Net Zero Teesside Project

Planning Inspectorate Reference: EN010103

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

[The Net Zero Teesside Order]

Document Reference: 9.17 Hydrogeological Impact Assessment Report

Applicants: Net Zero Teesside Power Limited (NZT Power Ltd) & Net Zero North Sea Storage Limited (NZNS Storage Ltd)

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GLOSSARY

Abbreviation	Description
BGL	Below Ground Level
BPM	Best Practicable Means
CCGT	Combined-cycle Gas Turbine
CCU	Carbon-capture unit
CEMP	Construction Environmental Management Plan
CJEU	Court of Justice of the European Union
CL	Critical load
CoC	Contaminants of Concern
CO_2	Carbon Dioxide
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
DPD	Development Plan Document
EA	Environment Agency
EC	European Commission
EEA	European Economic Area
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
GI	Ground Investigation
GWDTE	Groundwater Dependent Terrestrial Ecosystem
HDD	Horizontal Directional Drilling
HIA	Hydrogeological Impact Assessment
HRSG	Heat Recovery Steam Generator
LSE	Likely Significant Effects
MAGIC	Multi-Agency Geographic Information for the Countryside
MLWS	Mean Low Water Springs
MW	Megawatt
NE	Natural England
NPPF	National Planning Policy Framework
NZT	Net Zero Teesside

Abbreviation	Description
NZTNS	NZT North Sea
PA 2008	Planning Act 2008
PAH	Polycyclic Aromatic Hydrocarbons
PCC	Power, Capture and Compressor
PEIR	Preliminary Environmental Information Report
PINS	The Planning Inspectorate
PTS	Permanent threshold shifts
RSIS	Ramsar Sites Information Service
SAC	Special Area of Conservation
SIP	Site Improvement Plan
SPA	Special Protection Area
SPZ	Source Protection Zone for groundwater
SSSI	Site of Special Scientific Interest
SVOC	Semi-volatile Organic Compounds
TIN	Technical Information Note
TTS	Temporary threshold shifts
TPH	Total Petroleum Hydrocarbons
TVCA	Tees Valley Combined Authority
VOC	Volatile Organic Compounds
WMP	Water Management Plan

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1.0 INTRODUCTION

1.1 Overview

1.1.1 This Hydrogeological Impact Assessment (HIA) Report (Document Ref. 9.17) has been prepared on behalf of NZT Power Ltd. and NZNS Storage Ltd. (the 'Applicants'). It will ultimately form part of the application (the 'Application') for a Development Consent Order (a 'DCO'), that will be submitted to the Secretary of State (the 'SoS') for Business, Energy and Industrial Strategy, under Section 37 of 'The Planning Act 2008' (the 'PA 2008').

1.1.2 The HIA has been prepared to address comments made in respect of groundwater by the Environment Agency (EA) in their response to the DCO application made to the Planning Inspectorate, dated 17 December 2021, [RR-024].

1.1.3 The Applicants are seeking development consent for the construction, operation and decommissioning of a Carbon Capture Utilisation and Storage (CCUS) project (hereafter referred to as the 'Proposed Development'), comprising a gas-fired Combined Cycle Gas Turbine (CCGT) plant together with the equipment required for the capture of carbon dioxide (CO_2) emissions from the generating station. Captured CO_2 from the site and other industrial sources in Teesside will be compressed and exported for offshore geological storage under the North Sea. Refer to Chapter 4: Proposed Development **[APP-086]** of the Environmental Statement (ES) and the ES Addendum (ES Addendum Vol I **[AS-050]**) for full details of the Proposed Development.

1.1.4 A DCO is required for the Proposed Development as it falls within the definition and thresholds for a 'Nationally Significant Infrastructure Project' (a 'NSIP') under Sections 14 and 15(2) of the PA 2008.

<u>The Proposed Development</u>

1.1.5 The location of the Proposed Development is on the east coast of England to the west of Redcar and south of Hartlepool in an area that has been greatly modified by human development. It will be developed on an existing brownfield site, formerly part of the Redcar Steelworks. The Proposed Development lies between Hartlepool and Middlesbrough, where the River Tees meets the North Sea. The Proposed Development site is located entirely within the boundary of the unitary authorities of Redcar and Cleveland, and Stockton-on-Tees.

1.1.6 The Power Capture and Compression (PCC) Site, within the wider Proposed Development site, lies directly adjacent to the Teesmouth and Cleveland Coast Special Protection Area (SPA) / Ramsar, which is designated both for breeding birds and non-breeding birds. The SPA and Ramsar site have recently been extended. This extension includes an area of dunes and pools immediately north-east of the PCC Site that has been included in the designation because overwintering birds use the pools for roosting, loafing and foraging; they are therefore now recognised as essential to maintaining the integrity of the SPA / Ramsar.

1.1.7 The parts of the site boundary which cross the SPA / Ramsar and extend into Tees Bay are corridors for the underground pipeline for the offshore export of CO_2 and the existing or replacement wastewater outfalls to Tees Bay. There will be no surface works other than monitoring and surveillance within these areas.

1.1.8 The Proposed Development will comprise the following main components and features (for a detailed description of the specifications of this project, please see Chapter 4: The Proposed Development **[APP-086]** of the Environmental Statement (ES) and the ES Addendum (ES Addendum Vol I, Document Ref. 7.8.1) for full details of the Proposed Development:

- The operational PCC site, which contains a natural gas-fired generating station, comprised of one Combined Cycle Gas Turbine with an associated carbon capture plant;
- The operational power plant is to be located on part of the former Redcar Steelworks Site, directly adjacent to the Teesmouth and Cleveland Coast SPA / Ramsar and SSSI;
- CO_2 Gathering Network to collect CO_2 from third-party industrial carbon capture connections and to supply this CO_2 to the compression station at the PCC Site;
- CO_2 Export, consisting of a High Pressure Compressor Station at the PCC Site and a CO_2 export pipeline installed using trenchless techniques beneath Coatham dunes and sands within the Teesmouth and Cleveland Coast SPA / Ramsar and SSSI; and
- Other Connections, such as to gas, electricity and, most notably from an HIA perspective, water: the PCC Site is to be cooled by mechanical draft wet cooling towers that are to use water from the existing Northumbrian Water feed which will be discharged to Tees Bay via the former steelworks outfall or a replacement outfall. The replacement outfall will be constructed by trenchless techniques.

2.0 GEOLOGY AND HYDROGEOLOGY

2.1 Scope of the Project

2.1.1 In their formal response to the DCO [RR-024], the EA raised several points regarding the Environmental Statement (ES) for the proposed scheme. Within the response, a number of points were raised in respect of the interpreted groundwater conditions at and in the vicinity of the Proposed Development and a request was made for a Hydrogeological Impact Assessment to assess the impact of the Proposed Development on groundwater and surface water. It should be recognised that the ES was submitted before a detailed ground investigation of the PCC Site and the CO_2 Export Corridor was undertaken between May and July 2021.

2.1.2 The purpose of the HIA is to address the points raised by the EA in their response [RR-024] with the benefit of this new information obtained from the 2021 ground investigation (GI).

2.2 Sources of Information

2.2.1 The following sources have been used to inform the HIA, in particular to confirm the geology and hydrogeology beneath and surrounding the Proposed Development:-

- British Geological Survey (BGS) 1:50,000 scale maps, Sheets 34, Guisborough and 35, Stockton;
- A review of borehole logs held on the BGS on-line Geoindex records;
- The results of ground investigations carried out between 2008 and 2018;
- The results of the ground investigation carried out by AEG between May and July 2021;
- AECOM report, entitled *'Preliminary Onshore Ground Investigation for Net Zero Teesside Ground Investigation Report',* dated January 2022 [REP2-043];
- AECOM report, *5.13 Habitat Regulations Assessment Report,* dated April 2022 **[AS-194]**; and,
- Net Zero Teesside, Environmental Statement: Chapters 9, Surface Water, Flood Risk and Water Resources **[APP-091]** and 10 Geology, Hydrogeology and Contaminated Land **[APP-092]**.

2.3 Geology

2.3.1 The geology of the Proposed Development is interpreted from BGS geological maps of the area, borehole logs held on the BGS borehole archive and the results of the ground investigations listed above.

Regional Geology

2.3.2 The regional geology of the area is dominated by a thick sequence of superficial deposits consisting of Blown Sand and estuarine and Tidal Flat Deposits overlying glacio-lacustrine deposits and boulder clay. The superficial deposits overlie strata of Triassic and Jurassic age. Across most of the area the natural deposits are covered

by fill and made ground, as a result of the deposition of dredgings and of waste materials, particularly slag, from former steel and iron works utilised for land reclamation.

2.3.3 Blown sand is present mainly to the north of the Proposed Development site and has been proved to a maximum thickness of approximately 10m in one borehole. It is understood that the Blown Sand has accumulated against a breakwater built of slag in the 19th century. The area was also used for the rolling and disposal of slag from local iron and steel works and as a result, slag is intermixed with the sand in this area.

2.3.4 The Tidal Flat Deposits typically comprise a sequence of light brown sand with little gravel and occasional shell fragments overlying a soft clay and silt. The Tidal Flat Deposits vary considerably in thickness up to a maximum proven thickness of approximately 21m.

2.3.5 The Tidal Flat Deposits are underlain by glacial deposits consisting of glacial till (boulder clay) and/or glacio-lacustrine deposits. The glacial till comprises a stiff brownish-grey clay with gravel and the glacio-lacustrine deposits consist of dark grey laminated clay and silt. The till has been deposited in a series of channels cut into the bedrock 30m to 40m deep. The till varies in thickness between approximately 30m north and west of Teesside thinning to less than 5m to the south and east. The glacio-lacustrine deposits have been proven to a maximum thickness of approximately 9m and a maximum depth of 27m.

2.3.6 The bedrock underlying the glacial deposits varies across the area. The strata dip to the east. To the west of the Proposed Development, the superficial deposits are underlain by the Triassic, Sherwood Sandstone and the overlying Mercia Mudstone. Further east and beneath the Proposed Development, the superficial deposits are underlain by the Triassic Penarth Group and the Jurassic Redcar Mudstone Formation. The Sherwood Sandstone comprises a red, yellow and brown pebbly sandstone with argillaceous bands and varies in thickness between 250m and 450m. The Mercia Mudstone typically consists of a reddish-brown mudstone with occasional greenish-grey silty mudstone bands and gypsum layers. In a borehole at Seal Sands (NGR NZ 53796 23805) approximately 5km west of the PCC Site, the Mercia Mudstone is 113m thick and the Sherwood Sandstone approximately 251m thick. The Sherwood Sandstone is underlain by marls, limestones and salt (halite and anhydrite) bands of Permian age. **Table 2.1** provides a summary of the regional geology.

