the far north-western extent of the Hydrogen Pipeline Corridor (west of the River Tees). Tidal Flat Deposits: The Blown Sand Deposits, Peat Deposits, the north-eastern extent (east of the River Tees) and central extent (west of the River Tees) as well as small parcels of land in the far western extent are anticipated to be underlain by Tidal Flat Deposits. Glaciolacustrine Deposits: The south-eastern extent (east of the River Tees) and south-western extent (west of the River Tees), and the Tidal Flat Deposits are anticipated to be underlain by Glaciolacustrine Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): The far south-western extent (east of the River Tees) and the Glaciolacustrine Deposits are anticipated to be underlain by Glacial Till Deposits.	Penarth Group (Rhaetic): The western and south-western extent (east of the River Tees) and the Redcar Mudstone Formation is underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The far western and south-western extent (east of the River Tees), the eastern area (west of the River Tees) and the Penarth Group are anticipated to be underlain by the Mercia Mudstone Group. Sherwood Sandstone Group (Keuper Marl, New Red Sandstone Supergroup): The western extent (west of the River Tees) and the Mercia Mudstone Group are anticipated to be underlain by the Sherwood Sandstone Group.
Other Gases Connection Corridor	Present – most of the Other Gases Connection Corridor, apart from a small parcel of land in the north-east corner.	Blown Sand: It is anticipated that Blown Sand will underlie a small parcel of land in the north-east corner of the Other Gases Connection Corridor.	Redcar Mudstone Formation (Lower Lais): The Redcar Mudstone Formation is anticipated to underlie most of the Other Gases Connection Corridor, apart from a small parcel of land in the north-west corner.

SITE	ARTIFICIAL GEOLOGY (MADE GROUND)	SUPERFICIAL GEOLOGY	BEDROCK GEOLOGY
		Tidal Flat Deposits: The remainder of the Other Gases Connection Corridor and the Blown Sand Deposits are anticipated to be underlain by Tidal Flat Deposits. Glaciolacustrine Deposits: It is anticipated that Glaciolacustrine Deposits will underlie the Tidal Flat Deposits. Till, Devensian (Glacial Till, Boulder Clay, Drift): It is anticipated that Glacial Till Deposits will underlie the Glaciolacustrine Deposits.	Penarth Group (Rhaetic): The north-west corner and the Redcar Mudstone Formation are anticipated to be underlain by the Penarth Group. Mercia Mudstone Group (Keuper Marl, New Red Sandstone Group): The Mercia Mudstone Group is anticipated to underlie the Penarth Group.

Artificial Ground

10A.2.31 Artificial Ground is described by the BGS Lexicon of Named Units as *Made Ground – Undivided, Made Ground is an area where the pre-existing (natural or artificial) land surface is raised by artificial deposits. The purpose of made ground is unspecified.*

10A.2.32 Figure 10-1a to 10-1g (ES Volume II, EN070009/APP/6.3) indicates that Artificial Ground (Made Ground) is widespread across the Proposed Development Site. The Artificial Ground (Made Ground) is associated with the long historical industrial use of the Proposed Development Site.

10A.2.33 Historical mapping and anecdotal evidence suggest that the River Tees was confined within training walls built of slag mostly constructed between 1859 and 1871, and adjacent areas were infilled in sections divided by slag walls with estuary dredging's and industry wastes e.g., slag. The South Gare Breakwater was constructed between 1863 and 1888 of slag and topped with a concrete wall.

10A.2.34 The land areas to the north underlying the Main Site and localised areas of the Connection Corridors, were completed using mainly blast furnace slag and smaller quantities of basic steel slag in the late nineteenth and twentieth century.

10A.2.35 Between 1900 and 1930 areas east and south of the Brinefields were reclaimed by infilling between porous slag walls, the Reclamation Pond remaining tidal until further land was reclaimed to the north. The area of "The Marshes" to the south of the Main Site appears to have been drained in the 1950s and thereafter it is assumed raised with industrial wastes and/or dredgings. Between 1964 and 1969 the main River Tees channels were deepened with dredgings pumped into the eastern margin of Seal Sands creating a raised bank of sand and clay known as "The Peninsular". This merged into the enclosure of the "Monsanto Option". The latter was progressively filled by dredging of the Tees deep water channel which continued irregularly until 1974 using the Dutch hydraulic fill method, which became the exclusive fill technique for the remainder of Seal Sands and potentially also Bran Sands.

Superficial Geology

10A.2.36 The BGS defines superficial geology as t*he youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 2.6 million years from the present. They rest on older deposits or rocks referred to as bedrock*. The published BGS 1:50,000 scale maps show the Proposed Development Site is underlain by variable superficial deposits. Details of superficial geology mapped across the Proposed Development Site and surrounding parts of Teesside are shown on Figure 10-2a to 10-2g (ES Volume II, EN070009/APP/6.3).

Peat

10A.2.37 Peat is described by the BGS Lexicon of Named Units as a "*partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps*."

Tidal Flat Deposits

10A.2.38 Tidal Flat Deposits, including mud flat and sand flat deposits are described by the BGS Lexicon of Named Units as "*forming extensive nearly horizontal marshy land in the intertidal zone that is alternately covered and uncovered by the rise and fall of the tide. They consist of unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit."*

Blown Sand

10A.2.39 Blown Sand is described by the BGS Lexicon of Named Units as "*sand that has been transported by wind, or sand consisting predominantly of wind-borne particles*."

Glaciolacustrine Deposits

10A.2.40 Glaciolacustrine Deposits are described by the BGS Lexicon of Named Units as "*deposits that were laid down in glacial lakes. Composed of coarse-grained bedload and suspended fine-grained material transported by meltwater flowing into lakes bordering the glacier. Deposits include sands, silts and clays of deltaic origin, shoreface sand and gravel and lake bottom varved, fine-grained (fine sand, silt and clay) sediments. Drop stones from floating ice are a common feature*."

Till, Devensian

10A.2.41 Till (Devensian) is described by the BGS Lexicon of Named Units as "*unsorted and unstratified drift, generally over consolidated, deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. It consists of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape (diamicton)."*

Bedrock Geology

Introduction

10A.2.42 Figure 10-3a to 10-3g (ES Volume II, EN070009/APP/6.3) presents the BGS 1:50,000 bedrock geology below the Proposed Development Site. In sequence oldest to youngest four rock formations subcrop across the Proposed Development Site: the Sherwood Sandstone Group in the west, the Mercia Mudstone Group in the centre and Redcar Mudstone Formation in the south and east. A fourth unit, the Penarth Group occurs as a thin band between the Mercia Mudstone Group (centre) and Redcar Mudstone Formation (south and east). The outcrop of the Penarth Group generally trends south-west – north-east but swings to the north-west below Bran Sands before turning to the north-east south of the former Redcar Steelworks. The oldest rocks occur to the north-west and the youngest to the south-east. The Sherwood Sandstone Group is underlain by Permian marls and mudstones which include beds of halite (sodium chloride, NaCl) and anhydrite which have been exploited in the past by mining and in Brine Well Fields to the south-west of Wilton and near Billingham.

