Net Zero Teesside Power Limited

Environmental Permit Variation

Appendix F - Water Impact Assessment

Reference:

P2 | 10th February 2026

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Ove Arup & Partners Limited
12 Wellington Place
Leeds
LS1 4AP
United Kingdom
arup.com

ARUP

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		Name	Livia Almeida	Kevin Barry	Helen Watson
		Signature			
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			Prepared by	**Checked by**	**Approved by**
		Name	Livia Almeida	Kevin Barry	Helen Watson
		Signature			
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		Name			Helen Watson
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1. Introduction

1.1 Methodology

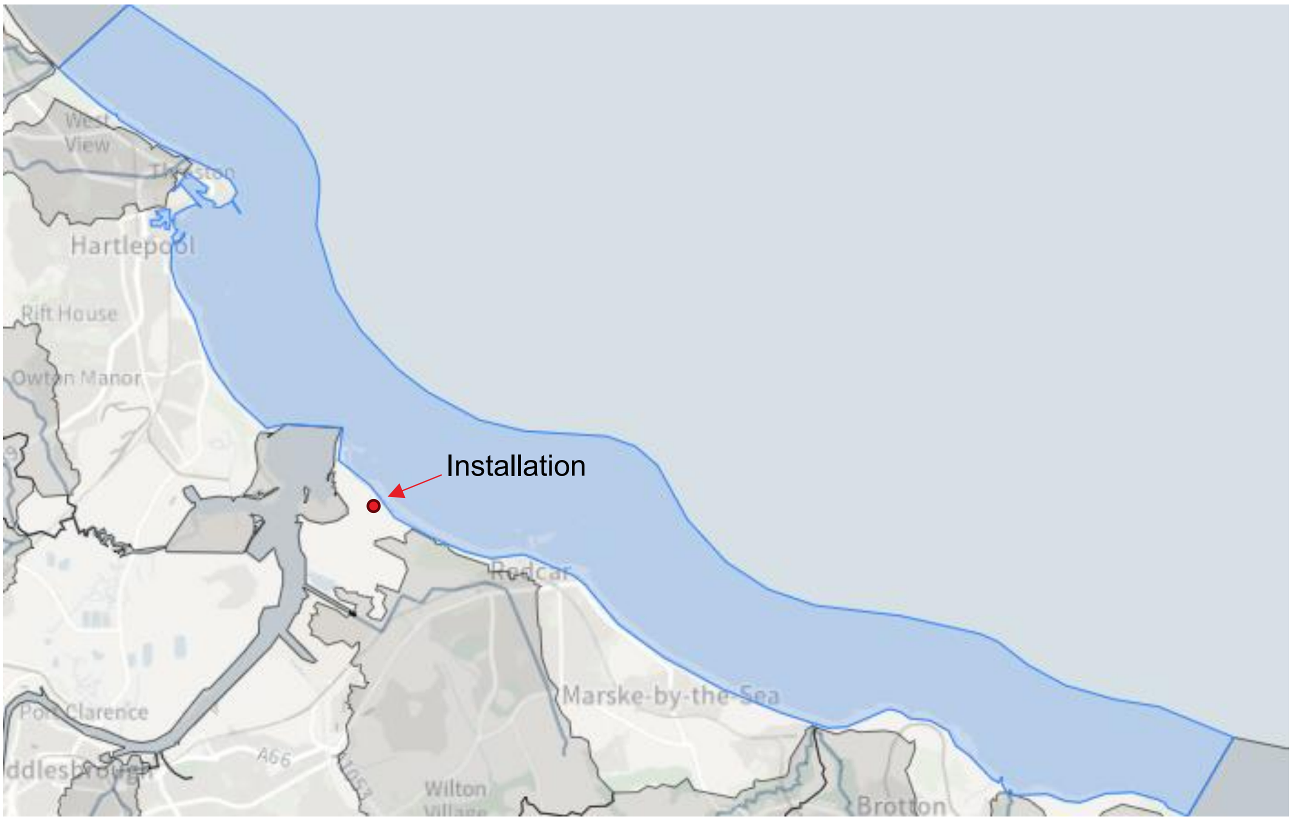
A Water Impact Assessment of the process wastewater emissions to receiving waters has been undertaken to support the Environmental Permit variation application for the Net Zero Teesside Power Station and Carbon Capture Plant (the "Installation") reference EPR/PP3501LR.

The Environment Agency's (EA) guidance 'Surface water pollution risk assessments for your environmental permit'[1] presents a methodology for the assessment of potential environmental impacts associated with discharges to different types of receiving waters: (1) Fresh waters, (2) Estuaries and coastal waters, and (3) Cooling waters which are then discharged to estuaries.

The methodology is utilised as part of the H1 screening assessment tool developed by the EA which is used to carry out an initial screening assessment of the potential impact of an effluent discharge to its receiving water, relative to established Environmental Quality Standards (EQSs). Any parameter discharged to a water body that is not screened out as part of the H1 assessment will need to be examined in greater detail using detailed modelling.

The screening assessment for the Installation has been undertaken for 'estuaries and coastal waters' given that the receiving water for the discharged from the Installation is designated as a Transitional Rivers and Coastal (TraC) as indicated in Figure 1.

Figure 1: Tees Coastal Water Body (Environment Agency UK)



1.2 Overview of the Assessment Steps

There are five separate steps to the H1 screening assessment tool for discharges to estuaries and coastal waters which are listed as:

[1] https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

Test 1 – Check if the effluent concentration is greater than the EQS. If not, the discharge is considered to have passed this test and can be considered to have "insignificant" impact and is therefore screened out of the assessment. However, if either the long-term or short-term concentrations are above the EQS, then the parameter cannot be screened out and the parameter needs to be considered as part of the next test (Test 2).

Test 2 – This test assesses if the effluent is discharged to a low water channel in the upper parts of an estuary where the water is mainly fresh. If this is the case, the screening tests for freshwater is to be undertaken. If these do not apply to the site of the discharge point, then the assessment proceeds to Test 3.

Test 3 - This test assesses whether the receiving waters have a restricted dilution or dispersion characteristics such as enclosed bays, docks and ports. If so, then the parameters cannot be screened out and detailed modelling needs to be undertaken. If the discharge is not to a restricted location then Test 4 needs to be undertaken.

Test 4 - This test assesses the distance between the discharge point and the point (or line) where the water depths are shown on nautical charts as zero (i.e. the chart datum). The parameters cannot be screened out as part of this test if either of the following conditions apply:

- the discharge location is less than 50m offshore from where the seabed is at chart datum;
- or the seabed at the discharge location is less than 1m below chart datum.

If these conditions do not apply to the discharge site, all the parameters remain screened in and Test 5 should be undertaken.

Test 5 - This test calculates the effective volume flux for each parameter and compares it with the allowable effective volume flux for the discharge location. If the effective volume flux of the discharge is less than the allowable effective volume flux, it is considered to have passed the test and is deemed to have an insignificant impact and is therefore screened out. However, if the discharge fails Test 5 then detailed modelling of the relevant parameter needs to be undertaken.

There are three steps to Test 5:

- Step 1 - the effluent discharge rate is multiplied by the release concentration of the chemical.
- Step 2 - the average background concentrations are subtracted from EQS limits.
- Step 3 - the result from Step 1 is divided by the result from Step 2. The result from Step 3 is the effective volume flux.

It is noted that for water depths more than 3.5m below chart datum, the allowable effective volume flux is fixed at 3.5 cubic metres per second.

2. Water Quality Screening Assessment

2.1 Input Data for the H1 Assessment

The concentrations for 21 separate parameters in the merged effluent waste streams from the Installation has been provided to Arup and have been used as input to the H1 assessment. The input parameters have been based on engineering data produced during detailed design of the Installation. The concentrations do not include any dilution from surface water run-off from the site and therefore represent a worse-case scenario.

The concentrations of the parameters in the effluent are provided in Table 2.1. It can be seen from the table that the final effluent (referred to as "combined reject" in the table) is the combination of the cooling tower blowdown and reverse osmosis (RO) reject concentrations. A calculated effluent flow rate of $0.040m^3/s$ ($143.4m^3/hr$) has been used which is indicted in the first row of the table and is based on normal operation. Further detail of the wastewaters generated through the operation of the Installation is provided in the Main Supporting Document.

Table 1: H1 Input Paramters

Parameter	Cooling tower blowdown	RO Reject	Combined Reject
Flow (m^3/h)	**120**	**23.4**	**143.4**
Total Organic Carbon (mg/l)	50	0	41.84
Chemical Oxygen Demand (mg/l)	150	0	125.52
Total Suspended Solids (mg/l)	30	10	26.74
Calcium (mg/l)	253	371	271.93
Magnesium (mg/l)	58	96	64.41
Iron (total) (mg/l)	2.75	0	2.30
Manganese (mg/l)	0.30	0	0.25
Chloride (mg/l)	221	372	245.64
Sulphate (mg/l)	493	769	538.04
Ammonia (mg/l)	7	0	5.86
Sodium (mg/l)	131	156	135.08
Fluoride (mg/l)	1.40	2	1.50
Cadmium (mg/l)	0.00034	-	0.00028
Chromium (mg/l)	0.0077	-	0.0064
Copper (mg/l)	0.012	-	0.010
Nickel (mg/l)	0.0088	-	0.0074
Lead (mg/l)	0.10	-	0.084
Zinc (mg/l)	0.20	-	0.17
Mercury (mg/l)	-	-	-
Total phosphorus (as P) (mg/l)	4.60	-	3.85
Dissolved Inorganic Nitrogen (mg/l)			20

2.2 Input Geometry Data

A number of the steps of the H1 assessment consider the depth of water at the outfall location as well as the distance of the outfall from land. As the bed level at the location of the outfall is -9.4mOD a minimum water depth of 10m has been assumed to inform the assessment. The distance of the outfall from the land is noted as approximately 1,130m.

2.3 Dissolved Inorganic Nitrogen

A Nutrient Nitrogen Safeguarding Scheme (NNSS) has been undertaken as part of the wider project to fulfil Requirement 37 of the Development Consent Order (DCO) for the Net Zero Teesside Proposed Development. This work is detailed in a report produced by AECOM in January 2025 (Annex A). As part of the NNSS, detailed dispersion modelling of dissolved inorganic nitrogen (DIN) in both the near and far field of the receiving waters was undertaken. The models were informed by the most up-to-date design of the plant at the time at which the study was undertaken (Q4 of 2024).

The findings of the study clearly demonstrate that there is no net increase in DIN loads within the Tees Estuary at the Seal Sands mud flats and that discharges from the Installation will not impact on the Water Framework Directive status of the Tees Coastal Water, Tees Transitional Waterbody or Tees Estuary. The Installation will therefore not impact on the delivery of good status in terms of winter average DIN concentrations in Tees Bay, as regulated under the Water Framework Directive.

Furthermore, through the NNSS study, the development was demonstrated to be compatible with the delivery of nutrient neutrality within the River Tees estuary and will slightly reduce the annual nitrogen loading of this waterbody. The Proposed Development was therefore demonstrated to be in compliance with Requirement 37 of the DCO.

The effluent monitoring strategy has been agreed with the EA following extensive consultation and is detailed in Chapter 5 of the AECOM report. The key discharge parameters agreed with the EA as part of the effluent monitoring strategy are stated for both (1) Process effluent only, and (2) With surface water runoff included:[2]

Process effluent only:

- Flow rate of 344 m^3/hr;
- An average effluent DIN concentration of 20.0 mg/l.

With surface water runoff included:

- Flow rate of 1,644 m^3/hr;
- An average effluent DIN concentration of 4.3 mg/l.

Since the NNSS assessment was produced by AECOM in January 2025, the design of the plant has been finalised and the effluent volumes have been confirmed (refer to Table 1 of this report). From inspection of the final effluent flows, it is evident that they are less than the flows adopted to inform the NNSS: i.e. 344m^3/hr as per the NNSS > 143.4m^3/hr as per Table 1.

As there is no change to the concentration of released DIN, and the effluent flows have reduced, it is not necessary to revise the DIN modelling as part of this Environmental Permit variation assessment given that the overall DIN loading in the final effluent will be much less than what was considered previously by AECOM as part of the NNSS. All the key conclusions from the NNSS therefore remain valid when the final flows are considered.

As DIN represents the sum of various nitrogen compounds in water that are available for uptake (i.e. nitrate (NO_3^-), nitrite (NO_2^-), and ammonium (NH_4^+)) it is therefore also not necessary to consider these additional species of nitrogen as part of the permit variation assessment.

[2] Refer to Table 2-1 of the AECOM report

3. H1 Assessment Results

3.1 Test 1

The findings of Test 1 are presented in Table 2. It can be seen from Table 2 that six of the parameters (iron, cadmium, chromium, copper, lead, zinc) are deemed to fail this test and cannot be screened out. Each of these parameters are therefore taken forward to Test 2.

The remaining parameters are screened out for one of two reasons: (1) their concentrations are less than the relevant EQS, or (2) there is no EQS in coastal waters for the parameters as they are not deemed to present a risk of the aquatic environment. These parameters are listed as: Total Organic Carbon; Chemical Oxygen Demand; Total Suspended Solids; Calcium; Magnesium; Manganese; Chloride; Sulphate; Sodium; Fluoride; Nickel; Mercury and total phosphorus.