2.3.7 The strata dip to the east and hence below the PCC Site the Sherwood Sandstone aquifer is at a depth of at least 250m.

Table 2.1: Summary of the regional geology of the Proposed Development area

	Formation	Lithological Description	Thickness (m)
Made Ground/Fill		Variable	Variable
Superficial Deposits	Blown Sand	Can contain slag and other waste	up to 10
	Tidal Flat Deposits	Sand overlying clay and silt	4.4 – 21.2
	Glacio-lacustrine Deposits	Laminated clay and silt with organic material	0 - 9
	Till	Stiff stony clay	2 - 30
Jurassic	Redcar Mudstone	Mudstone with thin sandstone and limestone beds in lower part	230 - 275
Triassic	Penarth Group	Grey and green mudstone and sandstone	10 - 15
	Mercia Mudstone Formation	Red and green mudstone with gypsum and siltstone bands. Halite and anhydrite in lower part.	200 - 270
	Sherwood Sandstone Formation	Red, yellow and brown pebbly sandstone with argillaceous bands	250 - 330
Permian+	Eskdale Group/Staintondale Group	Red marl and sandstone bands	315 - 610
	Teesside Group	Limestones with halite and anhydrite beds	

+ - only proven in boreholes

Site-specific geology

2.3.8 A series of ground investigations have been carried out at the former Redcar Steelworks, including the area of the proposed PCC site within the Proposed Development area between 2008 and 2021. These ground investigations confirm the published geology of the area. The GIs consisted of the following:-

- 2008: 15 No. trial pits to 4.5m depth and 26 No. boreholes to 15m-20m depth
- 2016/2017: 360 No. trial pits to 6m depth
- Feb 2018: 7 No. boreholes to 15.5m to 40.3m depth
- June 2018: 15 No. trial pits 1.8m to 4.5m depth and 31 No. boreholes 0.5m to 41m depth.

The ground investigations confirmed the nature of the superficial deposits and of the underlying bedrock of the Mercia Mudstone, Penarth Group and the Redcar Mudstone. The Mercia Mudstone was proved in the west of the site with the Penarth Group and the Redcar Mudstone underlying the majority of the Proposed

Development in the centre and east. In addition, the investigations confirmed that across the majority of the PCC Site, the superficial deposits are covered by a thick layer of made ground/fill, comprising mainly gravel to boulder size fragments of slag together with concrete, brick and other waste materials. The thickness of the made ground varies between approximately 6m and more than 9m.

2.3.9 Contamination was identified in the fill, principally associated with widespread alkaline conditions (pH 10 – 12.5) and asbestos and point sources of hydrocarbon contamination reported as total petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PAH) associated with former industrial uses.

2.3.10 The ground investigation carried out between May and July 2021 was of the proposed PCC Site and the onshore CO_2 Export Pipeline Corridor. The investigation consisted of:-

- 18 No. sonic boreholes 11.7m to 20m depth
- 15 No. sonic boreholes extended by rotary coring to 29.1m to 38.5m depth
- 12 No. trial pits to 4.5m depth
- In-situ CPT and permeability tests
- Geotechnical and geo-environmental laboratory testing
- Three round of groundwater level and quality monitoring

Figure 2.1 (Drawing 60657467-ACM-GIR-DRG-008) shows the locations of the boreholes and trial pits. The borehole and trial pit logs and the results of the testing are provided in the factual report of the investigation [REP2-026 – REP2-042]. Due to access restrictions and existing buildings and structures, there is limited data for the north western part of the Proposed Development.

2.3.11 In summary, the ground investigation proved that apart from the beach section of the CO_2 Export Corridor, the whole of the PCC Site is underlain by made ground, principally slag, varying in thickness between 0.6m and 7.8m. The thickest made ground is in the south of the site. The made ground is underlain by the Tidal Flat Deposits, which comprise an upper granular layer over a lower clay layer, especially at the junction with the underlying glacio-lacustrine deposits or glacial till. The Tidal Flat Deposits vary in thickness between approximately 4.4m and 21.2m, thickening to the north below the CO_2 Export Corridor.

2.3.12 The Tidal Flat Deposits are underlain by glacial till and/or glacio-lacustrine deposits. The base of the glacial deposits varies significantly between -9.59mOD (15.3m depth) and -21.37mOD (28.65m depth), reflecting the deposition in glacial channels. The thickest sequence of glacial deposits was proven in borehole LF/BH01 at 11.9m in the CO_2 Export Corridor.

2.3.13 All of the boreholes proved the Redcar Mudstone below the superficial deposits. The Redcar Mudstone consists of a weak grey mudstone, locally fossiliferous and occasionally heavily fractured. The Redcar Mudstone was proved to a thickness of 15.6m. The base of the Redcar Mudstone was not proved in any of the boreholes. The depth of the rockhead increase to the north to a proved depth of 38.6m (-

31.32mOD), as shown on **Figure 2.2** (Drawing 60657467-ACM-GIR-DRG-016). Geological cross-sections of the Proposed Development, based on the 2021 ground investigation and previous GIs, are provided at **Appendix A**.

2.3.14 A detailed interpretation of the findings of the ground investigation is provided in the AECOM Interpretative Report of January 2022 [REP2-043].

2.4 Hydrogeology

2.4.1 It is likely that the majority of the superficial deposits, apart from the Blown Sand and the upper granular layers in the Tidal Flat Deposits, have a low permeability that restricts the movement of groundwater. It is likely that the Blown Sand and the sandier layers in the Tidal Flat Deposits have a moderate intergranular permeability, which facilitates groundwater movement.

2.4.2 It is considered that the glacial till and the Redcar Mudstone have a low permeability which restricts vertical groundwater flow and that with the underlying low permeability Mercia Mudstone provide protection to the Sherwood Sandstone aquifer, which is present at depth, possibly more than 250m, below the site.

2.4.3 During the 2021 GI, a series of in-situ permeability tests were carried out on boreholes in both the Tidal Flat Deposits and the Redcar Mudstone. The results of the tests are provided in **Table 2.2**. The results from tests in five boreholes in the sand layers of the Tidal Flat Deposits show that the permeability varies between 1.483×10^{-4}m/sec and 4.086×10^{-3}m/sec with a mean of 1.535×10^{-3}m/sec and a median of 1.362×10^{-3}m/sec. Permeability tests were also carried out on three boreholes in the Redcar Mudstone. These showed a lower permeability than the Tidal Flat Deposits sand with a range of 1.58×10^{-7}m/sec to 6.171×10^{-5}m/sec with a mean of 2.44×10^{-5}m/sec and a median of 3.797×10^{-5}m/sec.

2.4.4 Based on the results of the permeability tests, it is considered likely that there is hydraulic continuity between the made ground/fill and the upper sand horizon in the Tidal Flat Deposits and that the sand horizon acts as a pathway for groundwater movement beneath the Proposed Development.

2.4.5 It is considered that groundwater movement in the Redcar Mudstone is limited and that the overlying glacial till provides a hydraulic barrier between groundwater in the Redcar Mudstone with that in the Tidal Flat Deposits.