Permian Strata

10A.2.43 Permian strata underlies the whole Proposed Development Site at depth and comprise interbedded limestones, mudstones and evaporate deposits. These

deposits are part of the thick evaporites laid down in Zechstein Sea during Middle to Late Permian times 250 million years ago. Exploitation of the evaporite deposits comprising mining of anhydrite at Billingham and brine pumping from locations scattered across the whole Proposed Development Site area but concentrated north of the River Tees, within this sequence led to the development of the chemical industry in Teesside. The 1:50,000 Stockton Sheet 33 geological map Sheet shows the halite deposit to extend below the eastern half of the study area. The BGS Lexicon of Named Units describes the formations as "*Dolostone, grey to buff grey, commonly oolitic or granular, with subordinate mudstone, dolomitic siltstone and sandstone" and "Mudstone, red-brown, with subordinate siltstone and sandstone, Dolostone and gypsum / anhydrite locally common*."

Sherwood Sandstone Group

10A.2.44 The Sherwood Sandstone Group is described by the BGS Lexicon of Named Units as "*sandstone, red, yellow and brown, part pebbly; conglomeratic in lower part; pebbles generally extra formational quartz and quartzite, with some intraformational clasts; subordinate red mudstone and siltstone."*

10A.2.45 Rocks of the Sherwood Sandstone Group underlie the entire Proposed Development Site subcropping along the western extent of the Hydrogen Pipeline Corridor. The BGS Baseline Series Report indicates that the sandstone comprises "*a thick sequence of fine to medium grained sandstones with common argillaceous beds varying in thickness from 250 to 450 m gently dipping ~1 - 2° to the east, in the Yorkshire and Cleveland area. The sandstones are of Triassic age*."

Mercia Mudstone Group

10A.2.46 The Mercia Mudstone Group is described by the BGS Lexicon of Named Units as "*dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite are widespread; thin sandstones are also present*."

10A.2.47 The rocks subcropping in the centre of the Proposed Development Site and underlying the Proposed Development Site to the east of this are early Triassic rocks of the Mercia Mudstone Group, described on the Sheet 34 legend as "*Red and green mudstone with gypsum and sandstone: halite in lower part*." The BGS memoir of the country around Northallerton, an area underlain by a similar solid succession located to the south west of Teesside, reports based on the geological map sheet sections, the thickness of the formation ranges from 200 m (Sheet 33) and 200 to 215 m (Sheet 34). A bed of Halite is indicated to be present at the base of the succession on the Guisborough sheet; the evaporite is unnamed and occurs just above the unconformity between the Triassic and Permian strata. The Stockton sheet identifies the Seaton Carew Formation to form the base of the Mercia Mudstone Group; the BGS Lexicon describes these rocks as "*mudstone, red brown and grey green mottled, and sandstone, coarse-grained, sporadically pebbly, brown or grey-green. Sandstone occurs within convoluted soft injection structures and sandstone dykes*."

Penarth Group

10A.2.48 The Penarth Group is described by the BGS Lexicon of Named Units as "*grey to black mudstones with subordinate limestones and sandstones; predominantly marine in origin*." The BGS Lexicon of Named Units identifies the thickness of the group to vary between 0 and >12 m compared to 10 m and 11 m to 19 m approximately on geological map sheets 33 and 34, respectively. The rocks are of Triassic age forming the top of the succession.

10A.2.49 The subcrop of the Penarth Group occurs in a narrow band extending from South Bank towards the Container Terminal at Teesport before swinging towards the former SSI Redcar Steelworks.

Redcar Mudstone Formation

10A.2.50 The Redcar Mudstone Formation is described by the BGS Lexicon of Named Units *as "grey, fossiliferous, fissile mudstones and siltstones with subordinate thin beds of shelly limestone in lower part, and fine-grained carbonate-cemented sandstone in upper part; argillaceous limestone concretions occur throughout*." Based on the geological map sheet sections, the thickness of the formation ranges from 230 to 275 m (Sheet 33) to around 275 m (Sheet 34).

10A.2.51 The BGS Memoir of the country around Northallerton reports that the formation has been divided into four units based on composition from logging of coastal exposures on the North Yorkshire coast, south of Saltburn by the Sea. The Calcareous Shale Member forms the base of the formation and comprises mudstone with numerous thin beds of shelly, argillaceous limestone, which tend to become sandier up-sequence. The overlying Siliceous Shale member, around 30 m thick on the coast, comprises silty mudstones with intercalations of strong calcareous siltstone and sandstone. The top of the formation has been divided into the Pyritous Shale Member consisting of mudstones with pyritic burrows and fossils, and the Ironstone Shale Member with hard sideritic ironstone nodules. It should be noted from this that only the two basal sub-divisions of this formation are expected to be encountered.

Structure

10A.2.52 Faults and Linear Features are presented on Figure 10-5 (ES Volume II, EN070009/APP/6.3).

10A.2.53 The 1:50,000 BGS geological mapping (Stockton 1:50,000 geological map Sheet 33) shows the strata to have a regional dip to the east cut by one fault through the southern half of the Hydrogen Pipeline Corridor, north of the River Tees. The fault is named the Saltholme Fault on 1:10,000 geological map Sheet NZ52SW, trending east to west approximately. The fault extends east towards the River Tees south of Seal Sands Industrial Estate. It is assumed that the fault has been traced in underground anhydrite workings and associated preliminary prospecting bores located north of the Tees and may extend further east across Teesport on the south of the estuary. The fault downthrows strata to the north but the throw is not recorded. Additional detail is provided on 1:10,000 geological map sheet NZ42SE

which reports a throw of ~30 m to the north in the Billingham Anhydrite, confirming how the presence of the fracture was discovered.

10A.2.54 The presence of bedrock at depth overlain by a considerable cover of Artificial Ground (Made Ground) and recent and drift superficial deposits masks the faulting pattern in the soil succession below the Proposed Development Site.

Agricultural Land Classification

10A.2.55 Information provided on Magic Maps for Agricultural Land Classification (ALC) as supplied by Defra, presented in two data sets, Provisional ALC and Post 1988 ALC maps. The Provisional ALC data covers the entire study area, whereas the Post 1988 ALC data shows a localised area in greater detail. The Agricultural Land Classification has been summarised into the individual Proposed Development Site areas in Table 10A-12. Figure 10-19a to 10-19g (ES Volume II, EN070009/APP/6.3) presents the site wide Provisional ALC data.

10A.2.56 The ALCs by Natural England summarise agricultural land into five grades with Grade One being the best quality land and Grade Five being the poorest, all other land is classified into Non-Agricultural or Urban. A summary of the ALC definitions is presented in Table 10A-13.

Table 10A-12: Agricultural Land Classification

SITE	AGRICULTURAL LAND CLASSIFICATION
Main Site	Urban and Non-Agricultural – Entirety of Main Site
CO_2 Export Corridor	Urban and Non-Agricultural – Entirety of the CO_2 Export Corridor
Natural Gas Connection Corridor	Urban and Non-Agricultural – Entirety of the Natural Gas Connection Corridor
Water Connection Corridor	Urban and Non-Agricultural – Entirety of the Water Connection Corridor
Electrical Connection Corridor	Urban and Non-Agricultural – Entirety of the Electrical Connection Corridor
Hydrogen Pipeline Corridor, North of River Tees	Urban – Adjacent to the River Tees up to the start of Greatham Creek and then followed south. Including the far west of the Hydrogen Pipeline Corridor from Cowpen Bewley Road, encompassing the CF Fertiliser Site and surrounding area. Urban also located north of Greatham Creek. Grade 5 – Adjacent to the end of the Urban Classification from the end of Greatham Creek and moving west to encompass, Swallow Fleet, Holme Fleet and Greatham Creek, and the surrounding land. Grade 4 – Adjacent to the Grade 5 Classification and encompassing Cowpen Bewley Wood and the A1185 Road.