Table 2: Results of Test 1

Parameter	Conc from Effluent	Permit Emission Limit Value (ELV)	Annual Average (AA) EQS	Maximum Allowable Concentration (MAC) EQS	Category	Screening Test 1 (ELV)	Screening Test 1 (AA)	Screening Test 1 (MAC)
Total Organic Carbon (mg/l)	41.84	50				Pass		
Chemical Oxygen Demand (mg/l)	125.52	150				Pass		
Total Suspended Solids (mg/l)	26.74	30	100			Pass	Pass	
Calcium (mg/l)	271.93							
Magnesium (mg/l)	64.41							
Iron (total) (mg/l)	2.30		1	Not applicable	SP		Fail	
Manganese (mg/l)	0.25		Not applicable	Not applicable	SP			
Chloride (mg/l)	245.64		Not applicable	Not applicable	O			
Sulphate (mg/l)	538.04		Not applicable	Not applicable	O			
Sodium (mg/l)	135.08							
Fluoride (mg/l)	1.50	25	5	15	O	Pass	Pass	Pass
Cadmium (mg/l)	0.00028	0.005	0.0002	Not applicable	PHS	Pass	Fail	
Chromium (mg/l)	0.0064	0.05	0.006	0.03 (95th percentile)	SP	Pass	Fail	Pass
Copper (mg/l)	0.010	0.05	0.004	Not applicable	SP	Pass	Fail	
		-	(3.76+(2.677x((DOC/2)–0.5)))/1000	Not applicable	SP	-	-	-
Nickel (mg/l)	0.0074	0.05	0.009	0.03	PS	Pass	Pass	Pass
Lead (mg/l)	0.084	0.02	0.001	0.01	PS	Fail	Fail	Fail
Zinc (mg/l)	0.17	0.2	0.007	Not applicable	SP	Pass	Fail	
Mercury (mg/l)	-	0.003	Not applicable	0.00007	PHS	-	-	-
Total phosphorus (as P) (mg/l)	3.85							

*Some abbreviations are used in this table, O is operational, SP is specific pollutant, PHS is priority hazardous substance and PS is priority substance.

3.2 Test 2

A minimum depth of water of approximately 10m is achieved at the outfall location for all stages of the tidal cycle. The outfall location is therefore not in the intertidal zone and is not subject to flooding and drying of the tide. Freshwater dilution conditions are therefore not relevant. Each of the six parameters remain screened in and are taken forward to Test 3.

3.3 Test 3

The discharge location is not to an area with a “restricted dilution” designation. Each of the six parameters remain screened in and are therefore taken forward to Test 4.

3.4 Test 4

The proposed outfall location is located approximately 1,130m from the shoreline which is significantly greater than 50m. As the minimum depth of water is approximately 10m, each of the six parameters remain screened in and are therefore taken forward to Test 5.

3.5 Test 5

As noted above, there are three separate steps to estimating the volumetric flux from the outfall as part of Step 5. These are summarised as:

- Test 5, Step 1 – the flux of each parameter from the outfall was calculated by multiplying the release concentrations and effluent flow rates;
- Test 5, Step 2 – the average background concentrations of the various parameters were first taken from three separate sources: (1) NZT DCO Appendix 9C WFD Assessment (report provided as Annex B, information taken from its Annex C – Surface Water Quality Data at the Tees at the Gares station (2009 to 2019)), (2) measured concentration at the Tees at the Gares station, and (3) measured concentration at the Redcar Jetty station. Once these background concentrations were established there were subtracted from the EQS of the relevant parameter in order to provide an estimate of the capacity of the system as regards concentration of the relevant parameter;
- Test 5, Step 3 – the effective volume flux for each parameter was then calculated by dividing the flux from the outfall (estimated from Step 1) by the capacity in the system (estimated from Step 2).

As per EA guidance the allowable effective volume flux at the site is fixed at 3.5 m^3/s (3,500 l/s) given that water depths at site are more than 3.5m below chart datum. Any parameters with an effective volume flux greater than this value remains screened and will therefore require detailed modelling.

The findings of Test 5 are presented in the following three tables, each of which corresponds to one of the Steps of Test 5:

- Table 3 – Step 1 of Test 5;
- Table 4 – Step 2 of Test 5;
- Table 5 – Step 3 of Test 5;

It can be seen from Table 5 that all six parameters have an effective volumetric flux less than the maximum allowable for the three separate EQS scenarios considered: Permit ELV, Annual Average concentration (AA) and Maximum Annual Concentration (MAC). This is due to their being significant "capacity" in the receiving water to accommodate the loadings from the Installation for each of the parameters considered – the background concentrations represent a relatively small fraction of the EQS and the loadings from the Installation are relatively low. It can therefore be concluded that each of the six parameters will not have any adverse impact on the quality of the receiving water and can therefore be screened out as part of Test 5. Detailed modelling of the parameters in the receiving water is therefore not required.

The H1 screening assessment is provided in Annex C, which contains the EA's H1 Access screening tool and Arup's calculation spreadsheet.

Table 3: Test 5 Step 1

Element	Release Conc (mg/l)	Flux (mg/s)
Iron (total)	2.30	91.67
Cadmium	0.0003	0.011
Chromium	0.01	0.26
Copper	0.01	0.40
Lead	0.08	3.33
Zinc	0.17	6.67

Table 4: Test 5 Step 2

Element	Avg Bac Conc (mg/l)	PL Conc (mg/l)	EQS AA (mg/l)	EQS MAC (mg/l)	Capacity PL (mg/l)	Capacity AA (mg/l)	Capacity MAC (mg/l)
Iron (total)	0.2380	-	1.0000	-	-	0.76	-
Cadmium	0.0001	0.0050	0.0002	-	0.005	0.0001	-
Chromium	0.0052	0.0500	0.0060	0.03	0.045	0.001	-
Copper	0.0006	0.0500	0.0038	-	0.049	0.003	-
Lead	0.0001	0.0200	0.0013	0.01	0.020	0.001	0.01
Zinc	0.0022	0.2000	0.0068	-	0.198	0.005	-

Table 5: Test 5 Step 3

Element	Eff Vol Flux Per Lim (l/s)	Eff Vol Flux AA (l/s)	Eff Vol Flux MAC (l/s)	Max Allow Vol Flux (l/s)
Iron (total)	-	120.30	-	3500
Cadmium	2.30	85.21	-	3500
Chromium	5.73	329.06	-	3500
Copper	8.17	128.86	-	3500
Lead	167.74	2,844.14	240.29	3500
Zinc	33.70	1,438.95	-	3500

4. Conclusions

A Water Impact Assessment of the process wastewater emissions to receiving waters has been undertaken to support the Environmental Permit variation application for the Installation.

The methodology set out in the EA's guidance 'Surface water pollution risk assessments for your environmental permit' has been followed to determine the potential environmental impacts associated with the discharge to the "estuaries and coastal waters receiving water "type".

The assessment assumed no dilution from clean surface waters collected on site and discharged with the process wastewaters and therefore is considered to represent very much a worst case assessment.

The findings of the H1 screening assessment confirm that all the parameters potentially released from the Installation will not have any adverse impact on the quality of the receiving waters. It is therefore considered that further detailed modelling is not required to support the Environmental Permit variation application.

Annex A -AECOM (2025) Net Zero Teesside, Effluent Nutrient Nitrogen Safeguarding Scheme Report

Net Zero Teesside

Effluent Nutrient Nitrogen Safeguarding Scheme

bp

Project number: 60689030

24 January 2025

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Quality information

Prepared by	Checked by	Verified by	Approved by
Sarah Waite Senior Hydrologist	Paul Norton Technical Director	Katie Pearson Technical Director	Ian Campbell Associate Environmental Scientist

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Prepared for:

bp

Prepared by:

Sarah Waite
Senior Hydrologist
E: sarah.waite@aecom.com

AECOM Limited
100 Embankment
Cathedral Approach
Manchester M3 7FB
United Kingdom

T: +44 161 601 1700
aecom.com

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1. Introduction

1.1 Compliance with DCO Requirement 37

The proposed Net Zero Teesside development (the Proposed Development) is located on part of the former Redcar Steel Works which operated until 2015. It is proposed to redevelop the site and construct a gas fired power station with carbon capture and associated infrastructure required to enable CO_2 produced by the power station to be compressed and conveyed to offshore geological storage.

During operations, it is proposed to discharge wastewater from on-site processes to Tees Bay via an offshore discharge point. Following the examination stage of the application for a Development Consent Order (DCO), permission for implementation of the proposals was given subject to a number of Requirements. Requirement 37 states as follows:

1) *No part of the authorised development other than the permitted preliminary works may commence until an effluent nutrient nitrogen safeguarding scheme has been submitted to and, after consultation with Natural England and the Environment Agency, approved by the relevant planning authority.*

2) *The effluent nutrient nitrogen safeguarding scheme submitted pursuant to paragraph (1) must include the following –*

   a. *Details of the selected design and discharge location of the infrastructure that will treat and discharge effluent containing nitrogen produced by the operation of the authorised development;*

   b. *Discharge modelling of the design selected pursuant to sub-paragraph (a) and which (unless otherwise agreed with the relevant planning authority after consultation with Natural England and the Environment Agency) is based on the modelling methodology in Appendix B of the nutrient nitrogen briefing paper; and*

   c. *Information on the wastewater discharge monitoring methods, frequency and locations that will be undertaken pursuant to any environmental permits required for the authorised development.*

3) *The effluent nutrient nitrogen safeguarding scheme submitted pursuant to paragraph (1) must demonstrate that nitrogen in effluent from the operation of the authorised development is controlled and discharged in order that nitrogen in the effluent will –*

   a. *Not cause a net increase in total nitrogen loads in water with the Tees Estuary at the Seal Sands mud flats; and*

   b. *Not impact on the Water Framework Directive status of the Tees Coastal Water, Tees Transitional Waterbody or Tees Estuary.*

4) *The undertaker must implement the effluent nutrient nitrogen safeguarding scheme as approved, unless otherwise agreed with the relevant planning authority following consultation with Natural England and the Environment Agency.*

This document sets out the Effluent Nutrient Nitrogen Safeguarding Scheme as described in Requirement 37 of the DCO. The document is structured as follows:

- Section 2 provides details of the onsite generation, management and treatment of effluent and provides realistic values for final discharge effluent flows and nutrient nitrogen loads. This section also provides a summary of the diffuser head design and outfall location.
- Section 3 provides details of the receiving environment of Tees Bay, including the current ambient nutrient nitrogen concentrations. This section provides the background information on the hydrodynamic model used to simulate dispersion of the effluent plume within the coastal waters, following the same methodology as in Appendix B of the nutrient nitrogen briefing paper.
- Section 4 sets out the results of the dispersion modelling and assesses the impact of the discharge on the Water Framework Directive status of the receiving waters as well as impacts at Seal Sands. The modelling demonstrates that the Proposed Development will have limited impact on nutrient concentrations in the Bay

and will not impact the Teesside and Cleveland Coast Special Protection Area/Ramsar site, including parts of Tees Bay and the Tees Estuary (Seal Sands).

- Section 5 outlines the proposed wastewater discharge monitoring method, frequency and location, in line with the requirements of the Environmental Permit issued for the site (permit number EPR/PP3501LR).

1.2 Previous Modelling Studies

Previous dispersion modelling and water quality impact assessments have been carried out for the wider Redcar Steelworks site and for the Proposed Development:

1) **Teesside Water Quality Modelling: Tidal Water Analysis, AECOM, June 2020.** Near field modelling of mixing zones from existing Redcar Steelworks outfalls to the River Tees and Tees Bay was carried out to support applications for ongoing discharges of surface water and generator cooling water at the Redcar site during the "keep safe" phase of decommissioning and demolition of the steel works. This work was carried out for the South Tees Site Company Ltd.

2) **Net Zero Teesside – Environmental Statement, Volume III – Appendices – Appendix 14E: Coastal Modelling Report, ABPmer and AECOM, April 2021.** A preliminary study of near field and far field mixing of discharges from the Proposed Development was conducted during the initial stages of site design. Given the limited design information available to inform the report, the dispersion modelling focussed on thermal impacts based on a single future discharge rate estimate and a worst-case scenario discharge temperature. The report assessed the impacts associated with discharges from a large existing legacy outfall point from the Redcar Steelworks site (described as discharge point W3 in the June 2020 report) and at potential new offshore outfall locations. The report also detailed the construction of a hydrodynamic model of Tees Bay and the River Tees estuary and concluded that thermal impacts would not be significant regardless of outfall location.

3) **PCC Outfall Study (Net Zero Teesside (NZT) / Northern Endurance Partnership (NEP) Carbon Capture & Storage Project), Wood & bp Exploration Operating Company Ltd, August 2022.** Wood designed the potential new offshore outfall, including the diffuser head, and carried out near field dispersion modelling to assess the plume mixing dynamics arising from the design.

4) **Net Zero Teesside – Water Quality Assessment: Intermediate Design Stage, Alternative Discharge Location, AECOM, October 2022.** AECOM used the hydrodynamic model developed for the April 2021 report to carry out further far field and near field dispersion modelling for the Proposed Development. This was carried out for the new offshore discharge location only following confirmation of the location and survey of the W3 outfall which confirmed it could no longer be used. AECOM's work incorporated the outfall design from the August 2022 report and the additional site design information available at that time, including improved information on effluent stream flows and loads. The modelling focussed on chemical and thermal impacts, with far field modelling of DIN and near field modelling of chromium (VI) and zinc mixing zones. Thermal impacts were confirmed to be negligible. This report was submitted with the DCO application and reviewed by regulators, however it was acknowledged that the modelling was still based on outline designs and further dispersion modelling would be carried out following finalisation of the design.

The Proposed Development is now at a later stage of design and the dispersion modelling detailed in the sections below is now informed by:

- The finalised design of the proposed outfall diffuser head (updated following submission of the October 2022 report)
- Further details of the planned process water treatment facilities to be provided, along with nitrogen removal capability
- Updated anticipated design flows for effluent streams through the Proposed Development, and;
- Additional information on raw water nitrogen concentrations supplied by Northumbrian Water subsequent to submission of the October 2022 report.