Figure 2.1: Plan showing borehole and trial pit locations

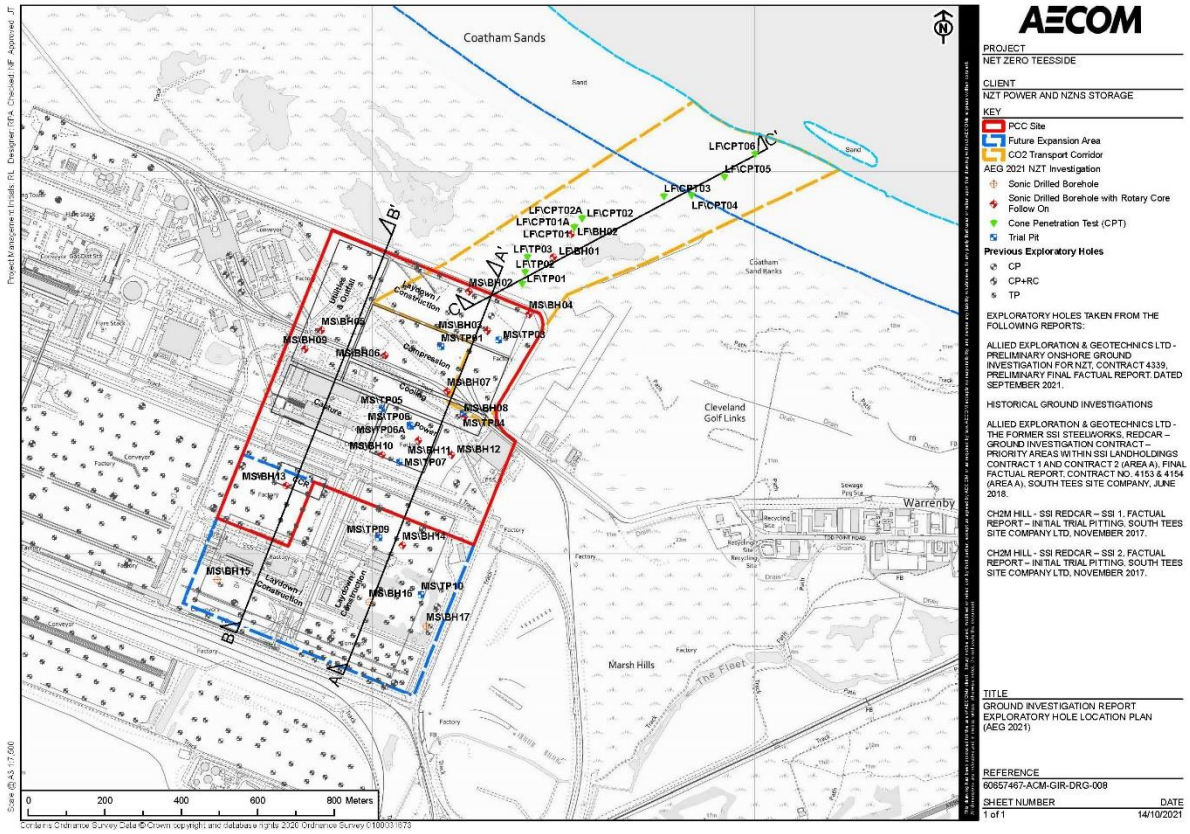


Figure 2.2: Plan showing rockhead

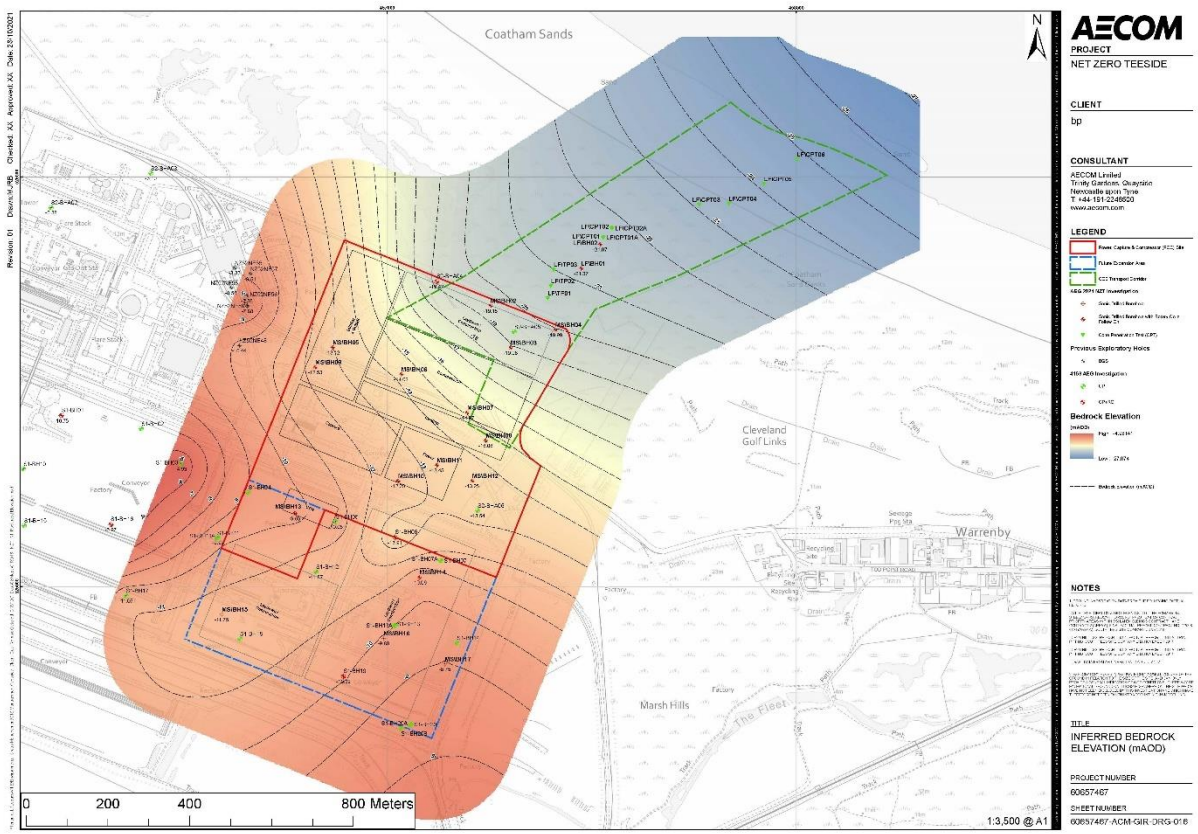


Table 2.2: In-situ permeability test results (m/sec)

Borehole	Slug tests		Variable head tests		Comments
	Falling head	Rising head	Mean	Maximum	
Tidal Flat Deposits					
BH05S	1.950×10^{-3}	1.219×10^{-3}			
	9.748×10^{-4}	1.625×10^{-3}			
BH07D	1.813×10^{-4}	1.483×10^{-4}			
BH13S	4.086×10^{-3}	1.816×10^{-3}			Borehole extends 0.1m into Tidal Flat Deposits clay
	3.269×10^{-3}	1.634×10^{-3}			
BH14	1.167×10^{-3}	1.167×10^{-3}			
	1.634×10^{-3}	1.167×10^{-3}			
BH15D	1.167×10^{-3}	1.362×10^{-3}			
Redcar Mudstone					
BH05D			1.58×10^{-7}	1.72×10^{-7}	
BH03D	5.801×10^{-5}	5.473×10^{-5}			
	6.171×10^{-5}	5.687×10^{-5}			
BH13D	1.973×10^{-6}	4.242×10^{-6}			
	2.333×10^{-6}	3.797×10^{-6}			
Made Ground and Tidal Flat Deposits sand					
BH03S			2.53×10^{-4}	2.53×10^{-5}	Data unreliable
BH15S			4.29×10^{-5}	2.04×10^{-4}	

2.4.6 The various superficial deposits and bedrock have been classified by the EA in respect of their importance for groundwater. **Table 2.3** provides a summary of the aquifer classifications.

Table 2.3: Summary of Environment Agency aquifer classifications

Formation	EA Aquifer Classification
Blown Sand	Secondary A
Tidal Flat Deposits - sand/silt	Secondary A
Tidal Flat Deposits - clay	Secondary (Undifferentiated)
Glacio-lacustrine Deposits – clay	Unproductive strata
Glacio-lacustrine Deposits - silt	Secondary A
Glacial till	Secondary (Undifferentiated)
Redcar Mudstone	Secondary (Undifferentiated)
Penarth Group	Secondary (Undifferentiated)/Secondary B
Mercia Mudstone Formation	Secondary B
Sherwood Sandstone Formation	Principal

2.4.7 The majority of the strata beneath the site is of limited importance as a groundwater resource. The only major aquifer is the Sherwood Sandstone which is present at a significant depth below most of the Proposed Development (including the PCC site). Under the WFD, the Proposed Development is within two designated groundwater waterbodies. The area east of the river, which covers the majority of the Proposed Development is within the Tees Mercia Mudstone and Redcar Mudstone groundwater body [WFD designation GB40302G701300]. The area west of the River Tees is principally within the Tees Sherwood Sandstone groundwater body [WFD designation GB40301G702000], apart from a small area around Port Clarence which is within the Tees Mercia Mudstone and Redcar Mudstone groundwater body.

2.4.8 The Tees Mercia Mudstone and Redcar Mudstone groundwater body has a Poor Overall Status with a good quantitative status but a poor chemical status, attributed to point source pollution and potentially to the presence of connate water and/or saline water ingress. The Tees Sherwood Sandstone groundwater body is at Good Overall status with both good quantitative and chemical status.

2.4.9 There are a number of licensed borehole abstractions from the Sherwood Sandstone for industrial, commercial and public water supply uses. However, these are located to the north west and west of the site where the sandstone aquifer is at a shallower depth. There are no licensed groundwater abstractions in the vicinity of the PCC Site and also no private domestic supplies.

2.4.10 Groundwater is present in the Tidal Flat Deposits and in the Redcar Mudstone. In addition, it is likely that there is perched groundwater in the made ground/fill which is isolated from the groundwater in the Tidal Flat Deposits sand. As part of the 2021 GI, three rounds of groundwater level and quality monitoring were undertaken in August, October and November 2021. The borehole locations are shown on **Figure 2.1** and the results of the groundwater level monitoring are summarised in **Table 2.4**.

2.4.11 The groundwater level monitoring results for the made ground/fill show that water is not present across the whole area with three of the seven boreholes being dry. It is considered that where present, the groundwater is a localised perched system. The water level in the made ground varies between 4.18m AOD (3.07m bgl) in borehole BH15 in the south western corner of the site and 1.87m AOD (2.8m below ground level[bgl]) in borehole BH03 on the northern edge of the site.

2.4.12 In the Tidal Flat Deposits, the groundwater level varies between 4.20m AOD (3.05mbgl) in borehole BH15 in the south western corner and 2.58m AOD (4.7m bgl) in borehole BH01, north of the main site in the CO_2 pipeline Export Corridor. Groundwater in the Tidal Flat Deposits flows in generally north north-easterly direction to the coast. **Figure 2.3** shows the groundwater contours for the Tidal Flat Deposits.

Table 2.4: Groundwater level monitoring 2021 (m AOD)

Borehole ID	Datum Elevation (m AOD)	Groundwater Level (m AOD)		
		August	October	November
Made Ground/Fill				
BH03S	4.67	2.78	1.87	2.76
BH07S	7.33	3.04	3.23	2.94
BH08S	8.74	Damp	Dry	
BH09S	7.47	Damp	Dry	
BH11S	7.25	3.31	3.28	Dry
BH15S	7.25	3.97	4.18	3.72
BH17S	9.25	Dry		
Tidal Flat Deposits				
BH01S	7.28	2.60	2.58	2.70
BH04S	5.01	3.01	3.15	2.87
BH05S	7.48	3.01	3.15	2.87
BH07D	7.33	3.03	2.82	2.95
BH08D	8.74	3.05	3.06	3.01
BH09D	7.47	2.83	2.77	3.13
BH11D	7.25	3.19	3.01	3.09
BH13S	5.71	3.60	3.78	3.43
BH14	7.19	3.69	3.71	3.59
BH15D	7.25	3.97	4.20	3.68
Glacio-lacustrine Deposits and Till				
BH04D	5.01	2.72	2.94	2.61
Redcar Mudstone				
BH01D	7.28	2.55	2.43	2.72
BH03D	4.67	2.90	3.00	2.69
BH05D	7.48	2.23	2.62	1.79
BH12S+	7.15	3.34	3.64	3.14
BH12D	7.15	3.52	4.00	3.17
BH13D	5.71	3.74	4.05	3.36
BH17D	9.25	3.84	4.08	3.61

[+]- Glacial till and Redcar Mudstone

2.4.13 The groundwater levels recorded in the Redcar Mudstone show that the groundwater within permeable siltstone horizons is confined under pressure and that the piezometric level is above the surface of the bedrock. The piezometric level varies between 4.08m AOD (5.17m bgl) in borehole BH17 in the south eastern corner of the site and 1.79m AOD (5.69m bgl) in borehole BH05 in the north west of the site. From a groundwater contour plan for August 2021, it is interpreted that groundwater in the Redcar Mudstone flows in a generally northerly direction **(Figure 2.4).**

2.4.14 The groundwater level in the Tidal Flat Deposits is similar to but slightly higher than the piezometric level in the Redcar Mudstone. It is interpreted that the glacio-lacustrine clays and the glacial till act as a low permeability barrier between the two units and that there is no direct hydraulic continuity between the mudstone and the superficial deposits.