SITE	AGRICULTURAL LAND CLASSIFICATION
	Grade 3 (not subgraded) – Parcel of land approximately 2ha in size for Cowpen Bewley Replacement Land. Assume worst case scenario Grade 3a. N.B – a small portion of the northern extent of the Hydrogen Pipeline Corridor falls within Grade 3 land adjacent to Billingham Cemetery, However, it is noted that this area of land comprises a road.
Hydrogen Pipeline Corridor, South of River Tees	Urban and Non-Agricultural – Entirety of the Hydrogen Pipeline Corridor N.B It is possible that Grade 2 ALC encroaches to the east of the southeastern extent at Lackenby industrial works area. However, it is considered that this is a mapping overlay area and the area itself already comprises a pipeline network.
Other Gases Connection Corridor	Urban and Non-Agricultural – Entirety of the Other Gases Connection Corridor

Table 10A-13: Agricultural Land Classification Definitions (Natural England, 2021).

ALC	DEFINITION
Urban Land	-
Non-Agricultural Land	-
Grade 5 – Very Poor Quality	*Land with very severe limitations that restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.*
Grade 4 – Poor Quality	*Land with severe limitations which significantly restrict the range of crops or level of yields. It is mainly suited to grass with occasional arable crops (for example cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties using the land. The grade also includes arable land that is very dry because of drought.*
Grade 3 – Good to Moderate Quality	*Land with moderate limitations that affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in grades 1 and 2.* *Subgrade 3a – Good quality agricultural land* *Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of crops* *Subgrade 3b – Moderate quality agricultural land* *Land capable of producing moderate yields of a narrow range of crops*

ALC	DEFINITION
Grade 2 – Very Good Quality	*Land with minor limitations that affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown. On some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops, such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than grade 1.*
Grade 1 – Excellent Quality	*Land with no or very minor limitations. A very wide range of agricultural and horticultural crops can be grown. Yields are high and less variable than on land of lower quality.*

10A.2.57 The Provisional ALC map indicates the Main Site, CO_2 Export Corridor, Natural Gas Connection Corridor, Water Connection Corridor, Electrical Connection Corridor, Hydrogen Pipeline Corridor – South of River Tees and Other Gases Connection Corridor to be underlain by Urban and Non-Agricultural soils giving the soils a negligible impact value.

10A.2.58 The Provisional ALC map indicates the Hydrogen Pipeline Corridor – North of River Tees is underlain by Urban, Grade 5, Grade 4 and Grade 3 soils. The Grade 3 soils have not been categorised into Grade 3a or 3b soils and are not present on the Post 1988 ALC map. Therefore, the majority of the Hydrogen Pipeline Corridor falls within a low impact value, with the Grade 3a and Grade 3b soils falling within a moderate to high impact value. A small portion of the northern extent of the Hydrogen Pipeline Corridor falls within Grade 3 land adjacent to Billingham Cemetery. However, it is noted that this area of land comprises a road. It is possible that Grade 2 ALC encroaches to the east of the southeastern extent at Lackenby industrial works area. However, it is considered that this is may be a mapping overlay error and the area itself already comprises a pipeline network.

BGS Boreholes

Main Site

10A.2.59 The BGS maintains an archive of historical exploratory hole records throughout the UK. Part of this desk study involved searching the database and those that are considered to provide useful information on the ground profile at the Main Site are presented in Table 10A-14.

10A.2.60 Also included in Table 10A-14 is borehole information from historical GIs that have been completed across the Main Site.

Table 10A-14: Main Site Geological Succession

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
S1-BH03 456495, 525299 On Site (Allied Explorations) November, 2017	Made Ground	Black sandy gravel. Sand is fine to coarse. Gravel is fine to coarse subangular and includes slag, concrete, black and clinker	G.L.	+7.17	6.80
	Tidal Flat Deposits	Medium dense grey-brown sand.	6.80	+0.37	4.10
	Glacial Till	Becomes medium dense brown gravelly sand. Sand is fine to coarse. Gravel is fine to coarse rounded and includes sandstone at 10.40 m bgl.	10.90	-3.73	1.20
	Redcar Mudstone Formation	Firm to stiff red brown slightly sandy slightly gravelly clay. Sand is fine to medium. Gravel is fine to medium subangular and includes sandstone, mudstone, and coal.	12.10	-4.93	>0.90
S1-BH16	Made Ground	Black-grey-brown clayey sandy gravel. Sand is fine to coarse. Gravel is fine to coarse subangular and includes slag, concrete, brick, and clinker	G.L.	6.93	7.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
456324, 525151 On Site (Allied Explorations) November, 2017	Tidal Flat Deposits	Dense brown clayey gravelly sand with fragments of shell. Sand is fine to coarse. Gravel is fine to coarse angular to rounded and includes sandstone.	7.00	-0.07	3.90
	Redcar Mudstone Formation	Extremely weak grey mudstone highly weathered.	10.90	-3.97	11.90
		Becomes distinctly weathered at weathered at 11.40 m below ground level (bgl).	22.80	-15.87	14.65
	Mercia Mudstone Formation	Extremely weak red brown mudstone distinctly weathered.	37.45	-30.52	>3.55
S1-BH17 456361, 524978 On Site (Allied Explorations)	Made ground	Black, brown sandy gravel and cobbles. Sand is fine to coarse. Gravel is fine to coarse subangular and includes concrete, slag, clinker, and brick. Cobbles are subangular to subrounded and include concrete and slag, Very dense at 2.00 m bgl. Slag inclusions are not present below 3.00 m bgl	G.L.	+6.95	6.00
	Tidal Flat Deposits	Medium dense grey-brown clayey slightly gravelly sand with occasional interbeds of gravel and fragments of	6.00	+0.95	6.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
October, 2017		shell. Sand is fine to coarse. Gravel is fine to medium rounded to angular and includes sandstone. 11.00 m bgl becomes less clay dominated.			
	Glacial Till	Soft to firm clayey silt with interbeds of slightly organic clay / very silty clay.	12.00	-5.05	6.00
	Redcar Mudstone Formation	Extremely weak grey mudstone distinctly Weathered	18.00	-11.05	>0.2
NZ52NE55 456627, 525778 September, 1972	Made Ground	Gravel and cobble sized slag and brick	G.L.	+6.87	4.50
	Tidal Flat Deposits	Brown-grey fine and medium sand with a trace of rounded fine gravel and occasional shell fragments.	4.50	+2.37	7.50
	Glacial Till (named Boulder Clay in the log)	Stiff brown and dark grey silty clay with a little subrounded and subangular fine and medium gravel	12.00	-5.13	2.00
	Glacio-lacustrine Deposits	Firm dark brown thinly laminated silty clay with light brown silt along partings	14.00	-7.13	1.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Glacial Till (named Boulder Clay in the log)	Red-brown silty clay with a trace of subrounded and subangular fine and medium gravel	15.00	-8.13	0.70
	Mercia Mudstone Formation (named Keuper Marl in the log)	Unweathered red brown very and grey-green moderately weak mudstone and silty mudstone.	15.70	-8.83	>23.30
NZ52NE56 456657, 525710 Onsite September, 1972	Made Ground	Sand to cobble sized slag	G.L.	+7.22	4.30
	Tidal Flat Deposits	Light brown fine and medium sand with a trace of rounded fine gravel and occasional shell fragments. Medium and coarse sand was located below 8.00 m bgl.	4.30	+2.92	7.90
	Glacial Till (named Boulder Clay in the log)	Stiff brown with a little pale grey mottled silty clay with a trace of subangular fine and medium gravel	12.20	-4.98	2.90
	Mercia Mudstone	Highly and moderately weathered, closely and moderately fractured red brown very weak mudstone	15.10	-7.88	27.50