The design flows used in this Nutrient Safeguarding Strategy reflect a realistic worst-case scenario for discharges from the Proposed Development. The actual flows may be less than the design flow, for example in times of reduced power station utilisation or when plant operation results in an intermittent discharge, however discharges at rates less than the design flow will result in reduced water quality impact compared to those shown in this report.

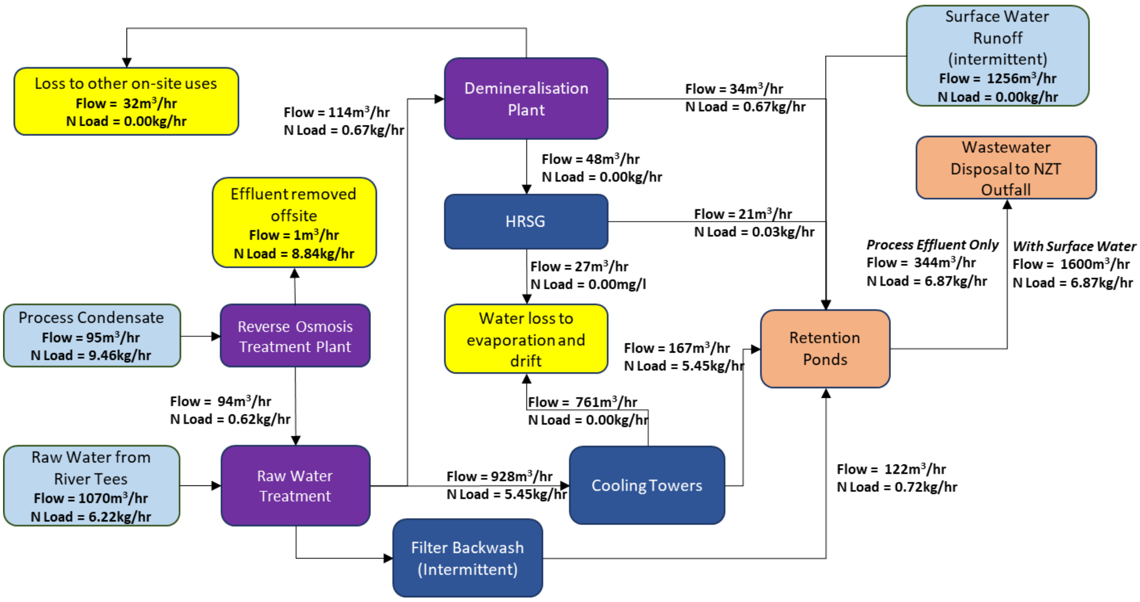
2. On-site Effluent Generation

2.1 Development Proposals

The Proposed Development is summarised as follows in terms of water supply, disposal and management:

- The Proposed Development is supplied with raw water from the River Tees. Additional water supply to the site is derived from recycled Process Condensate which contains a high concentration of nitrogen (99.6 mg/l N as ammonia) and will be treated by reverse osmosis which will remove 98% of the nitrogen load for disposal offsite.
- The two treated water supply streams will be combined and treated to remove solids via Dissolved Air Flotation (DAF) and ultrafiltration. This will remove some nitrogen, including particulate nitrogen, from the River Tees Water, however since the extent of removal of dissolved contaminants such as dissolved inorganic nitrogen (DIN) is likely to be variable, no reduction in DIN has been accounted for in this treatment stage. This is a realistic worst-case scenario.
- The treated water will be used to supply cooling towers and a demineralisation plant. Blowdown from the cooling towers, water from filter backwashing and reject water from the demineralisation plant will be directed to retention ponds for holding prior to discharge. This assessment has assumed that there will be no reduction in DIN load in the final waste stream from any of these stages. This is a conservative assumption because, for example, reactions between DIN and cooling tower dosing chemicals will convert some nitrogen compounds into forms other than DIN.
- Some demineralised water will be consumed by on-site users but the majority will be used in a Heat Recovery Steam Generator (HRSG) plant, from which there will be additional losses via evaporation. Operation of this plant requires the addition of nitrogen which will then be present in the HRSG blowdown effluent in the form of ammonia. This blowdown effluent will also be conveyed to the site retention ponds.
- Effluent collected and combined in the retention ponds will be pumped to the offshore outfall. The ponds will also be used to collect and store rainwater runoff from the Proposed Development's drainage system will be designed to manage peak stormwater flow rates of 1,256 m^3/hr. The runoff will be disposed of via the offshore outfall.

The flow chart in Figure 1-1 summarises the on-site water flows and nitrogen loads for the Proposed Development and Figure 1-2 shows the site boundary and offshore discharge point location. Section 2 of this report sets out the flows and nutrient loads of the final combined effluent discharges to Tees Bay**. It should be noted that the total DIN output considered in the model is 6.87 kg/hr. From this total 6.22 kg/hr (90%) is from pre-existing sources in the raw water supply and only 0.65 kg/hr (10%) comes from additions from the NZT development. If modelled in isolation the output of DIN from NZT would be negligible in comparison to the background.**



Legend

Water Sources	**On-site Water Use**	**Wastewater Disposal**
On-site Water Treatment	**On-site Water Loss**	

Figure 2-1: Proposed Water Flow and Nutrient Load Diagram for the Proposed Development

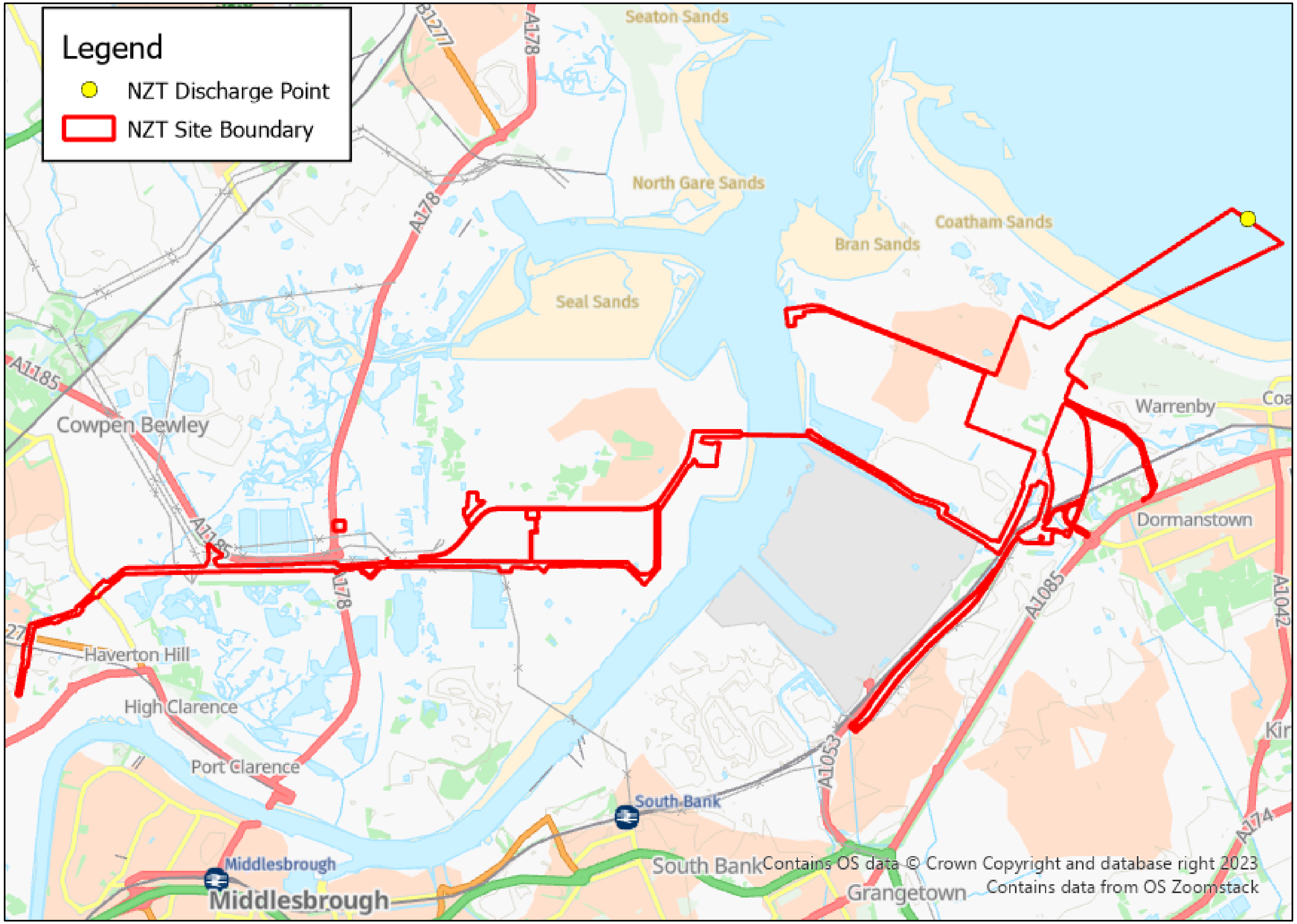


Figure 2-2: NZT Development Boundary and Proposed Effluent Discharge Location

2.2 Discharge Effluent Quality

The largest source of water to the Proposed Development will be untreated River Tees water. This water will be provided via Northumbrian Water's system and is taken from three abstraction points on the non-tidal river upstream of the Tees Barrage – Low Worsall, Blackwell and Broken Scar. River water quality monitoring data for the non-tidal River Tees have been obtained from Northumbrian Water and show the following quality statistics in terms of DIN concentration at Low Worsall:

- Long term mean = 3.34 mg/l
- Mean during regulatory coastal DIN concentration monitoring period (1 November to 28 February) = 3.04 mg/l
- Spring and summer mean (highest elevation period): 3.73 mg/l
- Overall long term 95%ile (short term peak concentrations): 5.81 mg/l

Pollutants contained within the River Tees water supplied to the Proposed Development will be concentrated in the final treated effluent. A total inflow of 1,070 m^3/hr (excluding surface water runoff) is reduced to a discharged volume of 344 m^3/hr (Figure 2-1) while the DIN load is expected reduce but, as a worst case scenario, has been assumed to remain the same in the dispersion modelling. The abstraction of water and dissolved nitrogen from the non-tidal River Tees, and subsequent discharge to Tees Bay, will reduce the overall annual pollutant mass reaching the Tees Estuary via the River. However, given the small abstraction volumes in comparison to the overall River Tees flow (estimated at 2.3% of the Q_{95} flow in the non-tidal River Tees[2]), this effect will not be significant and there will be no overall change in total annual pollutant mass reaching Tees Bay.

The only other significant source of water to the Proposed Development is Process Condensate (Figure 2-1). Process Condensate is expected to contain only one contaminant which is subject to an EQS in coastal waters, ammonia, which is limited through the DIN EQS. The Process Condensate will be treated by a reverse osmosis plant prior to and following use in on-site processes, with this treatment removing 98% of the ammonia for disposal offsite as ammonium sulphate concentrate. A small amount of additional nitrogen, again in the form of ammonia, will be added to the Proposed Development effluent by the HRSG plant. The waste streams from the on-site processes will be combined within retention ponds prior to discharge and may be diluted by the addition of surface water runoff, which is not anticipated to contain significant nitrogen in the form of DIN. The final effluent discharge rate will be controlled by the capacity of the pumps used to transfer the combined effluent from the ponds to the outfall.

Final anticipated discharge rates and effluent nitrogen concentrations are set out in Table 2-1 based on an absolute worst-case scenario River Tees concentration of 5.81 mg/l, equating to a final effluent concentration of 20 mg/l (Figure 2-1). The River Tees concentration is equivalent to the 95%ile condition with respect to DIN and modelling on this basis therefore represents an exceptionally conservative worst-case scenario in terms of water quality impacts. In reality, effluent DIN concentrations will remain well below 20 mg/l for most of the time. Future developments that may tie into the outfall may choose to consider more proportionate background concentrations for DIN and effluent discharge scenarios rather than the highly conservative scenario represented in this report which layers a number of worst-case scenarios to demonstrate in combination effects.

The onsite processes will generate warm effluent streams which will be cooled in the retention ponds prior to discharge and the effluent is expected to be discharged at a maximum temperature of 20°C when consisting of process effluent only, reducing to 15°C when combined with surface runoff.

[2] Non-tidal Tees Q_{95} flow (flow exceeded for more than 95% of the year) estimated as 3.36m^3/s, which is the total of the Q_{95} flows in the River Tees at Low More Gauge (see https://nrfa.ceh.ac.uk/data/station/meanflow/25009) and River Leven at Leven Bridge gauge (see https://nrfa.ceh.ac.uk/data/station/meanflow/25005). Abstraction for the H2Teesside site is taken at 298m^3/hr (0.083m^3/s).

Table 2-1: Effluent Flows and Nitrogen Loads for Proposed NZT Discharge

Parameter	Final Effluent Values – NZT Only	
	Process Effluent Only	With Surface Water Runoff
Flow Rate (m^3/hr)	344	1644
Flow Rate (m^3/s)	0.096	0.457
Temperature (°C)	20	15
DIN (mg/l)	20.0	4.30
DIN (kg/hr)	6.87	6.87

2.3 Outfall and Diffuser Design

Effluent from the Proposed Development will be discharged via a new outfall at the location indicated in Figure 2-2. This location has been selected to allow construction of the new outfall within the deepest water present within the NZT Order Limits (Figure 1-2). The diffuser design is summarised as follows:

- An inline diffuser pipe of total length 12.5 m with 11 upstands at 1.25 m spacing and two opposing ports on each upstand.
- The main diffuser pipe will have an internal diameter of 512 mm and an external diameter of 630 mm. The upstands will each have an internal diameter of 256 mm and an external diameter of 315 mm. The ports will have an internal diameter of 146 mm and an external diameter of 180 mm.
- The ports will be fitted with duckbill valves to prevent saline and sediment intrusion.