2.4.15 It is interpreted that groundwater in the Tidal Flat Deposits is in hydraulic continuity with the surface water system in the area. However, it is likely that artificial drainage across the industrial site provides the principal control on surface water drainage on the Proposed Development including the PCC Site. It is likely that undisturbed surface water drainage is limited to the area north of the PCC site within Coatham Dunes.

2.4.16 Further details of the monitoring boreholes are provided in the AECOM Ground Investigation Interpretative Report of January 2022 [REP2-043].

Figure 2.3: Groundwater contours for the Tidal Flat Deposits

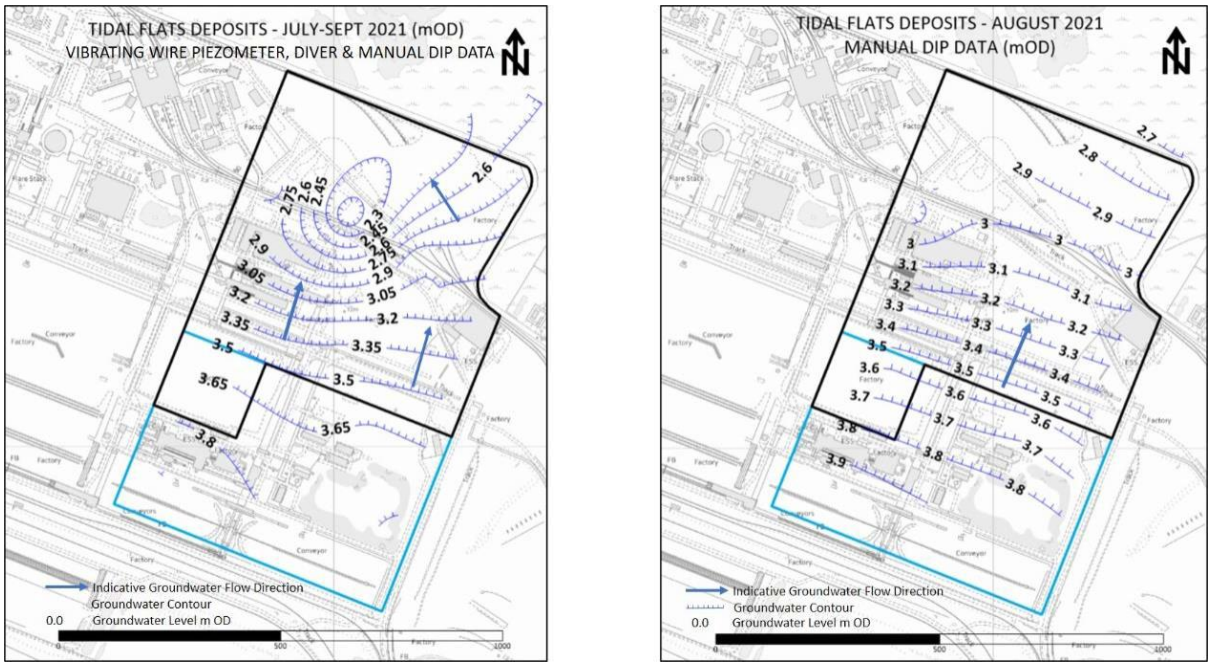
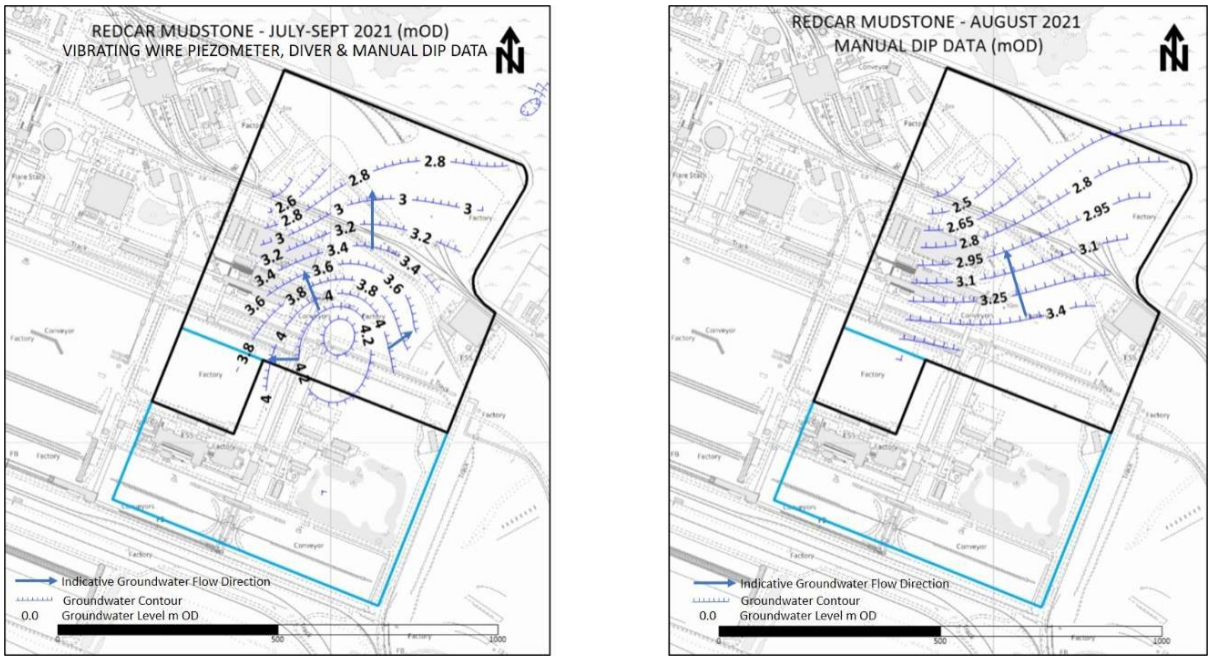


Figure 2.4: Groundwater contours for the Redcar Mudstone



Groundwater Quality

2.4.17 Previous ground investigations carried out at and in the vicinity of the Proposed Development site showed the presence of numerous sources of potential ground contamination but that the risk of leaching of these contaminants into the

groundwater was considered very low to moderate. Asbestos was identified as the principal contaminant of concern (CoC) and which posed a risk to human health. Asbestos does not present a risk to groundwater quality and resource value. Impacts to groundwater quality were considered as being generally minor apart from localised point sources of petroleum hydrocarbons and coal tars in the fill.

2.4.18 In the previous ground investigations hydrocarbons (TPH and PAHs) were detected in the groundwater. Elevated concentrations of fluoranthene and naphthalene were recorded together with thiocyanate above the screening criteria used. Slightly elevated concentrations of metals also were reported. A more detailed assessment of the findings of the previous ground investigations in respect of ground and groundwater contamination is provided in Appendix 10A of the Environmental Statement **[APP-292]**.

2.4.19 The 2021 ground investigation proved ground and groundwater conditions consistent with the findings of the earlier investigations. However, it should be recognised that there are no monitoring boreholes in the north western part of the PCC Site and off-site to the north west, down hydraulic gradient of the PCC Site. It is understood that additional monitoring boreholes will be drilled in these areas.

2.4.20 Fluoranthene was recorded with a maximum concentration of 0.266µg/l in borehole 14 in the south eastern part of the main site. Concentrations reported for boreholes on the northern, down gradient, edge of the site were much lower, generally varying between 0.01µg/l and 0.02µg/l or below the limit of detection of 0.01µg/l. In trial pit TP06 in the centre of the site, a layer of free product was present with a TPH concentration of 430,000µg/l and a fluoranthene concentration of 5,400µg/l. This was attributed to an isolated pocket of contamination near a former filling station.

2.4.21 PAHs were present mainly in the upper 2.5m of the made ground/fill and were shown to be relatively immobile. Naphthalene above the screening criteria of 2µg/l was reported in only one borehole. A concentration of 5.1µg/l was reported in the Tidal Flat Deposits in borehole BH15D, located in the south western corner of the site. This borehole is up hydraulic gradient of the main works and the contamination is attributed to flow from an off-site source. Naphthalene was not reported above the screening criteria in any of the other boreholes on the site, with most reporting levels below the limit of detection.

2.4.22 The highest TPH concentration in the groundwater was reported for borehole BH03S, in the fill in the north eastern corner of the site at 3,500µg/l. Elevated TPH concentrations also were reported in the Tidal Flat Deposits in boreholes BH05S and BH09D, both in the north west of the site and in borehole BH05D in the Redcar Mudstone.

2.4.23 Thiocyanate concentrations in groundwater were generally below 0.25mg/l, although higher concentrations were reported in the Tidal Flat Deposits at 4.4mg/l in borehole BH05S, in the north west of the PCC Site, and 9.3mg/l in borehole BH13 in the west central part of the site. A concentration of 3.9mg/l was reported for one borehole (BH05D) in the Redcar Mudstone, in the north west of the site. Cyanide above the screening criteria was reported in groundwater samples taken across the

site with the higher levels generally in the central and north western areas. However, the highest concentration of 0.076mg/l was reported for a sample taken from borehole BH17D in the Redcar Mudstone in the south eastern corner of the site.

2.4.24 During the period of groundwater monitoring in 2021, the ammoniacal nitrogen concentration increased and exceeded the screening criteria across the whole site. A maximum concentration of 19mg/l was reported in the Tidal Flat Deposits in borehole BH05S. The cause of the increasing ammoniacal nitrogen level currently is unclear.

2.4.25 In addition to anthropogenic impacts, the groundwater also is affected by naturally elevated chemical contamination. Elevated sulphate concentrations are widespread together with an elevated to high electrical conductivity, particularly in the Redcar Mudstone. Conductivity values range from 1888µS/cm to 2671µS/cm in the made ground/fill; between 489µS/cm and 5,369µS/cm in the Tidal Flat Deposits; and, between 2,432µS/cm and 38,705µS/cm in the Redcar Mudstone. The maximum concentration of sulphate of 3,000mg/l was reported for a sample in the Redcar Mudstone in borehole MS/BH13 in the south western part of the PCC Site. Most samples from the Redcar Mudstone reported a sulphate concentration above both the DWS and EQS limits of 250mg/l. The sulphate concentration in the Tidal Flat Deposits is more variable ranging between less than 100mg/l up to a maximum 1,500mg/l reported for borehole MS/BH07 in the north eastern part of the PCC Site.

2.4.26 The elevated to high sulphate concentrations and conductivity values are attributed to saline intrusion and/or the presence of connate water in the Redcar Mudstone. Based on the sulphate concentrations and the conductivity values, it is considered that the water quality in the Redcar Mudstone naturally is poor.

2.4.27 The laboratory data sheets for the groundwater samples are provided in the AECOM report of January 2022 [REP2-043].