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Formation (named Keuper Marl in the log)	with occasional bands of red-brown and green-grey weak silty mudstone.			
		Slightly weathered, moderately fractured brown, slightly gypsiferous weak mudstone	42.60	-35.38	>2.50
S1-BH01 456204, 525417 On Site (Allied Explorations) October, 2017	Made Ground	Black-grey clayey sandy gravel and cobbles. Sand is fine to coarse. Gravel is fine to coarse subangular and includes slag, brick, concrete and clinker. Cobbles are rounded and includes slag and concrete	G.L.	+6.55	6.00
	Tidal Flat Deposits	Medium dense brown slightly gravelly sand with shell fragments. Sand is fine to coarse. Gravel is fine subangular and includes sandstone.	6.00	+0.55	4.80
	Glacial Till	At 10.60 m bgl becomes gravelly and gravel is fine to coarse.	10.80	-4.25	6.50
	Mercia Mudstone Formation	Firm to stiff brown sandy gravelly clay. Sand is fine to coarse. Gravel is fine to medium angular to rounded and includes sandstone and	17.30	-10.75	>22.70
S1-BH10	Made ground	Black-grey sandy gravel. Sand is fine to coarse. Gravel is fine to coarse subangular and includes slag, brick, concrete and clinker	GL	+6.70	5.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
456111, 525287 On Site (Allied Explorations) October, 2017	Tidal Flat Deposits	Dense brown slightly gravelly sand. Sand is fine to medium. Gravel is fine to coarse subrounded and includes sandstone.	5.00	+1.70	5.30
	Mercia Mudstone Formation	Extremely weak grey mudstone distinctly weathered.	10.30	-3.60	>0.70
NZ52NE50 455919, 525410 Onsite September, 1972	Made Ground	Gravel to boulder sized slag.	G.L.	+2.61	0.90
	Estuarine Deposits	Dark brown silty clay.	0.90	+1.71	0.70
	Tidal Flat Deposits	Light brown fine and medium, with some coarse sand and trace of rounded fine and medium gravel below 6 m and occasional shell fragment.	1.60	+1.01	12.50
	Glacio-lacustrine Deposits	Firm grey-brown silty clay with light brown silt along the partings	14.10	-11.49	1.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Glacial Till (named Boulder Clay in the log)	Red-brown and brown slightly sandy silty clay with a trace of subrounded and subangular fine and medium gravel.	15.10	-12.49	0.90
	Mercia Mudstone Formation (named Keuper Marl in the log)	Highly and moderately weathered, closely and moderately fractured red brown, with a trace of pale green-grey, very weak and weak mudstone and silty mudstone.	16.00	-13.39	>15.60
NZ52NE51 456023, 525506 On Site September, 1972	Made Ground	Gravel and boulder sized slag.	G.L.	+5.50	6.20
	Tidal Flat Deposits	Light brown fine to coarse sand with occasional shell fragments.	6.20	-0.70	12.20
	Glacial Till (named Boulder Clay in the log)	Below 10.50 m bgl a little rounded fine gravel is present.	18.40	-12.90	2.10
	Mercia Mudstone Formation (named Keuper Marl in the log)	Stiff brown silty clay with a little subrounded and subangular fine and medium gravel.	20.50	-15.00	>12.50

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
S2-BHA01 456024, 526088 On Site (Allied Explorations) November, 2017	Made Ground	Black-brown very clayey sandy gravel with hydrocarbon/ creosote odour noted. Sand is fine to coarse. Gravel is fine to medium subangular and includes slag, concrete, brick and clinker	G.L.	+7.22	5.90
	Tidal Flat Deposits	Medium dense brown-grey slightly clayey sand with occasional interbeds of gravel and fragments of shell. Sand is fine to coarse. Gravel is fine to medium subrounded and includes sandstone.	5.90	+1.32	9.25
	Mercia Mudstone Formation	Weak red brown-green interbedded mudstone/marl partially weathered with frequent calcite veining. (Engineer notes calcite veins are 3mm-5mm in width with varying degrees of orientation).	15.15	-7.93	>28.85
S2-BHA03 456422, 526009	Made Ground	Black sandy gravel. Sand is fine to coarse. Gravel is fine to coarse subangular and includes concrete, brick, and slag.	G.L.	+7.40	5.50
	Tidal Flat Deposits	Medium dense becoming dense brown sand. Sand is fine to coarse.	5.50	+1.90	8.00

BOREHOLE REFERENCE NATIONAL GRID REFERENCE (NGR) DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
On Site (Allied Explorations) November, 2017	Redcar Mudstone Formation	Moderately weak grey mudstone partially weathered.	13.50	-6.10	1.00
NZ52NE53 456207, 525750 On Site September, 1972	Made Ground	Gravel to boulder sized slag with bricks	G.L.	+7.14	5.20
	Tidal Flat Deposits	Light brown-grey fine and medium sand with a trace of rounded fine gravel and occasional shell fragments.	5.20	+1.94	10.40
	Glacial Till (named Boulder Clay in the log)	At 14.80 m bgl the deposit becomes predominantly gravels and cobbles.	15.60	-8.46	2.00
	Mercia Mudstone Formation (named Keuper Marl in the log)	Highly weathered closely fractured red-brown and green-grey very weak mudstone	17.60	-10.46	0.80
		Unweathered laminated and thinly laminated green-grey moderately gypsiferous weak to moderately weak siltstone and mudstone.	18.40	-11.26	>5.50

CO_2 Export Corridor and Natural Gas Connection Corridor

10A.2.61 One BGS borehole located within the CO_2 Export Corridor and Natural Gas Connection Corridor boundary and one offsite BGS borehole has been summarised in Table 10A-15 to gain an understanding of the possible geology underlying the Corridors.

Table 10A-15: CO_2 Export Corridor and Natural Gas Connection Corridor Geological Succession

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE51, Redcar Stage 2 3001 456991, 524582 Onsite (both corridors) 1972	Made Ground	Gravel to boulder sized slag with a trace of dark grey-brown silty clay. Fill.	GL	5.16	4.5
	Tidal Flat Deposits (Estuarine Deposit on log)	Dark brown-grey fine and medium sand with occasional shell fragments	4.5	0.66	0.5
		Dark grey clayey coarse silt and fine sand with occasional shell fragments	5.0	0.16	0.8
		Dark grey-brown clayey silty fine with a little medium sand with occasional shell fragments	5.8	-0.64	2.0
		Soft to firm dark grey-brown structureless silty clay flecked with black carbonaceous matter and occasional pockets of green fine sand	7.8	-2.46	1.9