The diffuser is designed to optimise dispersion and has been designed and sized to allow additional flows from other facilities planned to be developed on Teesside and at an earlier stage of design.

An image of the diffuser is shown in Figure 2-3, with the duckbill valves omitted.

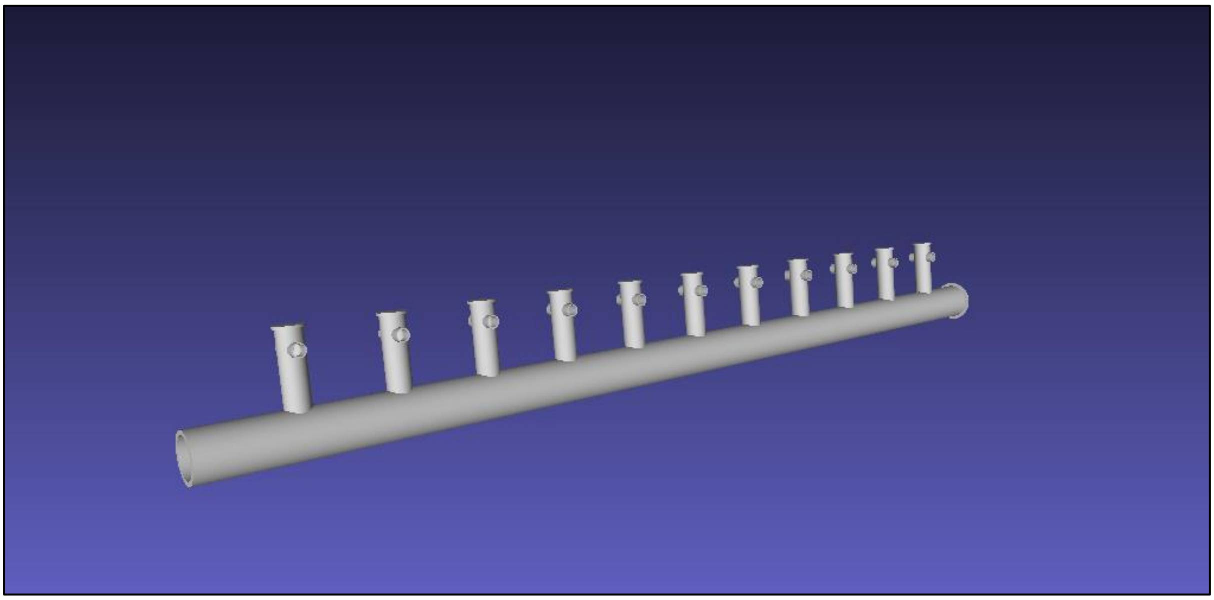


Figure 2-3: Proposed NZT Diffuser Design

3. Receiving Environment

3.1 Tees Estuary & Tees Bay Hydrodynamic Model

Information on the physical environment of Tees Bay has been obtained for the study area from the existing calibrated hydrodynamic model configured using the Delft3D (Deltares) software. This model was developed using the available data (ABPmer, 2019) and is provided in Appendix A. The model domain covers the River Tees Estuary and extends 10 km offshore and 30 km along the Hartlepool, Redcar and Cleveland coastline, as shown in Figure 3-1.

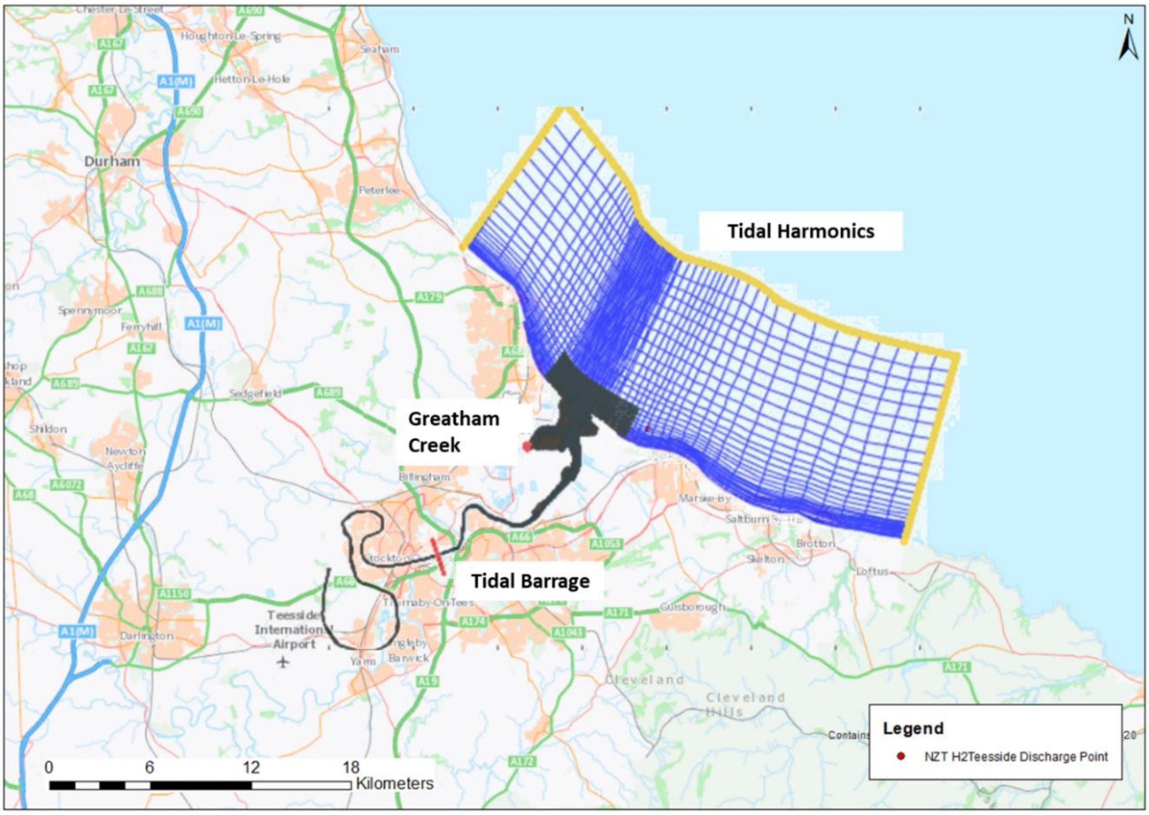


Figure 3-1: Delft3D hydrodynamic model extent

The model uses a curvilinear computational grid, which allows a grid composed of various sizes to be used throughout the model domain. A finer grid has been used for a section of the estuary west of the former steelworks (black shaded area in Figure 3-1) and a coarser grid for the offshore region (blue grid lines in Figure 3-1). The model uses a vertical layering with eight layers using a sigma coordinate system such that the layers compress or stretch with changes in the vertical water depth while retaining a given percentage of the total water depth in each layer. The vertical layering structure is as follows:

Table 3-1: Vertical Layering Details for the River Tees and Tees Bay Hydrodynamic Model

Layer	Layer Percentage	Percentage of Water Column Depth
1	5%	95%-100%
2	5%	90-95%
3	7%	82-90%
4	10%	72-82%
5	15%	58-72%
6	23%	35-58%
7	25%	10-35%
8	10%	Bed to 10%

Input flows to the model have been applied at three locations: tidal boundaries surrounding the offshore section of the model, the Greatham Creek inflow and the River Tees inflow at the Tees Barrage. These flows have been applied as follows:

- Three offshore boundaries have been used in the model (yellow lines in Figure 3-1) which are driven by tidal harmonics.
- The Tees Barrage has been represented as a “thin dam” structure (an infinitely thin barrier which prevents flow passing between two model cells without affecting the total volume of the channel) to prevent saline water extending upstream in the River Tees. A freshwater discharge has been added at this location which was calculated from flow data available from the National River Flow Archive (NRFA). Peak discharge rates used in the model vary seasonally between 3 m^3/s (summer) and 74 m^3/s (winter).
- A continuous inflow of 1.8 m^3/s has been added to the model to represent the flow from Greatham Creek. This has been based on previous values used in prior modelling work.

The Delft3D hydrodynamic model was run for three simulation periods: calibration (20/04/2005 – 01/05/2005), verification (13/01/2001 – 27/10/2001) and 2019 seasonal runs (23/06/2019 – 08/07/2019). The period chosen for the 2019 seasonal run was selected to ensure that the mean spring and mean neap tidal conditions are captured in the model simulation period. The results from this simulation have been used in this study to simulate the tidal water variations and flows at the proposed outfall location.

3.2 Bathymetry

The bathymetry data for the model has been compiled from a number of sources: PD Teessport Redcar Bulk Terminal Survey Data (29/01/2020), PD Teessport Survey Data (2019), LiDAR Contours, CMap, Admiralty Charts and survey data contained in previous models (2003). Where datasets overlapped, they were prioritised in the above order which has been dictated based on the quality of data. The bed profile extending from the shore towards the proposed outfall location is shown in Figure 3-2, where zero chainage is at the high tide shoreline (mean high water). The proposed outfall location is at approximately 1130 m chainage and at an elevation of -9.4 mAOD.

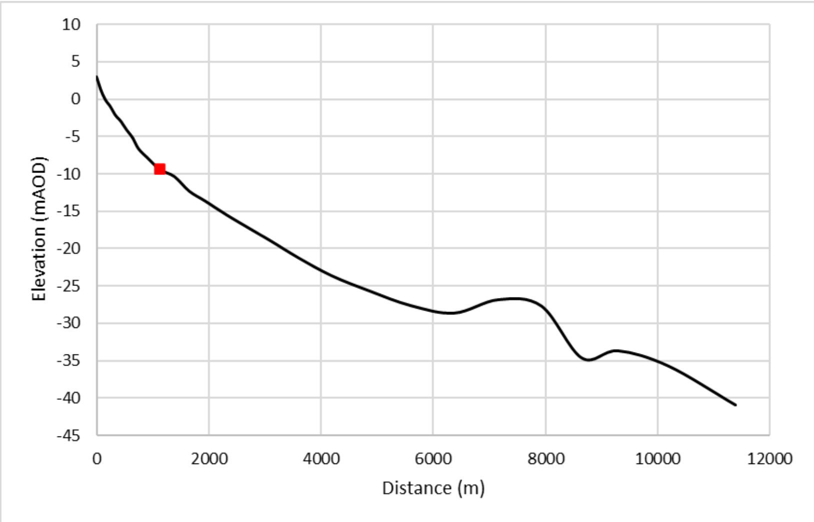


Figure 3-2: Bed Profile Extending Offshore at Proposed Outfall Location

3.3 Tide Levels and Currents

Water level and current data have been extracted from the Delft3D model for the 2019 seasonal runs at the location of the proposed new outfall and are shown in Figures 3-3 to 3-5.