2.4.28 Based on a review of the findings of the 2021 ground investigations, the following conclusions can be drawn in respect of the presence of contamination and the impact on groundwater quality:-

- Concentrations of CoC are low and similar to those detected in previous GIs;
- Soil leachate levels show limited exceedances of screening levels;
- There was a general increase in ammoniacal nitrogen in the groundwater over the monitoring period;
- It is likely that pockets of hydrocarbon contaminated water perched above the main water table are present in the fill;
- Slightly elevated levels of cyanide have been reported in the groundwater across the site;
- Localised elevated levels of hydrocarbons have been identified in the Tidal Flat Deposits and in one borehole in the Redcar Mudstone;
- Groundwater in the fill has an elevated pH;

- The natural groundwater quality in the Redcar Mudstone is poor; and,
- In conclusion, it is considered that despite the presence of historic contamination, the risk to controlled waters (groundwater and surface water) outside of the Proposed Development from the presence of low levels of contamination on the PCC Site are considered low.

2.5 Other Receptors

2.5.1 Based on an assessment of the groundwater flow beneath the site, it is considered likely that groundwater in the Tidal Flat Deposits is in hydraulic continuity with watercourses in the vicinity of the Proposed Development. It is considered that across much of the former steelworks site (including the proposed PCC site) surface water is managed by an existing drainage system, unconnected to the groundwater. This water is then either directed to the sewerage system or discharged to Tees Bay through an existing outfall. The majority of the surface watercourses are culverted beneath the site. Accordingly, it is considered that the only surface water features which are in continuity with groundwater in the Tidal Flat Deposits are located to the north of the site, principally on the intertidal zone of the North Sea, where it is likely that groundwater in the Tidal Flat Deposits discharges.

2.5.2 To the north of the Proposed Development is the Teesmouth and Cleveland Coast SPA / Ramsar site and SSSI. The SPA is a 12,210.62 ha estuarine and coastal site which comprises a range of coastal habitats, such as sand and mudflats, rocky shore, saltmarsh, freshwater marsh and sand dunes. The SPA / Ramsar lies along a stretch of coast that has been significantly modified by human activity. The site provides feeding and roosting opportunities for a significant number of waterfowl in winter and the passage period. The Teesmouth and Cleveland Coast Ramsar site is largely contiguous with the Teesmouth and Cleveland Coast SPA.

2.5.3 An assessment of the SPA identified that originally there were a number of ponds across the site within the sand dunes. However, field surveys in 2020 and 2021 showed that, apart from Pond 14, all of the ponds had been fully vegetated. A Phase 1 habitat survey in the dune system of Coatham Sands was undertaken by AECOM on the 4th of June and 8th of July 2020. A general finding of the Phase 1 Habitat Survey was that many of the standing waterbodies in the dunes are ephemeral, experiencing high seasonal drawdowns. As such, not all pools in the dunes are likely to be suitable to support roosting or loafing birds throughout the year.

2.5.4 Pond 14 is the only remaining pond that contains open water and appears to be perched on a layer of slag within the dunes. Water samples collected from Pond 14 show that it is slightly brackish, with an electrical conductivity of 2250µS/cm. There is no evidence of any significant contamination as TPHs, PAHs, VOCs and SVOCs were all reported at concentrations below the respective limits of detection. Due to its position, significantly higher than the groundwater level in the Tidal Flat Deposits, it was concluded that the pond was reliant on rainwater with no influence from tides or groundwater. Further details of the SPA are provided in Chapter 9 of the ES **[APP-091]**.

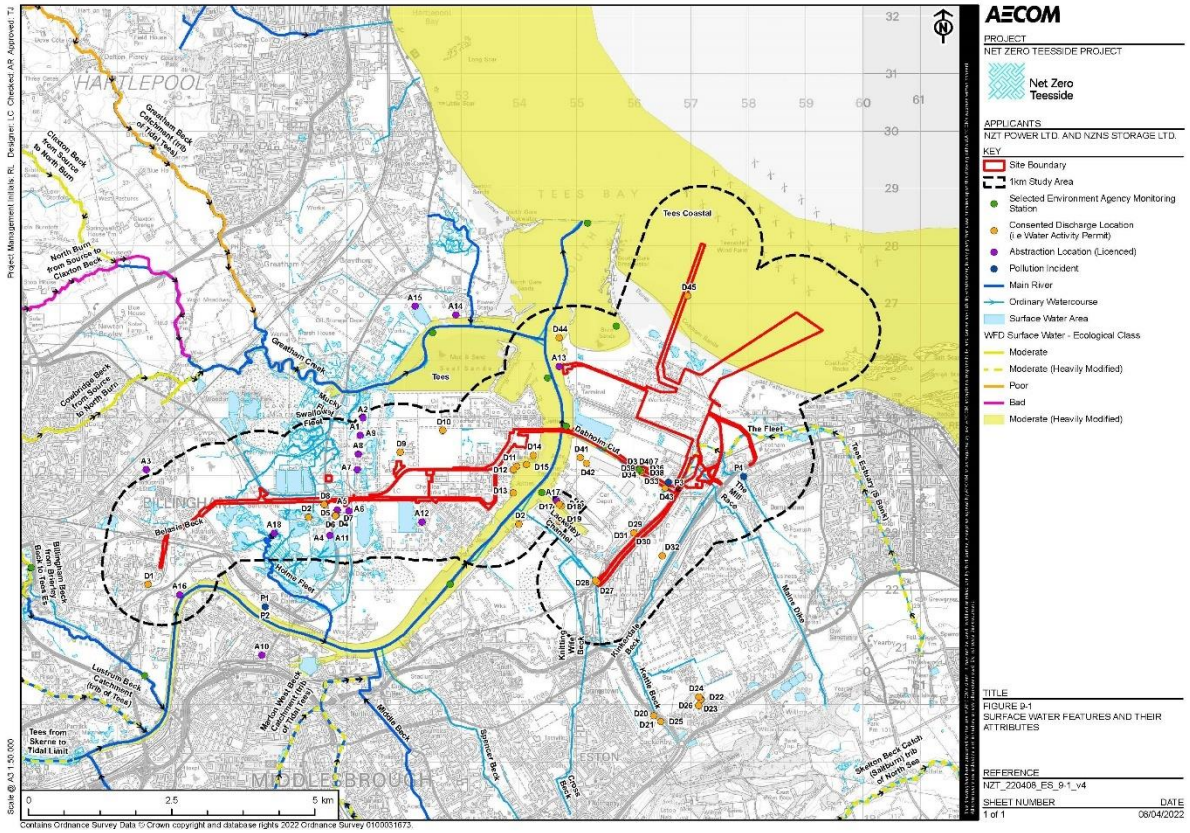
2.5.5 The majority of the water features on the eastern bank of the River Tees either discharge to the river upstream of the Proposed Development or are culverted beneath the development site. Watercourses draining from the higher ground to the south and east converge to the south and east of the PCC Site and either are directed to the River Tees by Lackenby Channel, an artificial drainage channel approximately 3km to the south or by the Dabholm Gut, a second artificial drainage channel approximately 800m south of the PCC Site. The Dabholm Gut forms part of the Tees Transitional Waterbody, designated under the Water Framework Directive.

2.5.6 Apart from a number of ponds in the sand dunes and in the fill north of the site, the only other water feature is The Fleet, a watercourse which flows south westerly across Coatham Marsh Nature Reserve to the east of the main development where it has been artificially widened to create a pond/wetland area. The Fleet discharges to the River Tees through the Dabholm Gut. **Figure 2.5** shows the surface water features across the Proposed Development.

2.5.7 There are no Groundwater Dependent Terrestrial Ecosystems in the vicinity of the Proposed Development that are likely to be affected by activities associated with the development.

2.5.8 A detailed assessment of the potential impacts of the Proposed Development on the SPA and associated water features is provided in the Habitat Regulations Assessment Report of April 2022 (V.3) **[AS-194]**.

Figure 2.5: Surface Water Features



3.0 HYDROGEOLOGICAL IMPACT ASSESSMENT

3.1 Introduction

3.1.1 Amongst their response of 17 December 2021 to the DCO application **[RR-024]** the Environment Agency raised a number of concerns regarding the potential for the Proposed Development to impact on groundwater. Included in their response are the statements:-

"*Changes to Hydrogeological regime may impact groundwater. 6.2.10 ES Vol I Chapter 10 Geology and Contaminated Land **[APP-092]** will need to be updated with a Hydrogeological Impact Assessment (HIA) and the conclusions of the HIA should inform the WFD assessment. This should include a CSM (schematic picture) identifying all of the receptors."*

And:-

"Solution: Applicant to provide a Hydrogeological Impact Assessment and to assess the cumulative impact of the development – ie all work packages….."

It should be recognised that the EA's response was made before information from the ground investigation was available. It is considered that the findings of the ground investigation address many of the points raised in respect of ground and groundwater conditions by the EA in their response.

3.1.2 The current WFD assessment is provided in Appendix 9C of the ES **[APP-254]**.

3.1.3 The purpose of this HIA is to address the concerns of the Environment Agency and to provide a detailed assessment of the potential impacts of the Proposed Development on the hydrogeological conditions. The assessment has been based on the source-pathway-receptor approach, which is commonly used in such assessments.

3.1.4 For there to be an impact on groundwater and/or surface water, associated with the Proposed Development, there must be a *source*, such as contaminated groundwater, active dewatering; a *receptor* such as groundwater, a borehole supply, watercourse; and a *pathway* which allows the source to impact on the receptor. All three elements must be present for a potential impact/plausible linkage to be realised. In order to identify potential linkages associated with the Proposed Development, a conceptual hydrogeological model has been developed, which identifies the various sources, pathways and receptors. **Figure 3.1** shows the conceptual model.

3.1.5 The HIA considers the importance/sensitivity of the receptors, the likelihood and degree of potential impact and the resulting significance of the impact. The assessment considers the potential impacts on both groundwater level and flow and groundwater quality during the construction, operation and decommissioning phases of the Proposed Development. The significance of any identified impacts is based on the approach in **Table 3.1**.