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Glacial Till (Boulder Clay on log)	Firm to stiff dark brown and grey mottled sandy silty clay with a little subangular siltstone and coal gravel	9.7	-4.54	2.5
	Redcar Mudstone Formation (Lower Lias on log)	Poorly thinly laminated moderately jointed dark grey calcareous weak mudstone with 50 to 150 mm bands of silty moderately weak mudstone.	12.2	-7.04	5.9
		Dark grey calcareous moderately weak mudstone with occasional bands of impure shelly moderately strong limestone.	18.10	-12.94	>10.1
NZ52NE48, Redcar Stage II 3118 456638, 525588 Offsite 60 m west CO_2 Export Corridor, Offsite 650 m north	Tidal Flat Deposits	Grey-brown fine and medium sand with a trace of fine gravel and occasional shell fragments	GL	4.46	7.30
	Tidal Flat Deposits	Grey-brown fine to coarse sand with some fine to coarse gravel and occasional shell fragments	7.3	-2.84	3.7
	Glacial Till (Boulder clay on log)	Stiff brown and grey mottled silty clay with a trace of subrounded and subangular fine and medium gravel	11.0	-6.54	3.2
	(Lacustrine deposits on log)	Firm grey-brown thinly laminated silty clay with light brown silt along partings	14.0	-9.74	0.2

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
Natural Gas Connection Corridor 1972	Glacial Till (Boulder clay on log)	Brown silty clay	14.4	-9.94	0.5
	Mercia Mudstone Formation (Coatham Beds on log)	Highly weathered grey very weak mudstone with occasional thin laminae of sandy siltstone	14.9	-10.44	2.0
	Westbury Beds on logs – interpreted as Mercia Mudstone Formation	Thinly laminated moderately fractured black weak silty mudstone with bands of weak to moderately weak siltstone, and occasional bands of irregular lenses of pyritous fine sandstone	16.9	-12.44	19.55
	Tea Green Marl on log – interpreted as Mercia Mudstone Formation	Poorly laminated moderately fractured grey-green calcareous weak to moderately weak silty mudstone and silstone	23.0	-15.09	5.2
	Mercia Mudstone Formation (Keuper Marl on log)	Red-brown and grey weak to moderately weak silty mudstone with small gypsum content	27.80	-23.34	>0.9

Water Connection Corridor

10A.2.62 Seven off-site BGS boreholes within 500 m of the Water Connection Corridor have been summarised in Table 10A-16.

Table 10A-16: Water Connection Corridor Geological Succession

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE51, Redcar Stage 2 3001 456991, 524582 35 m south 1972	Made Ground	Gravel to boulder sized slag with a trace of dark grey-brown silty clay. Fill.	GL	5.16	4.5
	Tidal Flat Deposits (Estuarine Deposit on log)	Dark brown-grey fine and medium sand with occasional shell fragments	4.5	0.66	0.5
		Dark grey clayey coarse silt and fine sand with occasional shell fragments	5.0	0.16	0.8
		Dark grey-brown clayey silty fine with a little medium sand with occasional shell fragments	5.8	-0.64	2.0
		Soft to firm dark grey-brown structureless silty clay flecked with black carbonaceous matter and occasional pockets of green fine sand	7.8	-2.46	1.9
	Glacial Till (Boulder Clay on log)	Firm to stiff dark brown and grey mottled sandy silty clay with a little subangular siltstone and coal gravel	9.7	-4.54	2.5
		Poorly thinly laminated moderately jointed dark grey calcareous weak mudstone with 50	12.2	-7.04	5.9

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Redcar Mudstone Formation (Lower Lias on log)	to 150 mm bands of silty moderately weak mudstone.			
		Dark grey calcareous moderately weak mudstone with occasional bands of impure shelly moderately strong limestone.	18.10	-12.94	>10.1
NZ52NE48, Redcar Stage II 3118 456638, 525588 Offsite 60 m west 1972	Tidal Flat Deposits	Grey-brown fine and medium sand with a trace of fine gravel and occasional shell fragments	GL	4.46	7.30
	Tidal Flat Deposits	Grey-brown fine to coarse sand with some fine to coarse gravel and occasional shell fragments	7.3	-2.84	3.7
	Glacial Till (Boulder clay on log)	Stiff brown and grey mottled silty clay with a trace of subrounded and subangular fine and medium gravel	11.0	-6.54	3.2
	(Lacustrine deposits on log)	Firm grey-brown thinly laminated silty clay with light brown silt along partings	14.0	-9.74	0.2
	Glacial Till (Boulder clay on log)	Brown silty clay	14.4	-9.94	0.5
	Mercia Mudstone Formation (Coatham Beds on log)	Highly weathered grey very weak mudstone with occasional thin laminae of sandy siltstone	14.9	-10.44	2.0

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
	Westbury Beds on logs – interpreted as Mercia Mudstone Formation	Thinly laminated moderately fractured black weak silty mudstone with bands of weak to moderately weak siltstone, and occasional bands of irregular lenses of pyritous fine sandstone	16.9	-12.44	19.55
	Tea Green Marl on log – interpreted as Mercia Mudstone Formation	Poorly laminated moderately fractured grey-green calcareous weak to moderately weak silty mudstone and siltstone	23.0	-15.09	5.2
	Mercia Mudstone Formation (Keuper Marl on log)	Red-brown and grey weak to moderately weak silty mudstone with small gypsum content	27.80	-23.34	>0.9
NZ52SE13551/14, Lackenby Power Line 14 457224, 524376 200 m south-east	Made Ground	Slag	GL	-	3.0
	Tidal Flat Deposits/Blown Sand	Grey clayey soft silt with occasional layers of sand	3.0	-	7.8
	Glaciolacustrine?	Stiff brown silty stoney clay	10.8	-	>1.3
NZ52SE13551/13 Lackenby Power Line 13	Made Ground	Slag	GL	-	2.8
	Tidal Flat Deposits	Silty sand, soft grey clayey silt	2.8	-	0.8
	Blown Sand?	Brown sand	3.6	-	0.6

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
457141, 524237 295m SE	Tidal Flat Deposits	Soft brown clayey silt with traces of sand	4.2	-	4.5
	Glaciolacustrine?	Stiff brown silty stoney clay	8.7	-	>2.1
NZ52SE13551/12 Lackenby Power Line 12 457060, 524099 465 m south	Made Ground	Slag	GL	-	>3.2
NZ52SE13551/12A Lackenby Power Line 12A 457055, 524098 465 m south	Made Ground	Slag	GL	-	>2.8
NZ52SE13551/12B Lackenby Power Line 12B	Made Ground	Slag, firebricks	GL	-	5.6
	Tidal Flat Deposits	Soft grey sandy clayey silt	5.6	-	2.1
		Soft brown clayey silt occasional layers of sand	7.7	-	3.0

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
457065, 524101 465 m south	Glacial Till?	Stiff brown silty stoney clay	10.7	-	>1.4

Electrical Connection Corridor

10A.2.63 Six onsite BGS boreholes and two off-site BGS boreholes within 200 m of the Electrical Connection Corridor have been chosen and summarised in Table 10A-17.