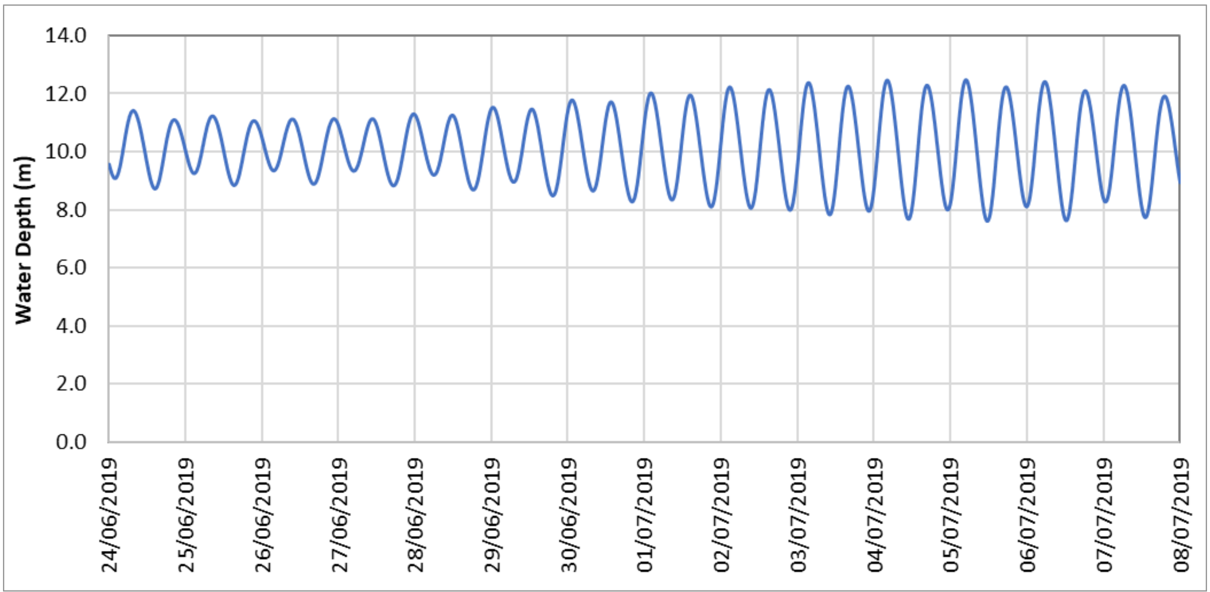


Figure 3-3: Water Depth at Proposed New Outfall Location

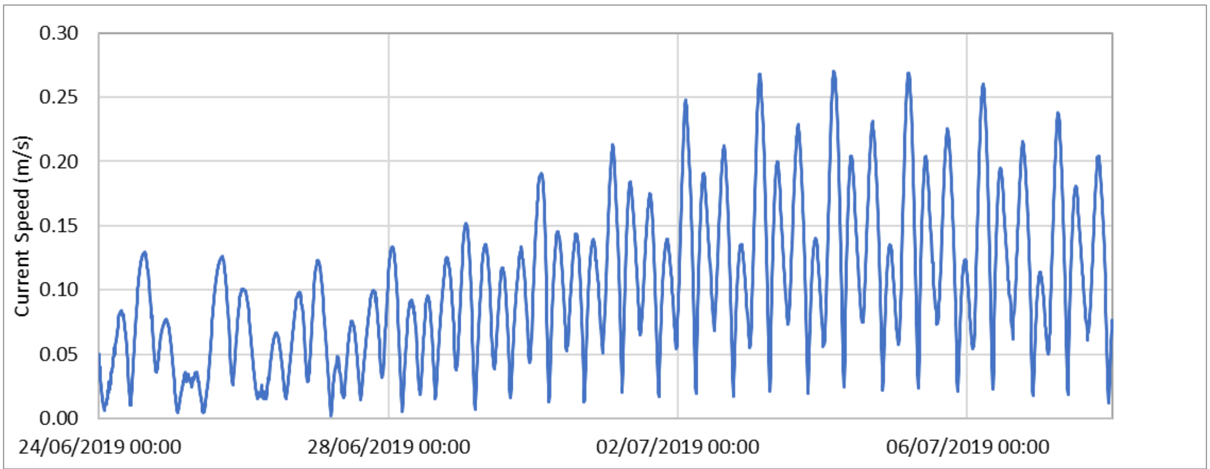


Figure 3-4: Depth Averaged Current Speeds at the Proposed New Outfall Location

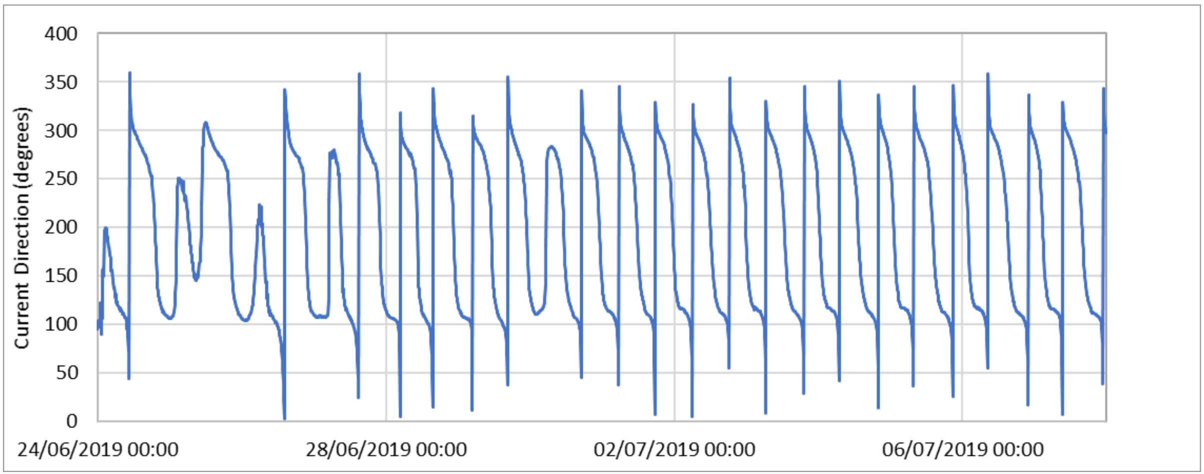


Figure 3-5: Current Directions at the Proposed New Outfall Location

Based on the above data, the values for water level, current speed and current direction, as listed in Table 3-2, have been used in the near field modelling of the proposed new outfall in Section 4.

Table 3-2: Water Level and Current Conditions at Proposed New Outfall Location

Tidal Stage	Water Level (mAOD)	Water Depth at Outfall (m)	Current Speed (m/s)	Current Direction (°)
Minimum Tide Level	-2.23	7.6 m	0.163	278
Maximum Tide Level	2.61	12.5 m	0.264	116
Maximum Current Condition	2.54	12.4 m	0.271	117
Minimum Current Condition	-0.42	9.3 m	0.0023	224

3.4 Wind Conditions

Wind speed data has been obtained from the Durham Tees Valley Airport anemometer. Data is available for the years 2015 to 2019 at hourly intervals. This data was analysed as part of the Delft3D thermal discharge modelling exercise to calculate a monthly average wind speed and direction. From this, the highest (5.32 m/s) and lowest (4.08 m/s) average speeds were taken as the winter and summer condition in the Delft3D model. A value of 4.0 m/s has been applied in the CORMIX modelling as a worst-case low wind speed scenario, however the results show that the near field mixing zone is not sensitive to seasonal changes, including in wind speeds over the observed range at Durham Tees Valley Airport.

3.5 Temperature and Salinity

Temperature and salinity are included in the Environment Agency ambient water monitoring data at the sample points shown in Figure 3-6. The water temperature in Tees Bay is shown in Figure 3-7 to vary between 5°C in winter and 16°C in summer at all sampling points. Dispersion model runs will be carried out to assess the seasonal variation in mixing zone extent. The salinity at sample point A varies due to inputs from the River Tees, however salinity at the other sample points in Tees Bay only varies between 32 and 34 ppt (Figure 3-7). This shows that the River Tees water becomes mixed and dispersed rapidly within Tees Bay. Average salinity at sample points C and D (at the proposed discharge point) is 34 ppt.

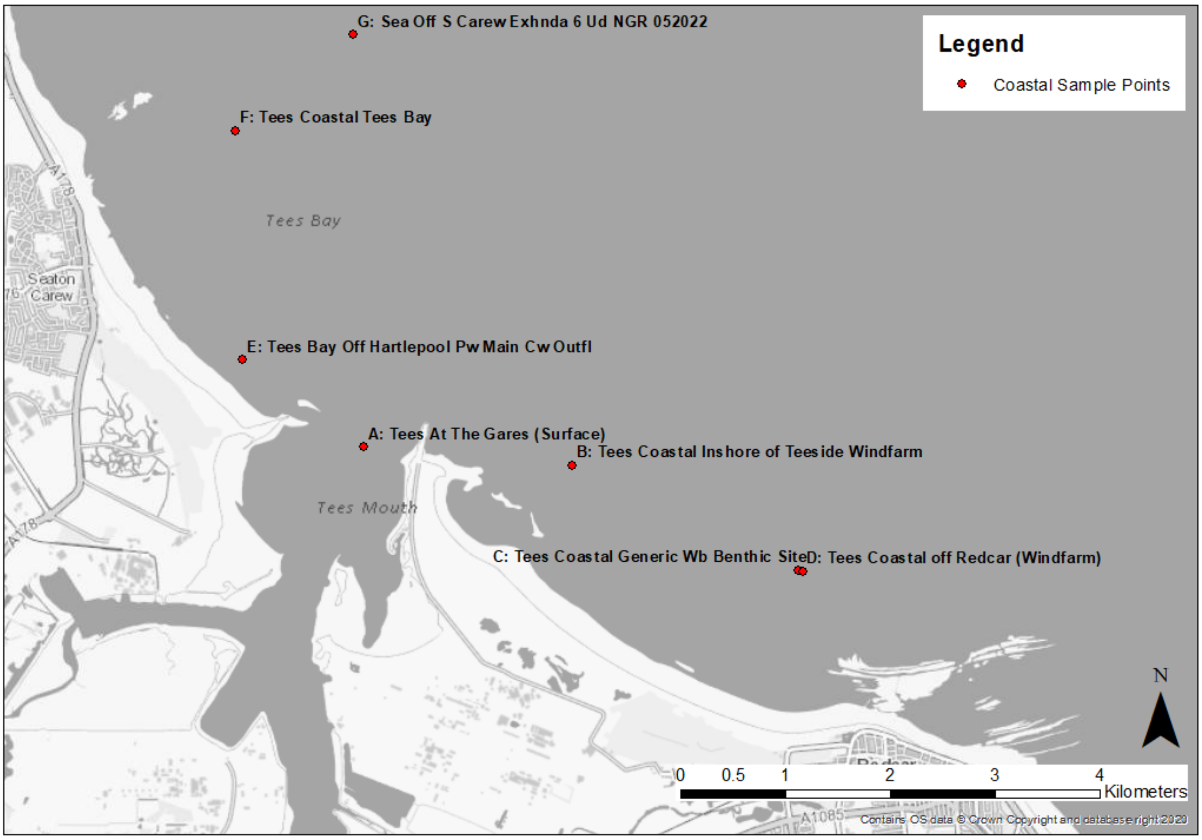


Figure 3-6: Environment Agency Ambient Water Quality Monitoring Locations

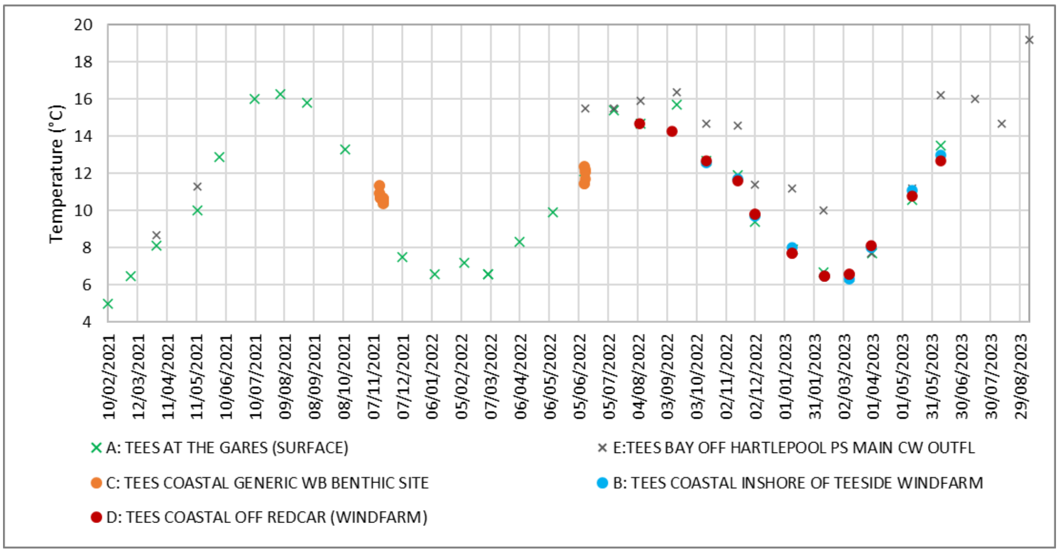


Figure 3-7: Water Temperature Data for Tees Bay

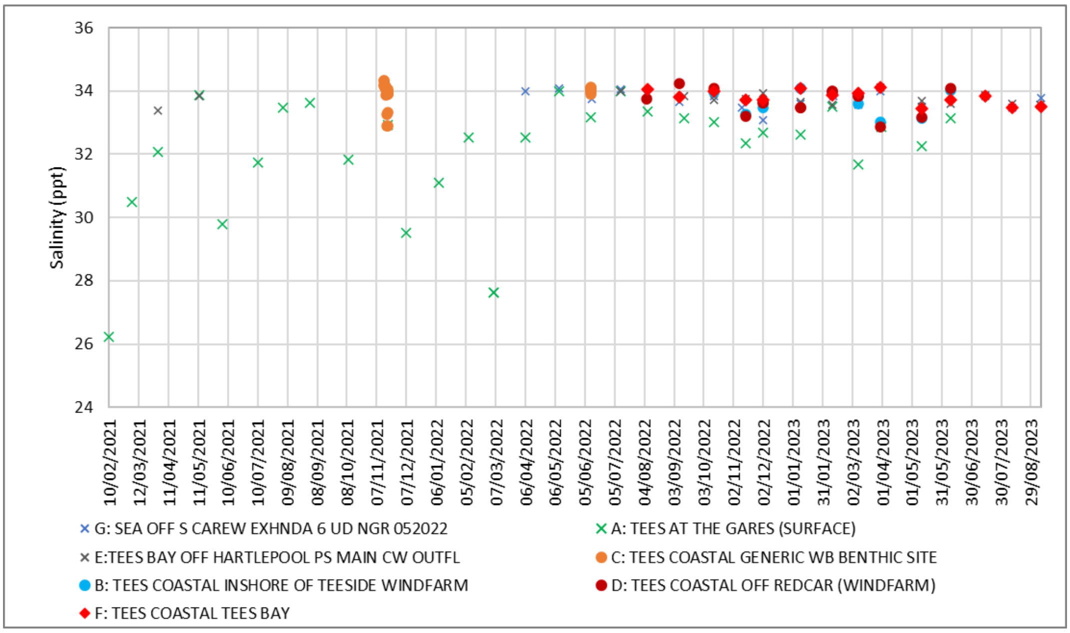


Figure 3-8: Salinity Data for Tees Bay

3.6 Ambient Water Quality and Environmental Quality Standard for DIN

Nitrogen concentrations in coastal waters are limited with reference to DIN. The applicable EQS values for DIN are selected for each coastal waterbody based on its recorded salinity and suspended particulate matter concentration[3]. In this case, Environment Agency data show an average of 8 mg/l suspended solids and normal salinity of 32 ppt at Tees Mouth (see Figure 3.6) and salinity of 34 ppt in Tees Bay. These values are consistent with clear water and coastal (i.e. not transitional) waters.

Table 3-3 sets out the WFD class boundaries for DIN concentrations for clear coastal waters. The boundaries are provided as µmol/l, which are cited in the WFD legislation, and as the equivalent concentration in mg/l based on guidance provided by the UK Technical Advisory Group[4] in their method statement document in which these standards are derived.

Table 3-3: WFD Class Boundary EQS Values for DIN

Unit Expression	WFD Class Boundary			
	High	Good	Moderate	Poor
Dissolved Inorganic Nitrogen (µmol/l)	12	18	27	40.5
Dissolved Inorganic Nitrogen (mg/l)	0.168	0.252	0.378	0.567

The Environment Agency data for the water quality sampling points shown in Figure 3-6 have been analysed to obtain suitable ambient DIN concentration values for near field mixing zone modelling. Monitoring for DIN is only carried out at sample points A, D, G and F in Figure 3-6 and sample point D is closest to the proposed discharge point.