Figure 3.1: Conceptual Hydrogeological Model

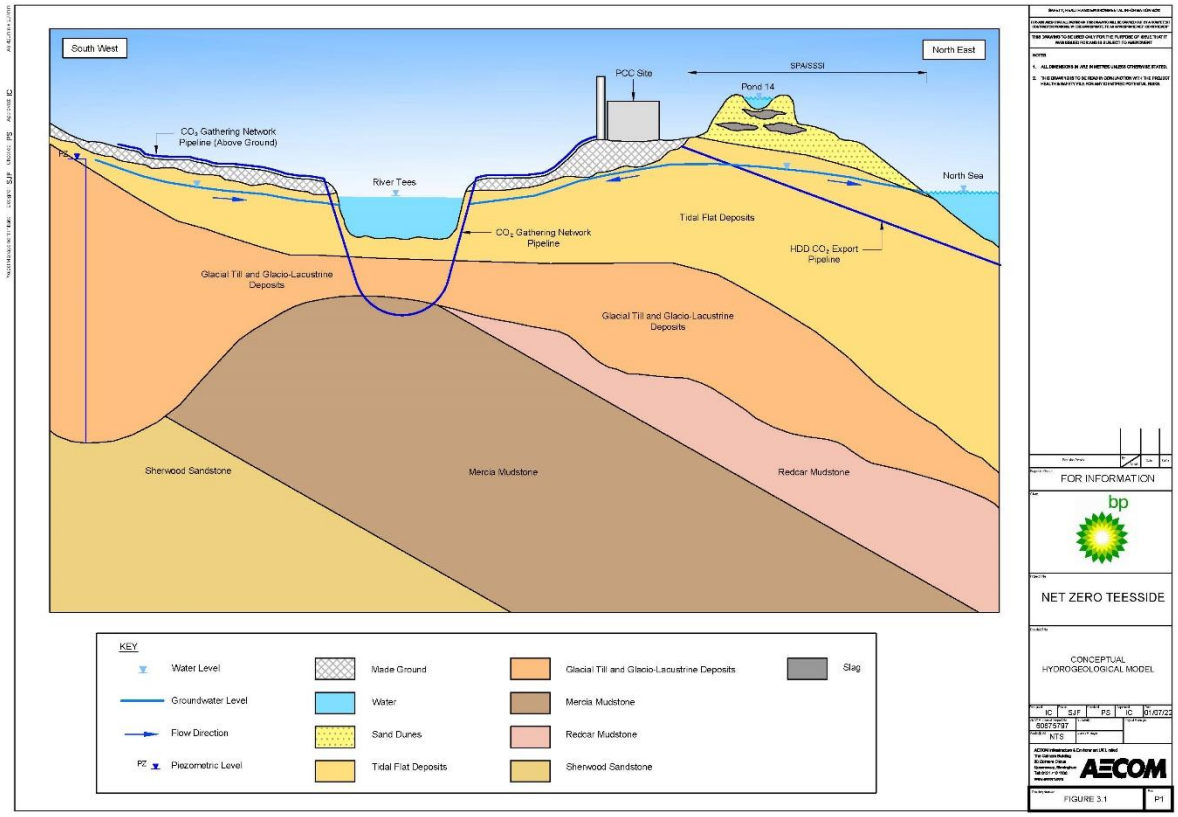


Table 3.1: Impact significance table

Magnitude of impact	Importance of attribute			
	Very high	**High**	**Medium**	**Low**
Major	Very large	Large/Very large	Moderate/Large	Slight/Moderate
Moderate	Large/Very large	Moderate/Large	Moderate	Slight
Minor	Moderate/Large	Slight/Moderate	Slight	Neutral/Slight
Negligible	Slight	Slight	Neutral/Slight	Neutral/Slight
No change	Neutral	Neutral	Neutral	Neutral

Receptors

3.1.6 The significance/importance of a surface water and groundwater feature within and in the vicinity of the Proposed Development is based on the criteria in **Table 3.2**, which has been adapted from LA113 *Road Drainage and the Water Environment.* Revision 1 March 2020.

Table 3.2: Estimating the Importance of Water Environment Attributes

Importance	Typical criteria	Examples	
Very high	Nationally significant attribute of high importance	Groundwater	Principal aquifer providing a regionally important resource. Aquifer supporting a site protected under EC and UK Regulations (SAC, SPA, SSSI, Ramsar site) SPZ 1 Groundwater supporting a GWDTE
		Surface water	Site protected under EC and UK Regulations (SAC, SPA, SSSI, Ramsar site) Watercourse having a WFD classification in a RBMP and a Q_{95} >1.0m^3/sec
High	Locally significant attribute of high importance	Groundwater	Principal aquifer providing a locally important resource and supporting a river ecosystem. SPZ 2 or 3 Groundwater supporting a GWDTE
		Surface water	Species protected under EC and UK Regulations Watercourse having a WFD classification in a RBMP and a Q_{95} <1.0m^3/sec
Medium	Of moderate quality and rarity	Groundwater	Secondary A aquifer providing water for agricultural or industrial use with limited continuity with surface water
		Surface water	Watercourses not having a WFD classification in a RBMP and a Q_{95} >0.001m^3/sec
Low	Lower quality	Groundwater	Secondary B or Undifferentiated aquifer Unproductive strata Strata with natural poor quality water
		Surface water	Watercourses not having a WFD classification in a RBMP and a Q_{95} <0.001m^3/sec

3.1.7 From a groundwater perspective, the only principal aquifer and a resource of very high importance in the area of the Proposed Development is the Sherwood Sandstone aquifer which subcrops beneath the superficial deposits approximately 6.5km to the west of the main development site. The Sherwood Sandstone is present at a significant depth below the PCC Site and protected from downward migration of contamination by the Mercia Mudstone and Redcar Mudstone and overlying low-permeability superficial deposits. There are no source protection zones (SPZ) in the area.

3.1.8 The upper granular layer of the Tidal Flat Deposits which underlies the main site is designated by the EA as a Secondary A aquifer, which is of medium importance as a water resource. The Blown Sands also are designated as a Secondary A aquifer. The lower cohesive layer of the Tidal Flat Deposits together with the underlying glacial till are designated as Secondary Undifferentiated aquifers, which are considered as having a low importance as a water resource.

3.1.9 The Redcar Mudstone, the Penarth Group and the Mercia Mudstone bedrock are designated as either Secondary B or Secondary Undifferentiated aquifers, which are considered as having a low importance as a water resource.

3.1.10 There are limited surface water features across the main development site. The main surface water receptor is the Teesmouth and Cleveland Coast SPA to the north of the main site, which includes the Coatham Marsh Nature Reserve/SSSI. The SPA is a feature of very high importance.

3.1.11 There are a number of shallow ponds developed within the made ground/fill to the north of the site. It is likely that these are of poor quality and are considered as being of low significance.

Sources

3.1.12 The main sources of potential impact associated with the Proposed Development are the effluent streams from the processes operating on the site. In addition, construction activities could expose and mobilise existing contaminants present in the fill across the site, which could adversely impact groundwater and surface water quality. Dewatering of any excavations could change groundwater flow and impact on groundwater levels.

3.1.13 It is likely that local dewatering at the launch and reception pits may be required to assist in the construction of the trenchless crossing of the River Tees and at the launch pit for the trenchless crossing for the CO_2 Export Corridor below the Teesmouth and Cleveland Coast SPA / Ramsar and SSSI. Other than these, no dewatering is anticipated.

3.1.14 During the construction period, in the absence of control measures, there is the potential for local contamination of groundwater and surface water through the escape of fuel oils and chemicals associated with the construction activities and from the uncontrolled discharge of sediment-rich water.

Pathways

3.1.15 The upper granular layer of the Tidal Flat Deposits is not only a potential receptor but also acts as a pathway allowing contaminated groundwater to migrate from the site. Surface watercourses and culverted drainage systems below the existing industrial site also provide potential pathways for contaminant movement towards the River Tees and the North Sea.

3.1.16 There are no proposals for the construction of deep basements and accordingly no significant dewatering will be required.

3.2 Construction Period

3.2.1 The HIA considers separately and in combination, the following main elements of the Proposed Development for the construction, operational and decommissioning phases of the scheme:-

- CO_2 Gathering Network to collect CO_2 from third-party industrial carbon capture connections and to supply this CO_2 to the compression station at the PCC Site;
- The operational PCC site, which contains a natural gas-fired generating station, comprised of one Combined Cycle Gas Turbine with an associated carbon capture plant. The power plant is to be located on part of the former Redcar Steelworks Site, directly adjacent to the Teesmouth and Cleveland Coast SPA / Ramsar;
- CO_2 Export, consisting of a High Pressure Compressor Station at the PCC Site and a CO_2 Export pipeline, drilled by a trenchless technique beneath the dune systems of the Teesmouth and Cleveland Coast SPA / Ramsar; and
- Other Connections, such as to gas, electricity and, most notably from an HIA perspective, water.

<u>CO2 Gathering Network: Groundwater Level and Flow</u>

3.2.2 The CO_2 Gathering Network is designed to collect CO_2 captured by third parties and deliver it to the PCC Site for compression and export for off-shore storage. The CO_2 Gathering Network extends several kilometres to the west of the PCC Site. The network passes over the sub-crop of the Sherwood Sandstone in the west, the Mercia Mudstone in the centre and the Redcar Mudstone in the east around the PCC Site.

3.2.3 Across the route of the CO_2 Gathering Network, the bedrock is covered by a variable thickness of superficial deposits. The Sherwood Sandstone aquifer in the west is overlain mainly by either glacial till or Tidal Flat Deposits and does not crop out in the Proposed Development. Logs from boreholes in this area obtained from the BGS well archive show that the superficial deposits typically are between 25m and 30m thick and that the groundwater is confined within these with a piezometric level between approximately 3m and 10m bgl.

3.2.4 The superficial deposits overlying the Mercia Mudstone and the Redcar Mudstone in the centre and east of the CO_2 Gathering Network, comprise the Tidal Flat Deposits, overlying glacio-lacustrine deposits above glacial till.

3.2.5 The CO_2 Gathering Network will utilise existing service corridors, pipeline routes and conduits, which are all above ground level, apart from the crossing below the River

Tees. As a result, no excavations will be required and hence there will be no dewatering and no impact on the groundwater level and flow conditions in the Sherwood Sandstone, Mercia Mudstone or Redcar Mudstone from the construction of the CO_2 Gathering Network.

3.2.6 The CO_2 Gathering Network needs to cross the River Tees in order to access the PCC Site. It is proposed that the network will cross below the river from Navigator Terminals to land on the northern bank of the Dabholm Gut either in the existing Sembcorp No. 2 services tunnel or by trenchless techniques. For the latter, the launch point would be situated on the eastern bank of the River Tees in a 40m wide strip of land between Dabholm Gut and the Bran Sands Lagoon to the north with the receiving point on the north bank of the Tees at Navigator Terminals. The Dabholm Gut and Bran Sands Lagoon form part of the Teesmouth and Cleveland Coast SPA/Ramsar site.