Table 10A-17: Electrical Connection Corridor Geological Succession

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE51, Redcar Stage 2 3001 456991,	Made Ground	Gravel to boulder sized slag with a trace of dark grey-brown silty clay. Fill.	GL	5.16	4.5
		Dark brown-grey fine and medium sand with occasional shell fragments	4.5	0.66	0.5

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
524582 Onsite 1972	Tidal Flat Deposits (Estuarine Deposit on log)	Dark grey clayey coarse silt and fine sand with occasional shell fragments	5.0	0.16	0.8
		Dark grey-brown clayey silty fine with a little medium sand with occasional shell fragments	5.8	-0.64	2.0
		Soft to firm dark grey-brown structureless silty clay flecked with black carbonaceous matter and occasional pockets of green fine sand	7.8	-2.46	1.9
	Glacial Till (Boulder Clay on log)	Firm to stiff dark brown and grey mottled sandy silty clay with a little subangular siltstone and coal gravel	9.7	-4.54	2.5
	Redcar Mudstone Formation (Lower Lias on log)	Poorly thinly laminated moderately jointed dark grey calcareous weak mudstone with 50 to 150 mm bands of silty moderately weak mudstone.	12.2	-7.04	5.9
		Dark grey calcareous moderately weak mudstone with occasional bands of impure shelly moderately strong limestone.	18.10	-12.94	>10.1
	Made Ground	Slag	GL	-	3.0

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE13551/14 Lackenby Power Line 14 Onsite 457224 524376	Tidal Flat Deposits/Blown Sand	Grey clayey soft silt with occasional layers of sand	3.0	-	7.8
	Glaciolacustrine?	Stiff brown silty stoney clay	10.8	-	>1.3
NZ52SE13551/13 Lackenby Power Line 13 Onsite 457141, 524237	Made Ground	Slag	GL	-	2.8
	Tidal Flat Deposits	Silty sand, soft grey clayey silt	2.8	-	0.8
	Blown Sand?	Brown sand	3.6	-	0.6
	Tidal Flat Deposits	Soft brown clayey silt with traces of sand	4.2	-	4.5
	Glaciolacustrine?	Stiff brown silty stoney clay	8.7	-	>2.1
NZ52SE13551/12A Lackenby Power Line 12 Onsite 457060, 524099	Made Ground	Slag	GL	-	>3.2

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE13551/12A Lackenby Power Line 12A Onsite 457055, 524098	Made Ground	Slag	GL	-	>2.8
NZ52SE13551/12B Lackenby Power Line 12B Onsite 457065, 524101	Made Ground	Slag, firebricks	GL	-	5.6
	Tidal Flat Deposits	Soft grey sandy clayey silt	5.6	-	2.1
		Soft brown clayey silt occasional layers of sand	7.7	-	3.0
	Glacial Till?	Stiff brown silty stoney clay	10.7	-	>1.4
NZ52NE60 Redcar Stage II 3651 Onsite	Made Ground	Gravel and cobble sized slag (Fill)	GL	6.96	6.5
	Tidal Flat Deposits	Light brown fine and medium sad with occasional shell fragments	6.5	0.46	2.3
	Glacial Till (Boulder clay on log)	Brown silty clay with a trace of subrounded and subangular fine and medium gravel	8.8	-1.84	0.2

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
455905, 525053 1972	(Lower Lias on log)	Highly weathered dark grey very weak mudstone	9.0	-2.04	2.3
		Thinly laminated dark grey very weak mudstone with silt along partings and bands of calcareous moderately weak siltstone	11.3	-4.34	>3.18
NZ52SE13551/10 Lackenby Power Line 10 Directly S 456776, 523581	Made Ground	Limestone fragments	GL	-	0.1
		Sandy silty stony clay	0.1	-	6.8
	Glaciolacustrine Deposits	Mottled grey brown laminated clay	6.9	-	2.1
		Stiff brown silty stony clay	9.1	-	>3.0

Hydrogen Pipeline Corridor

10A.2.64 There are a significant number of borehole records across the Hydrogen Pipeline Corridor. Selected boreholes (based on quality of record, access to record, distance and professional judgement) for the corridor north of the River Tees and south of the River Tees are summarised in Table 10A-18 and Table 10A-19.

10A.2.65 NZ52SE51, NZ52SE13551/14, NZ52SE13551/13 and NZ52SE13551/12A and B encroach on the Hydrogen Connection Corridor (south of the River Tees), these are not repeated in Table 10A-18and can be viewed in Table 10A-14 and Table 10A-15.

Table 10A-18: Hydrogen Pipeline Corridor, South of River Tees, Geological Succession

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SE13624/875 Wilton I.C.I Project H1100875 300 m north 457900, 521160	Topsoil	Topsoil	GL	-	0.2
		Subsoil	0.2	-	0.1
	Glacial Till	Sandy yellow/brown clay with gravel	0.3	-	0.2
		Stiff weathered brown boulder clay	0.5	-	0.9
		Stiff brown boulder clay	1.4	-	1.5
		Silt	2.9	-	0.8
		Firm silty brown laminated clay	3.7	-	0.5
		Silt	4.2	-	0.2
		Firm silty brown laminated clay	4.4	-	1.05
		Stiff red brown boulder clay	5.45	-	3.25
		Stiff silt, brown clay, with gravel	8.1	-	3.4
		Stiff red/brown boulder clay	12.1	-	>0.25
NZ52SW242/C Wilton Tip Extension T260 Onsite Crossing Point 454898,	Made Ground	Sandy silt and pieces of slag	GL	-	3.0
	Tidal Flat Deposits	Silty sand	3.0	-	6.4
	Mercia Mudstone Group	Red and grey marl	9.4	-	>1.5

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
524847					
NZ52SE41 Teesport T120 40 m east, Tees Dock Road roundabout 455484, 522431	Made Ground	Burnt Slag	GL	-	0.6
	Alluvium / Tidal Flat Deposits	Fairly loose fine and medium brown sand	0.6	-	3.2
		Loose dark brown organic f.m sand	3.8	-	0.5
		Firm mottled blue and brown laminated varved clay becoming stiff	4.3	-	1.8
		Stiff brown clay with some fine gravel	6.1	-	5.0
	Mercia Mudstone Group	Hard blue-green and red-brow MARL	11.1	-	>3.0

Table 10A-19: Hydrogen Pipeline Corridor, North of River Tees, Geological Succession

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SW820 I.C.I North Tees 2 70 m north, North Pipeline crossing 1981 454304, 524885	Made Ground	Slag	GL	-	0.6
		Backfill clay with intrusions of sand.	0.6	-	3.7
	Tidal Flat Deposits	Soft black silt	4.3	-	2.1
		Dark silty sand	6.4	-	1.6
		Fine/medium brown sand with shell fragments	8.0	-	6.5
		Gravel	14.5	-	0.4
		Red/brown Boulder Clay	14.9	-	3.4
	Mercia Mudstone Group	Firm red marl	18.3	-	19.0
NZ52SW204/A New Jetty – N Tees. 75 m east, West of the River Tees 1964 453666, 523415	Tidal Flat Deposits/Glacial Till	Silty sand	GL	-	7.2
		Brown Boulder Clay	7.2	-	4.0
	Mercia Mudstone Group	Red and Green Marl	11.4	-	>2.7

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
NZ52SW499 Brinefields, ICI North Tees 74 65 m west from the central extent (west of the River Tees) 1997 451147, 524307	Made Ground	Made up ground – slag chippings over brick	GL	-	0.12
		Made up ground – crushed up white slag	0.12	-	0.38
	Tidal Flat Deposits	Grey silty sand with silty clay and shells	1.0	-	0.4
		Very soft to firm red brown, grey laminated clay with sand partings	1.4	-	9.5
		Brown laminated clay with wet sand partings	10.9	-	0.9
		Firm brown laminated clay with sand partings	11.8	-	>0.7
NZ42SE224 Wolviston – Seal Sand Link Road 12 280 m east from the western extent (west of the River Tees) 1967 449181,	Topsoil	Topsoil	GL	-	0.2
	Alluvium on logs	Soft mottled brown sandy and silty clay	0.2	-	1.0
		Soft grey clayey peat	1.0	-	0.8
		Firm red/brown silty clay with silt partings and some organic matter	1.8	-	0.8
	Glaciolacustrine (Glacial on logs)	Firm mottled brown and grey laminated silty clay	2.6	-	2.0
		Fine gravel and clay	4.6	-	0.1