Ambient DIN concentrations are calculated in accordance with the WFD standards: winter (1 November to 28 February) DIN concentrations are plotted against the corresponding salinity at each sample point. A linear line of best fit is plotted through the data and the equation of this line is solved for DIN at a salinity of 34 ppt. This gives an ambient winter DIN concentration at this salinity value of 0.196 mg/l at sample point D. This is between the high and good class thresholds of 0.168 mg/l and 0.252 mg/l in Table 3-3. On this basis the current classification of Tees Bay at the proposed discharge point would be good with respect to DIN and exceeding the threshold of 0.252 mg/l

[3] For further information see https://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf
[4] https://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%202_Final_110309.pdf, page 40, accessed 23 August 2022

would result in a class deterioration to moderate water quality. A value of 0.252 mg/l has therefore been used as an EQS limit for DIN in Tees Bay.

4. Effluent Dispersion Modelling

4.1 Modelling Methodology

The dispersion of DIN contained in effluent from the Proposed Development has been simulated using two methods:

- The Cornell Mixing Model software (CORMIX), developed and maintained by MixZon Inc., has been used to simulate the initial rapid phase of turbulent mixing following discharge of the buoyant effluent plume into the higher density water of Tees Bay.
- The Delft3D model has been used to show how nutrient nitrogen is transported within the wider area of Tees Bay. Full details of the far field model setup and representation of the outfalls and ambient conditions are provided in Appendix A – the model was used as set up by ABPmer without modifying any of the model parameters or input data except for vertical layer spacing (Section 3.1), discharge flow rate and effluent concentration. The DIN load in the effluent was modelled as a conservative tracer and the model was run to identify mixing zone concentrations through the water column and laterally within Tees Bay.

The hydrodynamic model shows that complex rotational tidal currents within Tees Bay circulate water and mixing effluent along the coastline rather than promoting free exchange of water with the open ocean. This can result in accumulation of pollutants within shallower areas and movement of water from the discharge location north towards the River Tees Estuary. The prevailing current directions and circulation patterns are shown in Figure 4-1 and the green shows the potential transport of a dissolved substance from the proposed discharge point within Tees Bay.

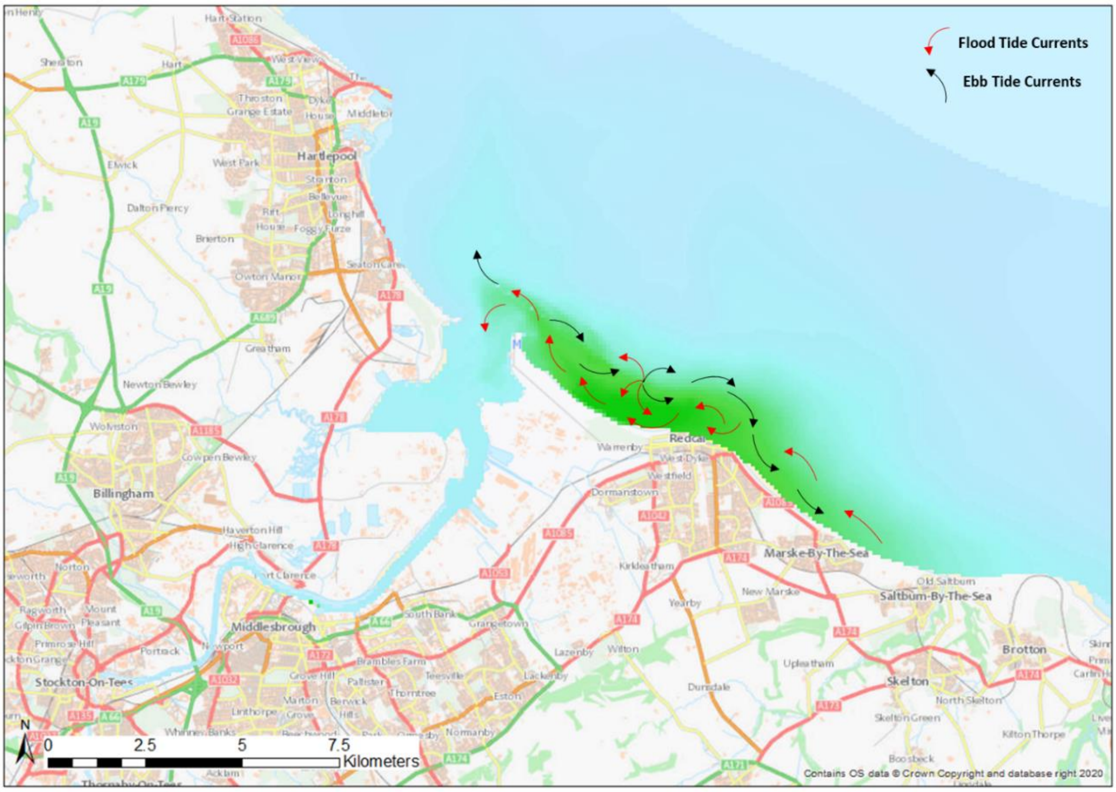


Figure 4-1: Tees Bay Coastal Current Circulation Patterns and Dispersion Pathway from the Proposed Outfall

Given the complex circulation patterns in Tees Bay, the CORMIX model has been used to map mixing zones over which the DIN concentrations in the effluent are diluted to the EQS value of 0.252 mg/l at key stages of the tidal cycle. This shows the impact of the discharge in terms of the status of the Tees Coastal waterbody under the Water Framework Directive. The Delft3D model has been used to show how DIN is transported within the wider area of Tees Bay and assess whether effluent may be conveyed into the River Tees Estuary and reach the Seal Sands mudflats. The model outputs have been used to map potential increases in DIN concentrations above 0.004 mg/l, which is the normal limit of detection for DIN in coastal waters using standard methods.

A limitation of the CORMIX model is that it has difficulty modelling surface spreading under very low current conditions as seen in Tees Bay during the turn of the tide (see Section 3.3 above and 4.3 below). The far field model has therefore also been used to simulate the surface mixing of DIN at the proposed outfall location under the absolute minimum current conditions (0.0023 m/s, with a corresponding water depth over the outfall of 9.34 m and a current direction of 224.2°, occurring in the model on 27 June 2019 at 5 am).

4.2 CORMIX Input Data

CORMIX requires details of the effluent, the ambient conditions and the outfall geometry. These aspects have been represented in the model as follows:

- **Outfall Representation:** The design of the outfall from the Proposed Development is outlined in Section 2.3 and has been represented in the CORMIX modelling using the multiport diffuser option and diffuser details as given in Section 2.3 above.
- **Ambient Geometry:** CORMIX requires information on the average water depth, water depth at the discharge, current velocity and seabed roughness (n, Manning's number or roughness coefficient). The parameters for each modelled scenario are set out in Table 3-2. A Manning's n value of 0.025 has been used to represent the low resistance to flow within the area of Tees Bay at the outfall.
- **Ambient Water Density:** The ambient water density is calculated within CORMIX based on temperature and salinity. The calculated densities used for each scenario have been summarised in Table 4-1.

Table 4-1: Ambient Water Density used in CORMIX

Scenario	Temperature (°C)	Salinity (ppt)	Density (kg/m3)
Winter	5	32	1025.3
Summer	16	32	1023.4

- **Heat Loss Coefficients:** A winter heat loss coefficient of 42 W/m^2,°C has been used in the modelling while the summer heat loss coefficient is 44 W/m^2,°C. These values have been selected based on ambient water temperatures and wind speeds of 5.37 m/s in winter and 4.00 m/s in summer.

4.3 Presentation of CORMIX Results

Near field mixing zone plumes in CORMIX are modelled over different stages; the stages relevant for this outfall are an initial period of mixing as effluent rises vertically and is deflected laterally by momentum and ambient currents (the rising stage) and the second period of mixing when the plume reaches the water surface and spreads laterally (the surface spreading stage). Dilution occurs during the rising stage due to turbulent mixing and entrainment of ambient water, while dilution during the surface spreading stage is more dominated by diffusion of the plume into the large ambient water volume.

Current velocities at the proposed outfall location are relatively low, however they vary by a factor of more than 100. In addition, the ports on the diffuser in Figure 2-3 are relatively close in terms of spacing. This means that the software models the mixing zone plumes in different ways depending on the current conditions specified:

- For low current and discharge rate conditions, the model resolves the dimensions of the individual plumes rising from each pair of ports (Figure 4-2). The effluent is extremely buoyant compared to the saline ambient water and does not travel a significant distance horizontally from the individual ports before it rises rapidly vertically above the diffuser. CORMIX therefore combines the vertically-rising mixing zone from each pair of ports and shows how effluent is diluted as it rises through the water column. The plumes spread laterally once they intersect with the water surface.

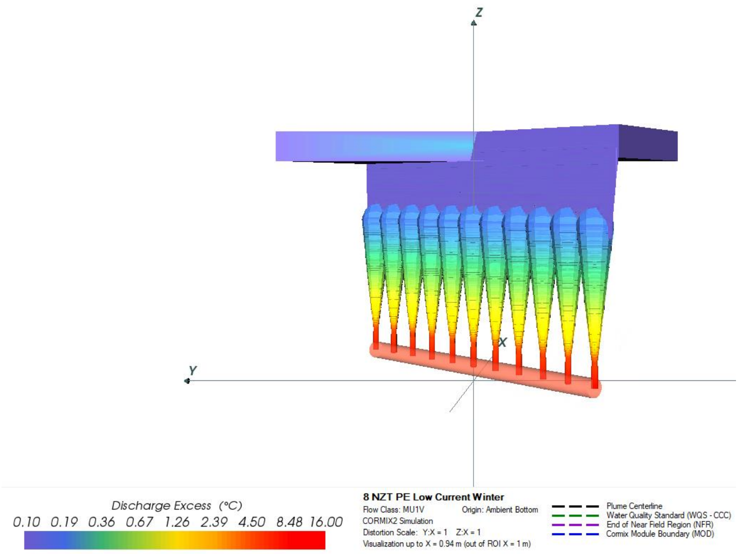


Figure 4-2: CORMIX Vertical Mixing Stage Visualisation Output for Low Current Conditions

- As ambient current velocities increase, the mixing plumes are rapidly deflected away from the diffuser and the rate of both lateral and longitudinal mixing increases. Given the number and spacing of ports on the proposed diffuser head, the individual plumes will combine into a single mixing zone within a very small distance. CORMIX represents this scenario by combining the individual mixing plumes into a single plume discharged through a slot along the entire diffuser length, with the slot geometry having equal area to the total diffuser port array. The resulting mixing shown is schematised as a trapezoid shape (Figure 4-3).

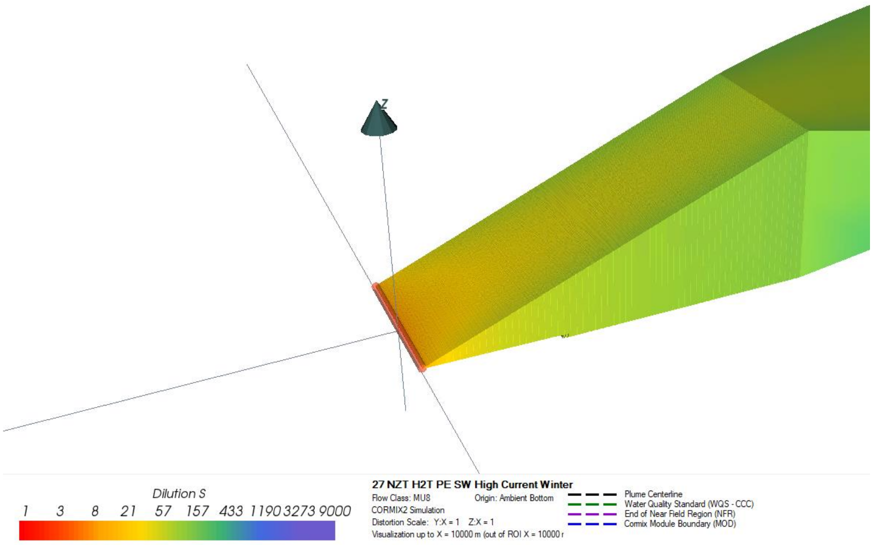


Figure 4-3: CORMIX Vertical Mixing Stage Visualisation Output for Low Current Conditions

- Various combinations of water depth and low current conditions can result in turbulent mixing which combines the rising plumes from each diffuser port in the vertical direction before the plume is significantly deflected downstream by the ambient current. CORMIX represents this situation by initially mixing the effluent discharge volume within a set volume of water around the diffuser, termed the control volume, then modelling how effluent mixes as the control volume disperses into the ambient water. The size of the control volume is calculated based on the velocity of the effluent exiting the diffuser head (represented using the equivalent slot geometry) the vertical water depth and the ambient current velocity. The mixing zone is schematised as shown in Figure 4-4.