3.2.7 The trenchless crossing will be constructed through made ground, Tidal Flat Deposits, Glacial Deposits and within the Mercia Mudstone and will require a launch and a reception pit excavating on either bank of the river. Limited dewatering will be required to construct the launch and reception pits. The dewatering will be concentrated in the Tidal Flat Deposits which is of **low** importance for water resources. A further ground investigation will be carried out in 2022 to confirm the hydrogeological and geotechnical characteristics of the launch and reception pits and the sequence of strata which would be penetrated by the trenchless crossing. There are no sensitive water features in the immediate vicinity of the launch and reception pits and hence any local, temporary change in the groundwater level and flow conditions will have a **negligible** impact of **neutral/slight** significance.

<u>CO_2 Gathering Network: Groundwater Quality</u>

3.2.8 As the CO_2 Gathering Network will utilise existing above ground infrastructure with limited excavations (e.g. for new footings for pipe racking) apart from at the Tees crossing, it is considered that the installation of the collection network does not pose a risk to groundwater quality in any of the underlying strata. It is considered that this aspect of the Proposed Development will result in **no change** and will be of **neutral** significance.

<u>PCC Site: Groundwater Level and Flow</u>

3.2.9 The PCC Site is underlain by a thick layer of fill, comprising mainly slag, which overlies the Tidal Flat Deposits. The groundwater level in the Tidal Flat Deposits is between approximately 3m and 4.7m bgl and groundwater flows to the north north-east from approximately 4.2m AOD in the south of the site to 2.6m AOD, north of the site into the Teesmouth and Cleveland Coast SPA, which is a feature of **very high** importance **(Figure 2.3).** There is one pond perched within the sand dunes of the SPA (Pond 14) which is considered to be of **high** importance. Based on an assessment of the groundwater levels in the Tidal Flat Deposits, it is concluded that Pond 14 is not in hydraulic continuity with the groundwater and hence will not be affected **(no change)** by the construction works resulting in an impact of **neutral** significance.

3.2.10 Beneath the PCC Site, it is considered that the Sherwood Sandstone aquifer is at a depth in excess of 250m and protected from potentially-polluting surface activities by the overlying, predominantly low permeability Redcar Mudstone and Mercia Mudstone. Across the Proposed Development the sandstone aquifer does not provide any support to the surface water system. Based on its hydrogeological conditions, it is considered that the Sherwood Sandstone aquifer will not be impacted by the construction works and hence it can be scoped out of any further assessment.

3.2.11 The ground conditions at the PCC Site are geotechnically poor due to the presence of the slag. The platform level for the PCC Site is 7.3m AOD, above the groundwater level in the Tidal Flat Deposits. As part of the site construction, it is proposed that the fill is reworked to form a competent platform for the PCC plant. The fill will be reworked to a depth of up to 3.5m (3.8m AOD) but reworking will not extend below groundwater.

3.2.12 As no dewatering will be required for the construction of the PCC, there will be no adverse impacts on the groundwater level and flow in the Tidal Flat Deposits, beneath the SPA or at Pond 14. Similarly, it is considered that there will be no impacts on the groundwater level and flow in the Sherwood Sandstone aquifer, which is present at depth below the PCC Site. It is considered that this aspect of the Proposed Development will result in **no change** in the groundwater level and flow conditions and therefore no impact on the SPA, resulting in an impact of **neutral** significance.

PCC Site: Groundwater Quality

3.2.13 Contamination has been identified in the fill and in the underlying Tidal Flat Deposits, although contaminant levels are generally low considering the long industrial history of the site. The findings of the contaminated land assessment (ES Chapter 10 Geology and Contaminated Land **[APP-092]**) indicated that contaminants present in the fill posed a low risk to groundwater in the underlying Tidal Flat Deposits and to surface water resources.

3.2.14 It is anticipated that localised pockets of water more highly contaminated with hydrocarbons are present in the fill, perched above the groundwater level in old basement, tanks and structures. As part of the proposals to rework the fill to a depth of 3.5 m, any “hot spots” of contamination identified, such as that proven in trial pit TP06 will be isolated and removed off-site, which will reduce future impacts on groundwater quality in the Tidal Flat Deposits.

3.2.15 Borehole MS/BH04 is located on the edge of the PCC Site to the north and borehole LF/BH01 is located within the CO_2 Export Corridor to the north east, both down hydraulic gradient of the Proposed Development. The groundwater samples collected from the two boreholes show no evidence of significant contamination. Occasional exceedances of the EQS and DWS standards are reported. The highest exceedances are for sulphate, which exceeds the DWS standard of 250mg/l in both boreholes with maximum reported levels of 900mg/l and 1500m/l in boreholes LF/BH01 and MS/BH04 respectively. In addition, in both boreholes, minor

exceedances of the standards were reported for fluoranthene, mercury, chromium, thiocyanate, cyanide and ammoniacal nitrogen. In borehole LF/BH01, mercury concentrations slightly exceeded the EQS standard of 0.05µg/l.

3.2.16 Based on an assessment of the potential risks associated with the contamination present on the PCC Site, it was considered unlikely that the existing groundwater quality poses a significant risk to surface water quality. Remedial measures undertaken on the PCC Site during construction further will reduce the contaminant load and result in an improvement in the quality of the groundwater in the Tidal Flat Deposits. However, it is recognised that currently there are no boreholes to the north west of the site to assess groundwater quality in this down gradient migration route from the PCC Site. These areas will be subject to further investigation and remediation as part of future reclamation and development of this area by Teesworks.

3.2.17 The quality of the water that feeds the Teesmouth and Cleveland Coast SPA is important in determining the nature of its habitats and the species it supports, and therefore is integral to meeting a site's conservation objectives. Poor water quality can have a range of environmental impacts. At high concentrations, toxic chemicals and heavy metals can result in the immediate death of aquatic life (both flora and fauna). At lower concentrations, negative impacts may be more subtle and could increase vulnerability to disease or change the behaviour of wildlife.

3.2.18 The results of the groundwater monitoring during 2021 showed no evidence of significantly contaminated groundwater in the Tidal Flat Deposits, which underlies the SPA and most likely discharges in the inter-tidal or sub-tidal zones. The construction of the PCC should result in an improvement in the quality of the groundwater in the Tidal Flat Deposits and hence reduce any risk to the SPA. The SPA is considered to be a feature of **very high** importance. As the construction of the PCC will not change the groundwater conditions - level, flow and quality, it is considered that there will be **no change** to the SPA and an impact of **neutral** significance.

3.2.19 Whilst no significant impact has been identified from the construction phase on groundwater quality, such works always pose a potential risk from the use and storage of fuels and chemicals and from the off-site migration of sediment-rich runoff. Standard mitigation measures to minimise the risk to water resources associated with these activities will be included in the CEMP.

<u>CO_2 Export Corridor: Groundwater Level and Flow</u>

3.2.20 The CO_2 Export Corridor runs in a north easterly direction extending from the northern edge of the PCC Site across the SPA and out to sea. The corridor will pass through sand dunes of the SPA. The export pipeline will be constructed using trenchless techniques which will pass beneath the dunes of the SPA.

3.2.21 The launch pit for the export pipeline will be located on the PCC Site. A limited amount of dewatering of the Tidal Flat Deposits will be required to construct the launch pit. The upper granular layer of the Tidal Flat Deposits is considered of **medium** importance. As the SPA is not dependent on groundwater in the Tidal Flat

Deposits and there are no other sensitive water features in the area, it is considered that the installation of the export pipeline will have no significant impact on the SPA. Localised dewatering of the Tidal Flat Deposits will have a **negligible** impact on the groundwater level in the vicinity of the launch pit, resulting in an impact of **slight** significance.

CO_2 Export Corridor: Groundwater Quality

3.2.22 The installation of the CO_2 Export pipeline beneath the Teesmouth and Cleveland Coast SPA will have no adverse impact on groundwater quality in the Tidal Flat Deposits which underlies the SPA. As the construction of the PCC will not change the groundwater quality, it is considered that there will be **no change** to the SPA and an impact of **neutral** significance.

Other connections: Groundwater Level and Flow

3.2.23 The pipelines and cables for both the gas connection and electrical connection routes will be constructed below ground, largely through made ground/fill. It is anticipated that the shallow excavations required for the installation of both networks will be above the groundwater level in the Tidal Flat Deposits and hence no dewatering will be required. As a result, it is considered that there will be no impact on the groundwater level or flow in the superficial deposits as a result of the installation of the gas and electrical connections.

3.2.24 The PCC Site is to be cooled by mechanical draft wet cooling towers that are to use water from the existing Northumbrian Water feed. The cooling water will be discharged to Tees Bay via the former steelworks outfall or a replacement outfall. The replacement outfall will be constructed by trenchless techniques.

3.2.25 As there are no proposals to utilise groundwater from the strata beneath the PCC Site as a source of water supply, there will be no impact on the groundwater level and flow in any of the strata below the site. All other services to the site will be installed either at a shallow depth above the groundwater level in the Tidal Flat Deposits or above-ground and hence will have no impact on groundwater level and flow. Therefore, there will be **no change** in the groundwater flow or quality conditions and an impact of **neutral** significance.

Other connections: Groundwater Quality

3.2.26 As the pipelines and cables for the gas connections will be constructed below ground, there is potential that the excavations could intercept isolated pockets of contaminated water in the made ground. Consistent with the construction of other elements of the Proposed Development, any “hot spots” of contamination identified, will be isolated and removed off-site. This will reduce future impacts on groundwater quality in the underlying Tidal Flat Deposits

3.2.27 The design process for the Proposed Development has considered embedded mitigation measures to reduce the potential for adverse effects on surface water and groundwater quality. Many of these measures represent environmental best practice or are legislative requirements. The following impact avoidance measures are included in the Proposed Development and will enable adverse effects on the

water quality to be avoided, both during the construction/decommissioning and operational periods:

- Compliance with industry good practice and environmental legislation during construction, decommissioning and operation;
- Commitment to deliver a Final Construction Environmental Management Plan (CEMP), detailing the environmental protection measures (e.g. safe materials storage, emergency clean-up plans for leaks and spills, etc.); and,
- Minimisation of surface or underground water flow into the ponds of the Coatham Dunes units of the Teesmouth and Cleveland Coast SSSI during construction and decommissioning.