BOREHOLE REFERENCE NGR DISTANCE FROM THE SITE DATE	STRATUM	DESCRIPTION	DEPTH TO TOP OF STRATUM (m bgl)	LEVEL OF TOP OF STRATUM (m AOD)	THICKNESS (m)
524367		Soft to firm red/brown laminated very silty clay	4.7	-	0.6
		Stiff red/brown silty clay and stones	5.3	-	>4.0
NZ42SE13839/1670 Billingham C.F.P. Plant 1670 Onsite southwestern extent 1980 447540, 522440	Made Ground	Gravel, ash and stones, timber	GL	-	0.9
	Glaciolacustrine Deposits	Firm brown mottled silty clay	0.9	-	1.85
		Brown laminated clayey silt with sand partings	2.75	-	2.25
		Soft brown laminated silty clay with silt and sand partings	5.0	-	2.8
		Stiff brown silty stony clay	7.8	-	1.5
		Very stiff grey/brown sandy stony clay	9.3	-	1.6
		Stiff brown laminated silty clay	10.9	-	2.4
		Very stiff brown sandy stony clay	13.3	-	3.5
		Very dense red/brown clayey sand with bands of stiff brown stony clay	16.8	-	2.3
		Dense brown gravel	19.1	-	0.3
		Stiff grey stony clay	19.4	-	0.2
		Dense brown sand	19.6	-	>0.4

Other Gases Connection Corridor

10A.2.66 The BGS boreholes within the Oxygen and Nitrogen Connection Corridor are either confidential or illegible. Borehole NZ52E51 is located within the boundary of the Other Gases Connection Corridor, the borehole details are not repeated here and can be viewed in Table 10A-14 and Table 10A-15.

Mining

10A.2.67 Economic extraction of evaporite minerals including halite, gypsum and anhydrite and potash, have been of economic significance across Teesside since 1927. These minerals were precipitated during the evaporation of sea water which existed during the Permian age in North East England. As noted, these rocks occur at depth below the Triassic Sandstone and Mudstone which underlie most of Teesside. The drying cycles occurred on multiple occasions and resulted in the deposition of two mineral beds (the Billingham Anhydrite Formation and the Boulby Halite Formation) which have been extensively exploited across Teesside. CIRIA (2019) Abandoned Mine Workings Manual (CIRIA C758D) report states that "*salt deposits beneath Middlesbrough were discovered in the 1860s and were extracted by uncontrolled solution mining between 1874 and 1918 and during the latter part of the 20th Century.*" CIRIA also report that "*anhydrite was also mined in the Billingham and Hartlepool area from the 1920s to 1971.*"

10A.2.68 The BGS Durham and the Tees Valley Mineral Resources and Constraints Report indicated that *"the Billingham Anhydrite was extensively mined on Teesside between 1927 and 1971 as a source of sulphur for the manufacture of the fertiliser ammonium sulphate and sulphuric acid."* It was reported that *"the Boulby Halite formed the basis of the Teesside chemical industry and was still being worked by brine pumping in 2000."* The Report on Abandoned Mineral Workings and Possible Surface Instability Problems (Morris et al., 1982) indicates that the mine at Billingham (NZ478227) located within the Proposed Development Site was operational between 1926 and 1971. Mining ceased due to the decline in use of ammonia sulphate fertiliser and because the Anhydrite Process of sulphuric acid production became uncompetitive with alternative methods using elemental sulphur.

10A.2.69 It is noted that the Proposed Development Site falls outside of a Coal Authority Mining Reporting Area and CIRIA C758D indicates that it lies to the north of areas underlain by historic ironstone workings, these being located across the elevated topography of the North Yorkshire Moors.

Evaporite Minerals

Salt

10A.2.70 Halite or 'rock salt' occurs below large areas of Teesside and the chemical industry which developed in this area was initially based on exploitation of these extensive mineral deposits. The Boulby Halite Formation is up to 90 m thick close to the coast but thins west before thinning out sharply due to dissolution near its outcrop. The BGS Minerals Resources report states that "*salt was discovered in Permian strata in 1859-62 and commercial brine pumping began between 1876 and 1882, with the*

first recorded salt production in 1888." Early extraction was undertaken by allowing water from the overlying Sherwood Sandstone to flow down wells into the salt. The brine fluid which formed was then pumped up to the surface. According to the BGS, "*extraction resulted in subsidence around Haverton Hill and south of Saltholme. Brine was also pumped south of the Tees near Grangemouth.*" The settlement was caused by uncontrolled lateral cavity extension caused by the lower density of freshwater in comparison to the brine.

10A.2.71 In 2000, the BGS reported that brine was still extracted north of Saltholme Farm at 300 m bgl. Initially controlled brine pumping took place on Saltholme and Cowpen Marshes, to the west of Seal Sands. Initially, extraction took place in the south but has progressively moved to the north. Salt extraction was also undertaken at the ICI Wilton complex (latterly by SABIC). According to BGS / Office of the Deputy Prime Minister Mineral Planning Factsheet, all Teesside brine extraction ceased in 2002.

Potash

10A.2.72 Potash is a generic term for potassium-bearing minerals and refined manufactured products. Potash is extracted from Boulby Mine near Loftus below the North Yorkshire coast and North Sea to the south of the mine. The minerals are not exploited across Teesside in the vicinity of the Proposed Development Site and is therefore not discussed further.

Gypsum / Anhydrite

10A.2.73 Gypsum and anhydrite are naturally occurring forms of calcium sulphate which are deposited beds or in nodular bodies. Their thickness is variable, but beds can typically be a few metres thick. Gypsum develops due to the hydration of anhydrite but tends to pass into anhydrite at depths below 100 m approximately. The BGS Minerals Resources Report notes that "*gypsum is highly soluble and dissolves rapidly at or near surface and may give risk to subsidence problems.*" According to the BGS, gypsum has not been "*produced on any significant scale in the area*" but anhydrite was mined extensively from 1923 to 1955. The Permian strata dips gently to the east and the mineral beds slowly thicken in this direction. Anhydrite occurs at a number of horizons; from bottom to top, these are Hartlepool Anhydrite, the Permian Edlington Formation (formerly the Middle Marls), the Billingham Anhydrite and the Sherburn Anhydrite. According to the generalised vertical section on BGS Sheet 33, the Hartlepool Anhydrite is thickest, ~100 m thick, although the BGS Minerals Resources Report indicated it is up to 150 m thick. The Billingham Anhydrite and Sherburn Anhydrite are thinner but generally more consistent in extent and thickness. The former is indicated to be 80 m thick on the section, but the latter is not identified. The anhydrite in the Middle Marls is the thinnest mineral bed and although not shown on the generalised vertical section can reportedly be up over 20 m thick.

10A.2.74 The BGS report that the Billingham Anhydrite Mine was sunk to 260 m bgl to extract the Billingham Anhydrite Formation at around 220 m depth. The Report on Abandoned Mineral Workings and Possible Surface Instability Problems (Morris et

al, 1982) reports the 7m thick seam of the Main Anhydrite was mined. The mine closed in 1971. The BGS also state that the workings are flooded.