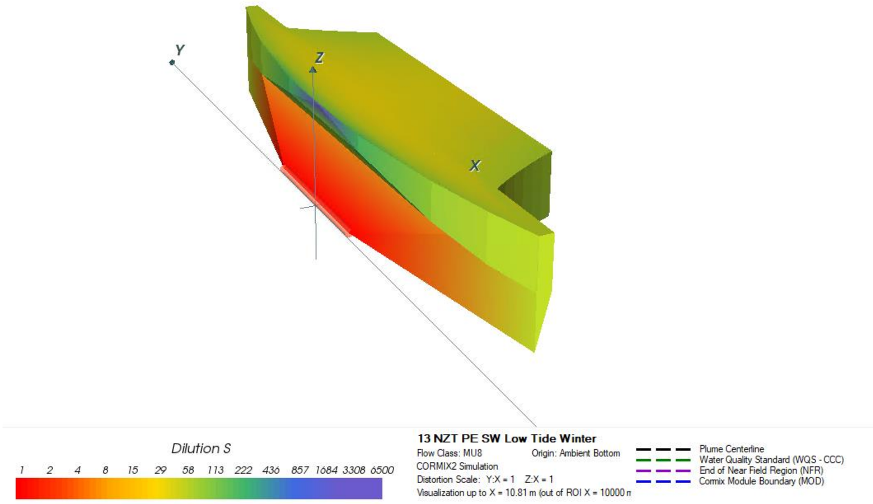


Figure 4-4: CORMIX Visualisation Output for Low Tide Conditions

The CORMIX modelling results are presented and discussed in Section 4.5 and the model log is provided in Appendix B. The model files are supplied as Appendix C.

4.4 Far Field Model Scenarios

The Delft3D model was run for two discharge scenarios as summarised in Table 4-2. A constant flow rate and effluent concentration (calculated as set out in Section 2.2) is assumed in each scenario from a discharge point within the relevant model cell.

Table 4-2: Discharge Scenario Input Data for Delft3D Model

Scenario Number	Description	Flow (m^3/s)	Temperature (°C)	Effluent DIN Concentration (kg/m^3)
1	NZT process effluent only, no surface water	0.096	20.0	0.020
2	NZT process effluent with surface water	0.444	15.0	0.004

The model outputs represent a worst-case scenario because the model does not take account of wave action. This is likely to be important for mixing because the proposed outfall location is close to Coatham Rocks, a rocky outcrop extending into Tees Bay which is under water at high tide but will promote wave breaking and vertical mixing. The omission of wave action allows for a worst-case scenario impact prediction based on the currently available information.

In addition, it is likely that operational discharges from the Proposed Development will be intermittent rather than continuous. In particular, the scenarios with a surface water component will only occur following periods of rainfall. However, it is not possible to accurately estimate the frequency of discharges prior to site commissioning and use so the continuous discharge scenario represents an appropriate worst-case representation of impacts. Finally, the modelling assumes that the discharge occurs continuously at concentrations of 20 mg/l for the entire model run period, when this condition will not be sustained because this represents the high 95%ile DIN concentrations in the River Tees at Low Worsall (Section 2.2).

4.5 Near Field Model Results

4.5.1 Proposed Development Process Effluent Discharges

Table 4-3 gives the dimensions of the mixing zone for DIN, taking account of process effluent discharges only from the Proposed Development. The results are presented for the low tide, high tide and high current scenarios and the summer and winter seasons. The CORMIX model represents this using the trapezoid mixing zone shape shown in Figure 4-3 and the distances in Table 4-3 give the maximum distance above the outfall, downstream distance from the outfall and the mixing zone spread parallel with the diffuser at the point at which the DIN in the effluent is diluted to below the EQS. The mixing zone is small for all modelled scenarios and only reaches the water surface under the low tide condition. The mixing zone under low tide and high tide are shown in Figure 4-5 and Figure 4-6 below – the mixing zone during the high tide condition is too small to be easily visible at an informative mapping scale.

Table 4-3: CORMIX Near Field Modelling Results (NZT Process Effluent Discharges Only)

Tide Condition	Mixing Zone Measurement (m)	Summer	Winter
Low Tide	Height above outfall	7.6	7.6
	Distance from outfall	343	330
	Plume Cross Section Width	40	40
High Tide	Height above outfall	4.2	4.2
	Distance from outfall	20	20
	Plume Cross Section Width	20	20
Maximum Current	Height above outfall	4.0	4.0
	Distance from outfall	19	19
	Plume Cross Section Width	20	20

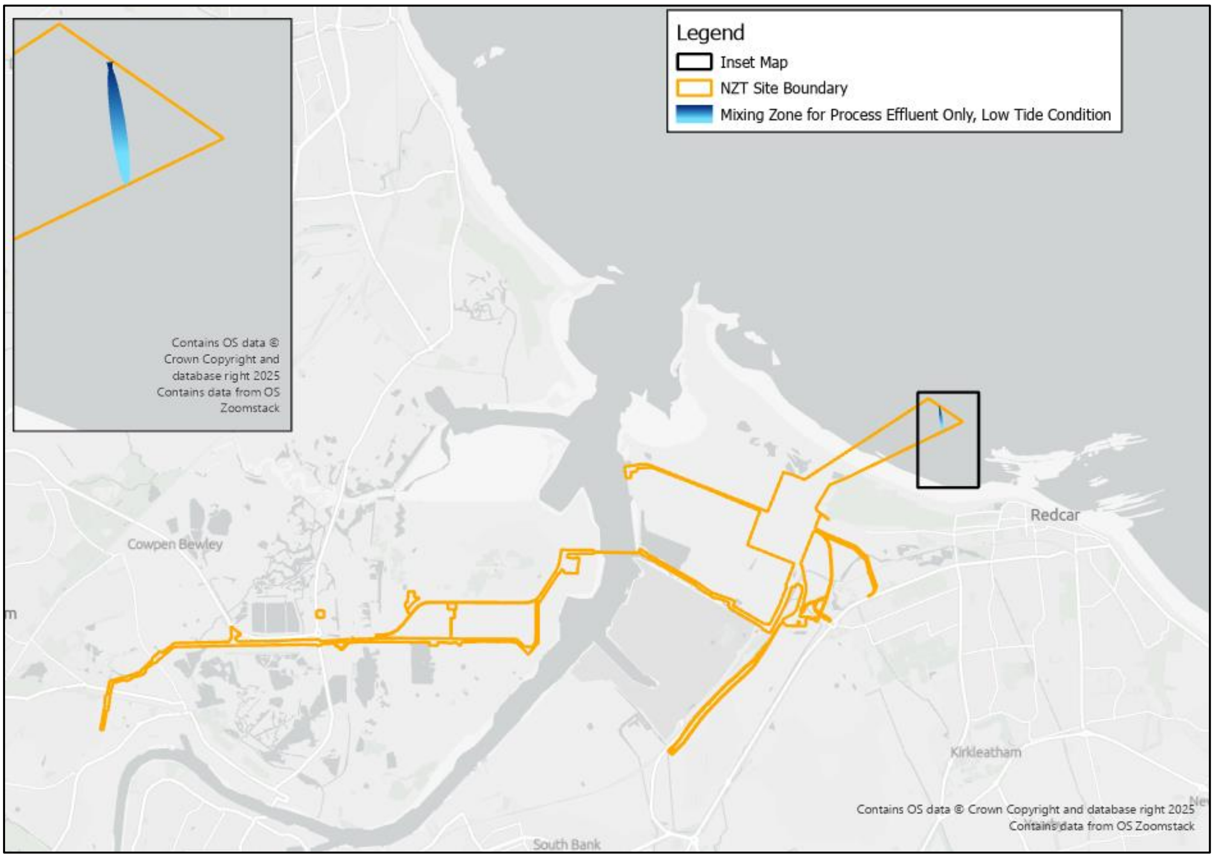


Figure 4-5: Near Field Mixing Zone for DIN in NZT Process Effluent (Low Tide Condition)

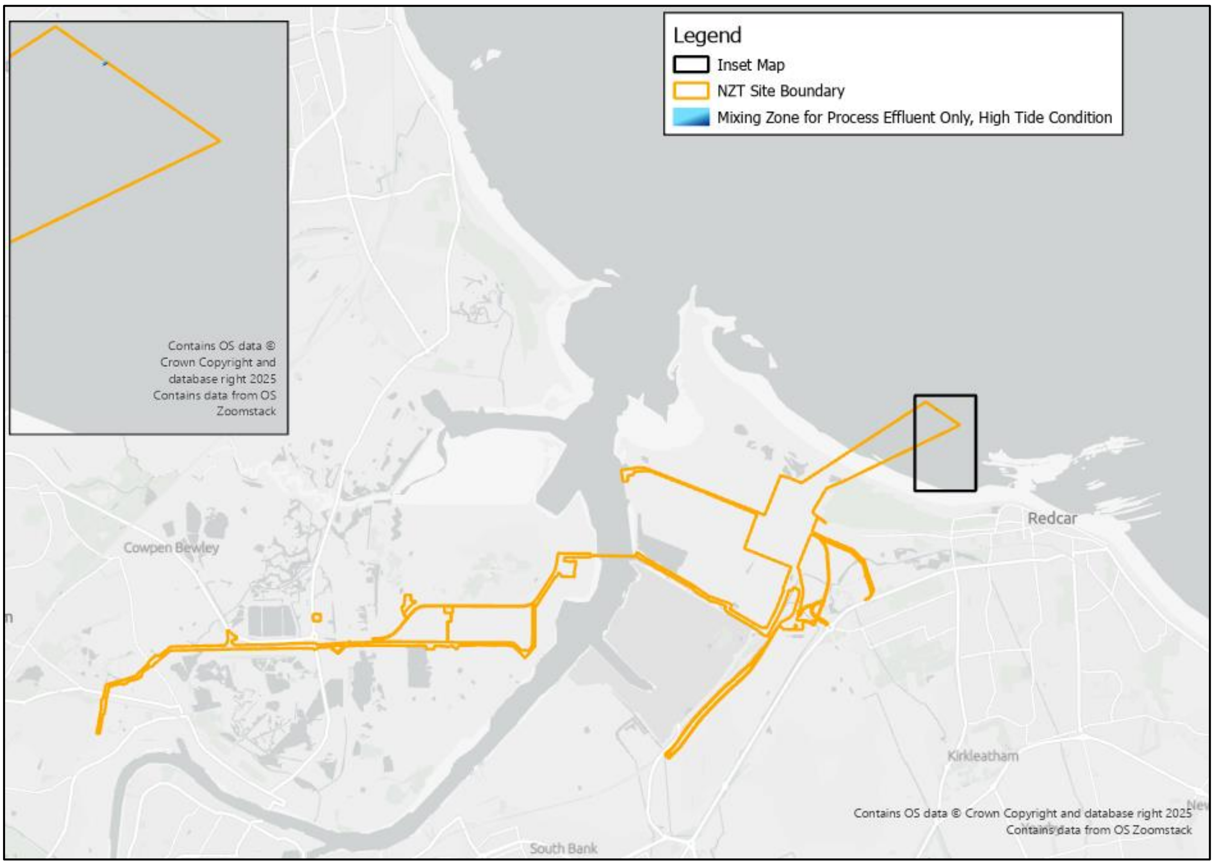


Figure 4-6: Near Field Mixing Zone for DIN in NZT Process Effluent (High Tide Condition)

For low current conditions the CORMIX model is able to resolve the individual rising plumes from each part of ports. During the rising stage of mixing the effluent is diluted by a factor of 53 under summer conditions and 54 under winter conditions compared to a factor of 354 required to reduce DIN concentrations to below the EQS. The model is unable to suitably represent the surface spreading stage of mixing during which the additional dilution to below the EQS actually occurs. The far field model results were interrogated to understand the extent of any surface spreading zone under minimum current conditions. Surface DIN concentrations during the minimum current condition (taking into account DIN discharged at tidal conditions prior to the minimum current time) are shown in Figure 4-7 and shows that surface DIN concentrations fall extremely rapidly such that surface concentrations near the outfall are diluted to below the EQS within a distance much smaller than can be resolved by the far field model in this area.

Process effluent will also be discharged from the Proposed Development at temperatures exceeding ambient. The CORMIX results show that the effluent is cooled to less than 3°C above ambient immediately on discharge from the diffuser head under low tide, high tide and high current conditions. Under minimum current conditions each plume rising from the 11 diffuser heads cools to less than 3°C above ambient within 2.4 m vertical distance from the diffuser. Each plume is extremely small, at less than 1.5 m diameter. This is a worst-case modelling of impacts because effluent is expected to cool significantly within the pipeline between the Proposed Development and the outfall location, but this effect has not been accounted for in the near field modelling.