3.2.28 Further specific mitigation guidance is identified in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2) to reduce surface run-off, dispersion of suspended sediments and spillage risk in the construction/decommissioning periods. The mitigation measures include:

- Temporary drainage system during construction/decommissioning to prevent direct surface run-off;
- Safe storage of flammable, toxic or corrosive materials within bunded and secured areas;
- Refuelling, oiling or greasing of machinery above drip rays or other impermeable surfaces;
- Provision of wash down facilities for plant and machinery; and
- Continued water quality monitoring in relevant waterbodies (groundwater and surface water) against established baseline levels, for any pollution incidents to be dealt with effectively.

3.2.29 As installation of the services will not impact on the groundwater in the Tidal Flat Deposits, the provision of services to the PCC Site will have no impact on groundwater quality. Mitigation measures will be included in the CEMP to control the use and storage of fuels and chemicals which will minimise the potential to adversely affect groundwater quality. Provided that these measures are implemented, impacts on groundwater quality in the Tidal Flat Deposits will be **negligible** with an impact of **neutral** significance.

Cumulative Effects

3.2.30 The main elements of the Proposed Development cover separate areas of the site and there is no overlap. The impacts on controlled waters are different, separate and specific for each element. Accordingly, it is considered that there are no cumulative impacts on groundwater or surface waters posed by the Proposed Development.

3.2.31 The area of the Proposed Development and the surrounding areas will be the subject of future remediation activities, which will be designed to reduce the potential contamination risks/impacts. These activities will result in an improvement in the

quality of the ground and the underlying groundwater resulting in a beneficial environmental impact.

3.3 Operational Period

Groundwater Level and Flow

3.3.1 No dewatering will be required during the operational period for any element of the Proposed Development and hence impacts on groundwater level and flow can be excluded for this phase of the Proposed Development. Accordingly, there will be **no change** in the groundwater level and flow conditions during the operational period and hence an impact of **neutral** significance.

Groundwater quality

3.3.2 In the absence of mitigation, similar water quality issues are likely to be relevant for the Proposed Development in the operational phase as apply in the construction phase. This includes potentially contaminated surface run-off and leaks from machinery and plant involved in the day-to-day operation of the power plant, and pollution from sewage effluent. Unmitigated, these pollutants may enter the Teesmouth and Cleveland Coast SPA / Ramsar directly or indirectly via groundwater or surface water in hydrogeological continuity with the SPA.

3.3.3 Mitigation measures will be included in the operational phase to minimise the risk of any leaks from machinery and runoff from areas containing potentially contaminated materials entering the site drainage, groundwater and surface watercourses. These will be refined from those measures included the Final Construction Environmental Management Plan. This will include a new surface water drainage system for the PCC Site. All sewage from the site will be discharged to the foul sewer for treatment at Northumbrian Water's Marske-by-the-Sea Wastewater Treatment Plant and hence will have no impact on water quality on the Proposed Development.

3.3.4 With the implementation of these mitigation and control measures, it is considered that the impact on groundwater and surface water quality, including on the Teesmouth and Cleveland Coast SPA, during the operational phase of the Proposed Development will be **negligible** with an impact significance of **slight**.

3.4 Decommissioning

3.4.1 The potential sources and the impacts of decommissioning on groundwater and surface water will be similar to those identified during the construction phase of the Proposed Development. In addition, there will be a need to manage residual contaminants associated with the operation of the site to minimise the risk of uncontrolled migration into groundwater and the surface water system.

3.4.2 Compliance with industry good practice and appropriate guidance should ensure that any risks/impacts to groundwater and surface water, including the Teesmouth and Cleveland Coast SPA will be minimised. Therefore, it is considered that the impact on groundwater level, flow and quality and on surface water quality, during decommissioning of the Proposed Development will be **negligible** with an impact significance of **slight.**

4.0 SUMMARY OF LIKELY SIGNIFICANT IMPACTS

4.1 Introduction

4.1.1 This section provides a summary of the anticipated impacts on groundwater and surface water features on and adjacent to the Proposed Development. The principal water receptors which have a plausible linkage with the Proposed Development are the Tidal Flat Deposits, which underlie much of the Proposed Development and the Teesmouth and Cleveland Coast SPA / Ramsar site to the north of the PCC Site. The Tidal Flat Deposits also form a pathway for effects to be transmitted to other water features.

4.1.2 The impact assessment is based on **Tables 3.1** and **3.2** to identify where significant impacts could be realised. Significant impacts are considered those of moderate or higher significance. Impacts of slight or neutral significance are considered acceptable. **Table 4.1** provides a summary of the impact assessment.

Table 4.1: Summary of the Impact Assessment

	Groundwater level and flow		Groundwater and surface water quality inc. SPA	
	Impact	**Significance**	**Impact**	**Significance**
CONSTRUCTION PHASE				
CO_2 Gathering Network	Negligible	Neutral/slight	No change	Neutral
PCC Site	No change	Neutral	No change	Neutral
CO_2 Export Corridor	Negligible	Slight	No change	Neutral
Other Connections	No change	Neutral	Negligible	Slight
OPERATIONAL PHASE				
All elements	No change	Neutral	Negligible	Slight
DECOMMISSIONING PHASE				
All elements	No change	Neutral	Negligible	Slight

4.1.3 Based on the findings of the hydrogeological Impact Assessment, it is considered that no unacceptable significant impacts will arise from the construction, operation and decommissioning of the Proposed Development. Predicted impacts are at worst 'slight', associated mainly with areas of limited and temporary dewatering required for the HDDs below the River Tees and the SPA.

4.1.4 Further groundwater monitoring is necessary to confirm the impact on groundwater quality beneath the SPA to the north and north west of the Proposed Development. However, based on the results of groundwater quality samples from boreholes down hydraulic gradient of the proposed PCC Site, there is currently no evidence of significant groundwater contamination migrating from the existing site.

4.1.5 In summary, although the Teesmouth and Cleveland Coast SPA is a feature of vary high importance and is in close proximity and downstream of the Proposed

Development, it is concluded that there will be no significant adverse impacts on the SPA

4.1.6 The findings of an Appropriate Assessment of the SPA included in the *Habitat Regulations Assessment Report,* V3 **[AS-194]** also conclude that the Proposed Development will not result in adverse effects on the Teesmouth and Cleveland Coast SPA / Ramsar in respect of water quality.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Based on the findings of the Hydrogeological Impact Assessment, the following conclusions can be drawn:-

- The Proposed Development is underlain by a variable thickness of superficial deposits, which overlie bedrock of Triassic and Jurassic age. The bedrock dips to the east;
- Tidal Flat Deposits underlie the majority of the Proposed Development, comprising an upper granular layer above a lower clay-rich unit. The Tidal Flat Deposits are between approximately 4m and 21m thick below the main PCC Site;
- The Tidal Flat Deposits are underlain by glacial till and glacio-lacustrine deposits, which has been deposited in valley features and which vary in thickness between approximately 2m and 30m;
- The Tidal Flat Deposits are overlain by a layer of made ground and slag up to at least 9 m thick arising from the historical use of the site as a steelworks;
- In the west of the Proposed Development, the bedrock comprises the Triassic Sherwood Sandstone. In the central part, the sandstone is overlain by the Triassic Mercia Mudstone and in the eastern part, including below the main PCC Site, the bedrock is the Jurassic, Redcar Mudstone;
- The Sherwood Sandstone is a principal aquifer that forms a regionally important water resource;
- The overlying Mercia Mudstone and Redcar Mudstone are of low permeability and provide protection to the Sherwood Sandstone aquifer. Both strata are of low importance as a water resource;
- There is evidence of contamination in the made ground, principally associated with 'hot spots' of hydrocarbons. Slight contamination, shown by locally elevated concentrations of cyanide, naphthalene and ammoniacal nitrogen, is present in the groundwater in the Tidal Flat Deposits within the PCC site;
- The groundwater quality in the Redcar Mudstone is poor attributed either to the presence of connate water or to saline intrusion with electrical conductivity values up to 38,705µS/cm and sulphate concentrations up to 1,500 mg/l;
- The principal hydrogeological receptors in the vicinity of the Proposed Development are the Sherwood Sandstone aquifer, the Tidal Flat Deposits and the Teesmouth and Cleveland Coast SPA and Coatham Dunes SSSI;
- The Sherwood Sandstone aquifer is present at a significant depth below the main PCC Site and is protected by the overlying, low permeability Mercia Mudstone and Redcar Mudstone. It is concluded that the Sherwood Sandstone aquifer is not at risk from the Proposed Development;

- Immediately north of the PCC Site is the Teesmouth and Cleveland Coast SPA and Coatham Dunes SSSI, which are of very high importance;
- Changes to groundwater level and flow in the Tidal Flat Deposits due to the Proposed Development will be temporary and are associated with the construction of the launch and reception pits for an HDD crossing below the River Tees and for the launch pit for the HDD pipeline in the CO_2 Export Corridor below the SPA. At both locations, limited dewatering of the Tidal Flat Deposits will be required;
- It is concluded that there will be no significant impact on groundwater level and flow as a result of the construction, operation and decommissioning of the Proposed Development;
- Slight adverse impacts are predicted on groundwater quality as a result of the Proposed Development. Proposals to remediate areas of contamination within the made ground to form the construction platform for the PCC Site will reduce the risks of future contamination of the groundwater in the Tidal Flat Deposits; and,
- It is concluded that with the mitigation measures in place to address construction, decommissioning and operational water quality impacts, there will be no adverse effects on groundwater or on the integrity of the Teesmouth and Cleveland Coast SPA either alone or in combination with other plans and projects.

5.2 Recommendations

5.2.1 The ground investigation carried out in 2021 included the installation of groundwater monitoring boreholes on the northern boundary of the PCC Site and within the CO_2 Export Corridor down hydraulic gradient. However due to access limitations, it was not possible to drill monitoring boreholes to the north and north west, also down hydraulic gradient of the main site. It is recommended that monitoring boreholes are drilled in this area to confirm the impact of the existing site on groundwater quality.

5.2.2 It is recommended that a monitoring programme is designed to assess the impact of the construction activities on groundwater level and quality in the Tidal Flat Deposits. Monitoring should commence in advance of construction and should include the proposed new boreholes to the north and north west of the PCC Site to understand the natural variations in groundwater level and quality and to establish a database against which to compare the results during construction of the Proposed Development.

5.2.3 Piled foundations are likely be used during the construction of the buildings on the PCC Site. A Piling Risk Assessment should be undertaken in advance of construction to assess the potential impacts on the groundwater flow and quality in the strata intercepted by the piles.

APPENDIX A GEOLOGICAL CROSS SECTIONS