Tees Valley Joint Minerals and Waste Development Documents

10A.2.75 Tees Valley Joint Minerals and Waste Development Documents, Policies & Sites DPD was adopted in September 2011. The Tees Valley consists of five Boroughs: Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees. In the case of minerals and waste planning, the five authorities have joined together to prepare planning policies on minerals and waste. The local authorities decided to combine minerals and waste planning policies in one set of Development Plan Documents (DPDs) because minerals and waste operations have many planning issues in common. In addition, the Tees Valley has relatively few remaining minerals operations and the preparation of minerals-only DPDs would not be justifiable. The Joint Minerals and Waste DPDs cover the period from 2011 to 2026.

10A.2.76 Historically there has been mineral extraction of salt and gypsum around Billingham and the River Tees.

10A.2.77 The Tees Valley has a rich history of mineral extraction, the specialist nature of which supported the development of the chemical and steel making industries on the Tees. Historically there has been mineral extraction of salt and gypsum around Billingham and the River Tees. However, the range of current primary mineral extraction is limited to crushed rock and sand and gravel with some brine extraction at Seal Sands and small-scale clay extraction at Cowpen Bewley. The Tees Valley has relatively few remaining minerals operations.

10A.2.78 Conversely there are significant secondary and recycled materials (blast furnace slag; construction and demolition waste) and marine-dredged aggregates landed at wharves along the Tees which help provide the minerals resources needed and move minerals provision up the minerals hierarchy. The challenge is to ensure that the use of secondary and recycled materials is facilitated whilst making sufficient land available to provide an appropriate level of primary mineral resources to contribute to the identified local, regional and national need for minerals; safeguarding resources and ensuring the prudent use of these resources in line with sustainable development objectives.

10A.2.79 There is one brinefield currently active near Seal Sands (Stockton-on-Tees). Two further brinefields in the Seal Sands area have extant planning permissions. Information from the BGS indicates brine extraction has limited viability itself, but it is acknowledged that there may be future interest to create storage caverns for gas and certain fluids. Permission was granted in 2009 for the extraction of gas at Kirkleatham (Redcar and Cleveland). Permission also exists for the extraction of anhydrite from a deep mine at Billingham (Stockton-on-Tees) although the mine has not been worked since 1971.

10A.2.80 Ten dormant sites were identified in the Tees Valley, one of which has had new conditions approved for minerals extraction (the anhydrite mines at Billingham). Of the remaining nine it is now considered that seven of these sites are highly unlikely to ever resume extraction due to recent development, designations or proposed

allocations for other uses. Land at the remaining sites at Low Middlesfield Farm and Eaglescliffe Brickworks (Stockton-on- Tees) would require new conditions to be approved before they could be reopened.

Mining, Ground Workings and Natural Cavities Risk

10A.2.81 A summary of the mining, ground workings and natural cavities risk is presented in Table 10A-21. Mining features derived from Groundsure GIS Mapping are presented on Figure 10-20 to Figure 10-23 (ES Volume II, EN070009/APP/6.3) and in Table 10-12 (ES Volume I, EN070009/APP/6.2).

10A.2.82 The Groundsure Reports (Annex A) indicate that the Proposed Development Site is not within a Coal Mining Affected Area.

10A.2.83 The Groundsure Reports (Annex A) indicate that the Hydrogen Pipeline Corridor is in Non-Coal Mining Areas. These include the following:

- Haverton Hill and Saltholme: Salt-brine;
- Saltholme Brinefield: Brine;
- Billingham: Anhydrite; and
- Cerebos Salt Brinewells: Salt – brine.

10A.2.84 The Groundsure Reports (Annex A) indicate there are no natural cavities located within the Proposed Development Site boundary or within 250 m.

10A.2.85 The Groundsure Reports (Annex A) indicate there are mining cavities within the Hydrogen Pipeline Corridor. These include the following:

- Billingham Mine (1, 4, 8, 29): Anhydrite;
- Cassel Works: Brine, Rock Salt, Salt, Halite; and
- Seal Sands Brine: Brine, Rock Salt, Salt, Halite.

10A.2.86 The Groundsure Reports (Annex A) incate that there are BritPits located within 250 m of the Hydrogen Pipeline Corridor and within 250 m of the Water Connection Corridor. These include the following:

- (Water Connection Corridor only) Wiley Bridge Plantation Clay Pit, Clay and Shale, surface mine working, ceased;
- (Hydrogen Pipeline Corridor) Greatham Creek, Salt, surface mineral working, ceased;
- (Hydrogen Pipeline Corridor) Billingham Anhydrite Mine: Anhydrite, wholly underground, ceased;
- (Hydrogen Pipeline Corridor) Haverton Hill Brick Works: Clay and Shale, surface mineral working, ceased;
- (Hydrogen Pipeline Corridor) Cowpen Brick and Tile Yard: Clay and Shale, surface mineral working, ceased;

- (Hydrogen Pipeline Corridor) Saltholme Brinefield No 4 South: Salt, wholly underground, inactive; and
- (Hydrogen Pipeline Corridor) Saltholme No 5 Brinefield: Salt, surface mineral working, inactive.

10A.2.87 The Groundsure Reports (Annex A) indicate there is one Underground Workings located across the River Tees. One tunnel is present along the proposed crossing point of the River Tees (1988 and 1992).

10A.2.88 The Groundsure Reports (Annex A) indicate there is one feature located within the Water Connection Corridor (Unspecified Workings, 1983) and one feature is located directly adjacent to the Water Connection Corridor, Electrical Connection Corridor, Natural Gas Corridor, Hydrogen Pipeline Corridor and Other Gases Connection Corridor (Iron Workings, 1893).

10A.2.89 The Groundsure Reports (Annex A) indicate that there are surface ground workings present at the Main Site and all associated Connection Corridors. A summary of the surface ground workings present at the Proposed Development Site is presented in Table 10A-22. Figure 10-22 (ES Volume II, EN070009/APP/6.3) presents the Groundsure GIS Mapping data.

10A.2.90 The Groundsure Reports (Annex A) indicate the Main Site and associated Connection Corridors are in or within 250 m of a Historical Mineral Planning Area. These include:

- Cassel Works: Salt (brine), surface mineral working, planning status: application, date not included;
- Billingham Mine (Anhydrite), working wholly underground, valid until 22/12/2049;
- Billingham Mine (Cement), surface mineral working, valid, date not included;
- Greatham: Marl (sand and gravel) surface mineral working, planning status: application, date not included;
- Greatham Creek (salt) surface mineral working, valid until 4/7/2066; and
- Wilton Works, surface mineral working, valid, date not included.

Table 10A-20: Mining Risk

SITE	COAL MINING AFFECTED AREAS		NON-COAL MINING		NATURAL CAVITIES		MINING CAVITIES		BRIT PITS		UNDERGROUND WORKINGS	
	ON SITE	0 TO 250 m	ONSITE	0 TO 250 m	ONSITE	0 TO 250 m	ONSITE	0 TO 250 m	ONSITE	0 TO 250 m	ONSITE	0 TO 250 m
Main Site	No	N/A	No	No	None	None	None	None	None	None	None	None
CO_2 Export Corridor	No	N/A	No	No	None	None	None	None	None	None	None	2
Natural Gas Connection Corridor	No	N/A	No	No	None	None	None	None	None	None	None	2
Water Connection Corridor	No	N/A	No	No	None	None	None	None	None	1	1	2
Electrical Connection Corridor	No	N/A	No	No	None	None	No	No	None	None	None	2
Hydrogen Pipeline Corridor	No	N/A	Yes	Yes	None	None	Yes	Yes	None	7	1	2
Other Gases Connection Corridor	No	N/A	No	No	None	None	None	None	None	None	None	2