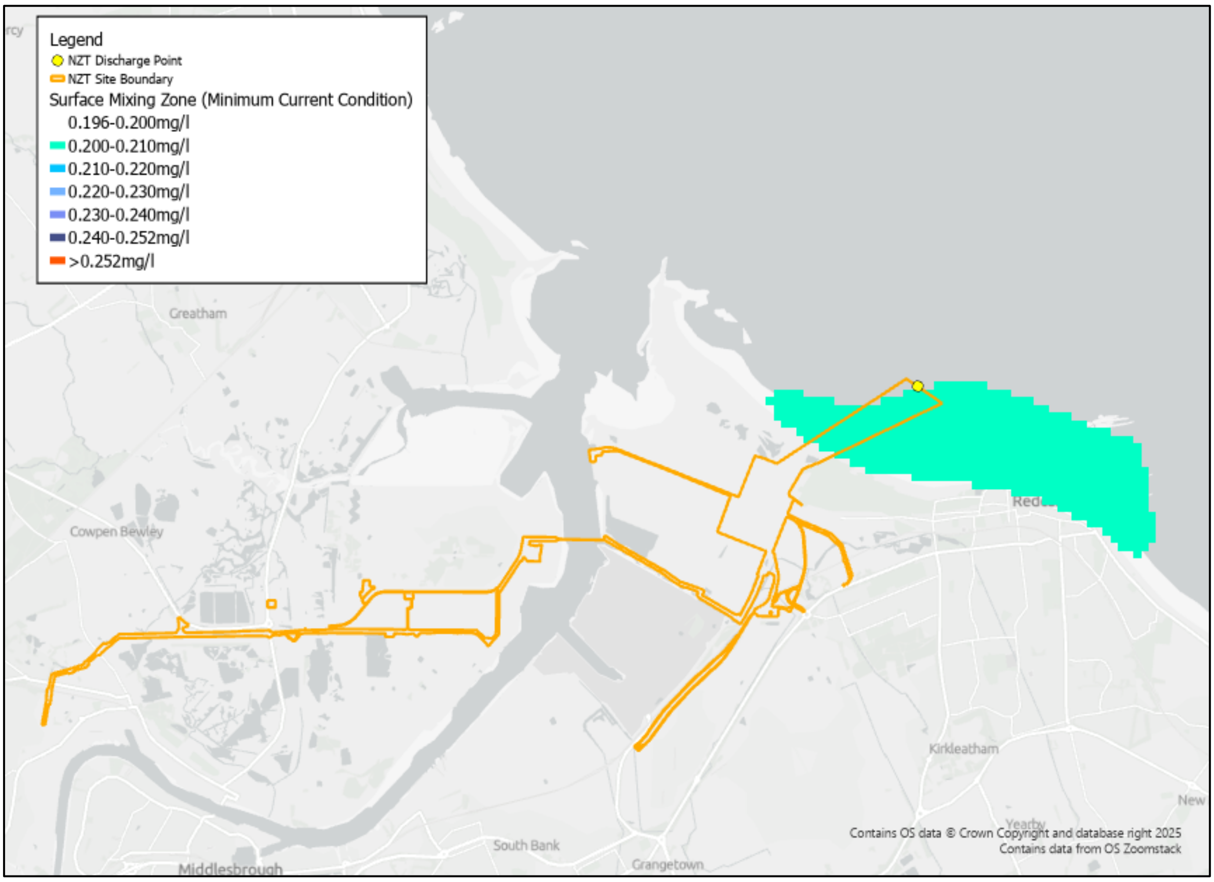


Figure 4-7: Surface DIN Concentrations During Minimum Current Conditions: Far Field Model, NZT Process Effluent Discharges Only

4.5.2 NZT Process Effluent with Surface Water Runoff

Table 4-4 gives the dimensions of the mixing zone for DIN, taking account of process effluent discharges and surface water runoff from the Proposed Development. The results are presented for the high tide and high current scenarios and the summer and winter seasons. CORMIX model represents this using the trapezoid mixing zone shape shown in Figure 4-3 and the distances in Table 4-4 give the maximum distance above the outfall, downstream distance from the outfall and the mixing zone spread along the line of the 12.5 m diffuser at the point at which the DIN in the effluent is diluted to below the EQS. The mixing zone is very small for both modelled scenarios and does not reach the water surface.

Table 4-4: CORMIX Near Field Modelling Results (NZT Process Effluent Discharges with Surface Water)

Tide Condition	Mixing Zone Measurement (m)	Summer	Winter
High Tide	Height above outfall	3.6	3.5
	Distance from outfall	18	17
	Plume Cross Section Width	20	20
Maximum Current	Height above outfall	3.4	3.4
	Distance from outfall	16	16
	Plume Cross Section Width	20	20

Under low tide conditions the combination of ambient water depth, increased effluent flow rate and low ambient current velocities results in CORMIX using the control volume option to represent mixing at the diffuser. For both summer and winter scenarios the control volume is limited to an area extending 3.2 m horizontally and vertically from the diffuser. The effluent is diluted by a factor of 41 within the control volume, compared to the dilution factor of 73 required to reduce effluent DIN concentrations to below the EQS. The effluent then continues to spread away from the diffuser and the EQS is met after a further 40 m of transport from the discharge point. The mixing zone under this low tide condition is shown in Figure 4-8 and is too small to be easily visible at an informative mapping scale.

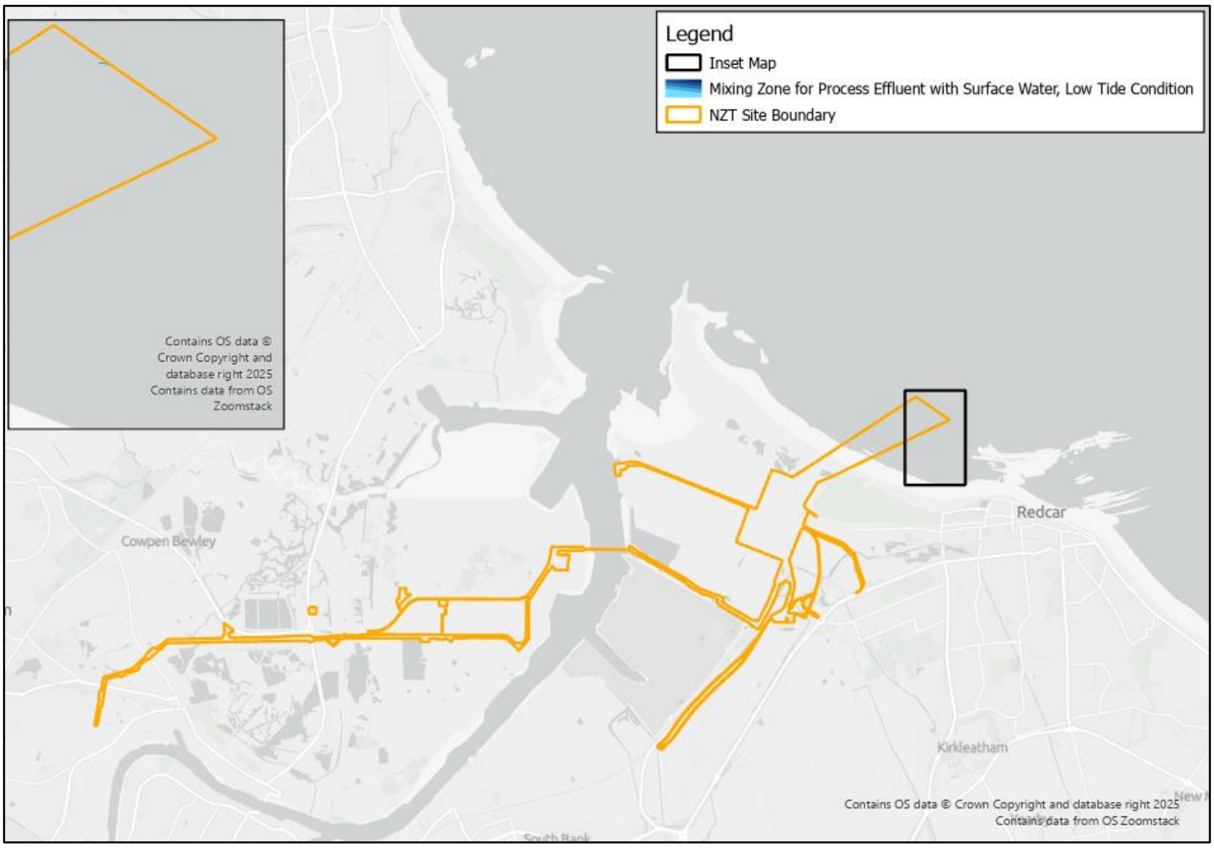


Figure 4-8: Surface DIN Concentrations During Low Tide Conditions: Far Field Model, NZT Process Effluent Discharges with Surface Water Runoff

For low current conditions the CORMIX model is able to resolve the individual rising plumes for each pair of diffuser ports. During the rising stage the effluent is diluted by a factor of 16 under summer conditions and 19 under winter conditions. However the model is unable to suitably represent the surface spreading stage of mixing during which the effluent is diluted to below the EQS. The far field model results were interrogated to understand the extent of any surface spreading zone under minimum current conditions. Surface DIN concentrations during the minimum current condition (taking into account DIN discharged at tidal conditions prior to the minimum current time) is shown in Figure 4-6 and shows that surface DIN concentrations fall extremely rapidly such that surface concentrations in the vicinity of the outfall are diluted to below the EQS within a distance much smaller than can be resolved by the far field model in this area.

During winter, process effluent and surface water may be discharged from the NZT site at temperatures exceeding ambient sea temperatures. The CORMIX results show that the effluent is cooled to less than 3°C above ambient immediately on discharge from the diffuser head under low tide, high tide and high current conditions. Under minimum current conditions each plume rising from the 11 diffuser heads cools to less than 3°C above ambient within 3.1 m vertical distance from the diffuser. Each plume is extremely small, at less than 0.7 m diameter. This represents a worst-case assessment of impacts because effluent may cool within the pipeline between the Proposed Development and the outfall location but this effect has not been accounted for in the near field modelling.

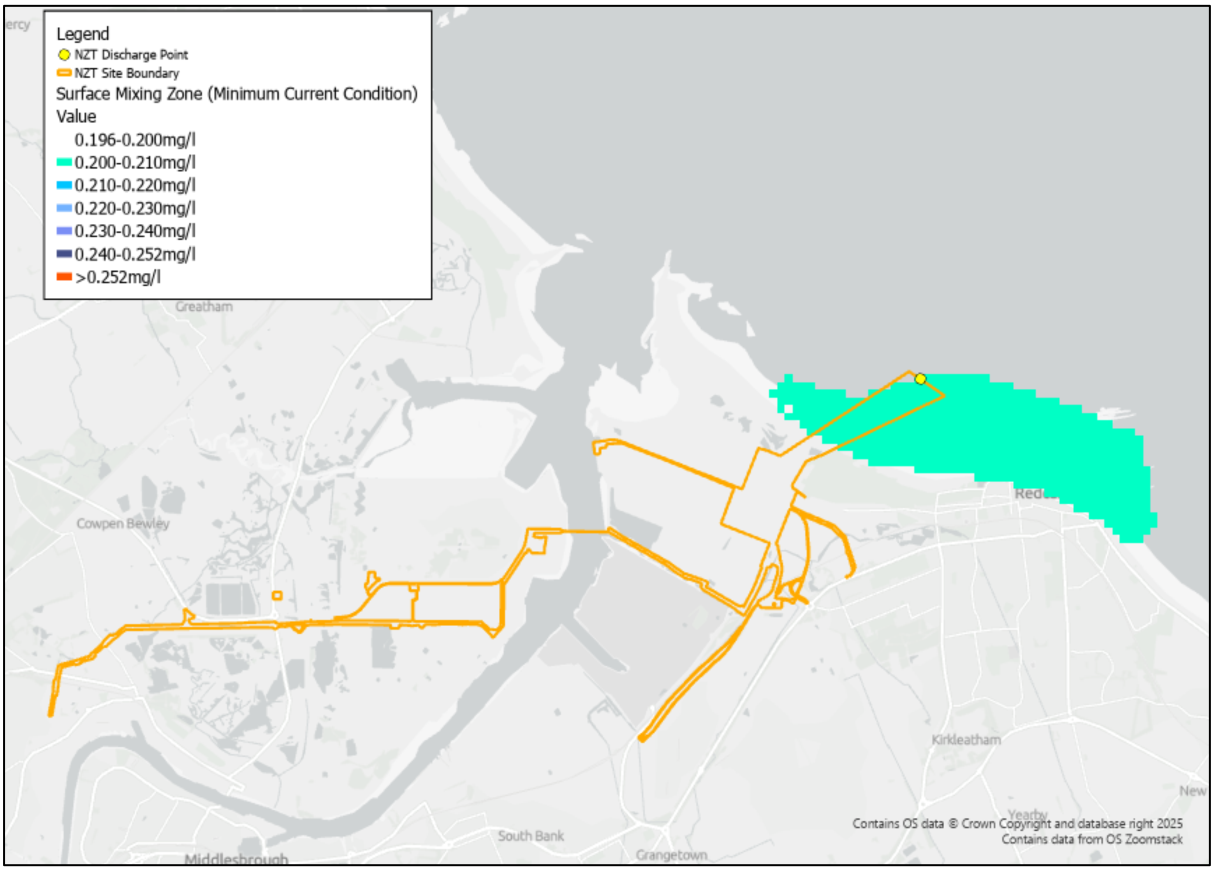


Figure 4-9: Surface DIN Concentrations During Minimum Current Conditions: Far Field Model, NZT Process Effluent and Surface Water Discharges

4.5.3 Near Field Modelling Summary

The far field and near field modelling results above show that process effluent discharges from the Proposed Development, would not result in a reduction in water quality in Tees Bay at any point over a tidal cycle.

4.6 Far Field Modelling Results

4.6.1 Impact on Tees Bay

DIN concentrations in Tees Bay are limited using average winter concentrations. The complex rotational currents in Tees Bay do not promote free exchange of water with the open ocean, as discussed in Section 4.1. The far field model has been run for multiple tidal cycles to assess the potential for DIN to accumulate within Tees Bay such that average DIN concentrations approach the EQS. Table 4-7 shows the maximum increase in average DIN in Tees Bay for each of the model scenario. Given the worst-case scenario assumptions in terms of effluent discharge rates and DIN concentrations used in the modelling, the results show that the risk of the discharge increasing DIN concentrations in Tees Bay exceeding the EQS is negligible.

Table 4-5: Far Field Model Change in Average Pollutant Concentrations in Tees Bay

		DIN Concentration (mg/l)
Reference Concentration Values	EQS (Mean)	0.252
	Ambient Mean	0.196
	Increase Required to Breach EQS	0.0560
Maximum Modelled Increase in Tees Bay	Scenario 1: NZT Process Effluent Only	0.0202
	Scenario 2: NZT Process Effluent with Surface Water Runoff	0.0142

The far field model outputs show that the maximum increases in average DIN concentrations occur in the deepest layers of the model. This is because the plume is strongly deflected by the local currents during most stages of the tidal cycle and mixes principally with the deeper water layers. Figures 4-9 and 4-10 show the average DIN concentration modelled in the seabed layer (layer 8) of the model. The maximum increase in average DIN in layer 8 in either scenario is in the range of 0.004 - 0.020 mg/l. The increase in average DIN concentration reduces in shallower water layers of the model such that the increase in the surface layer is limit to below 0.006 mg/l in both modelled scenarios.

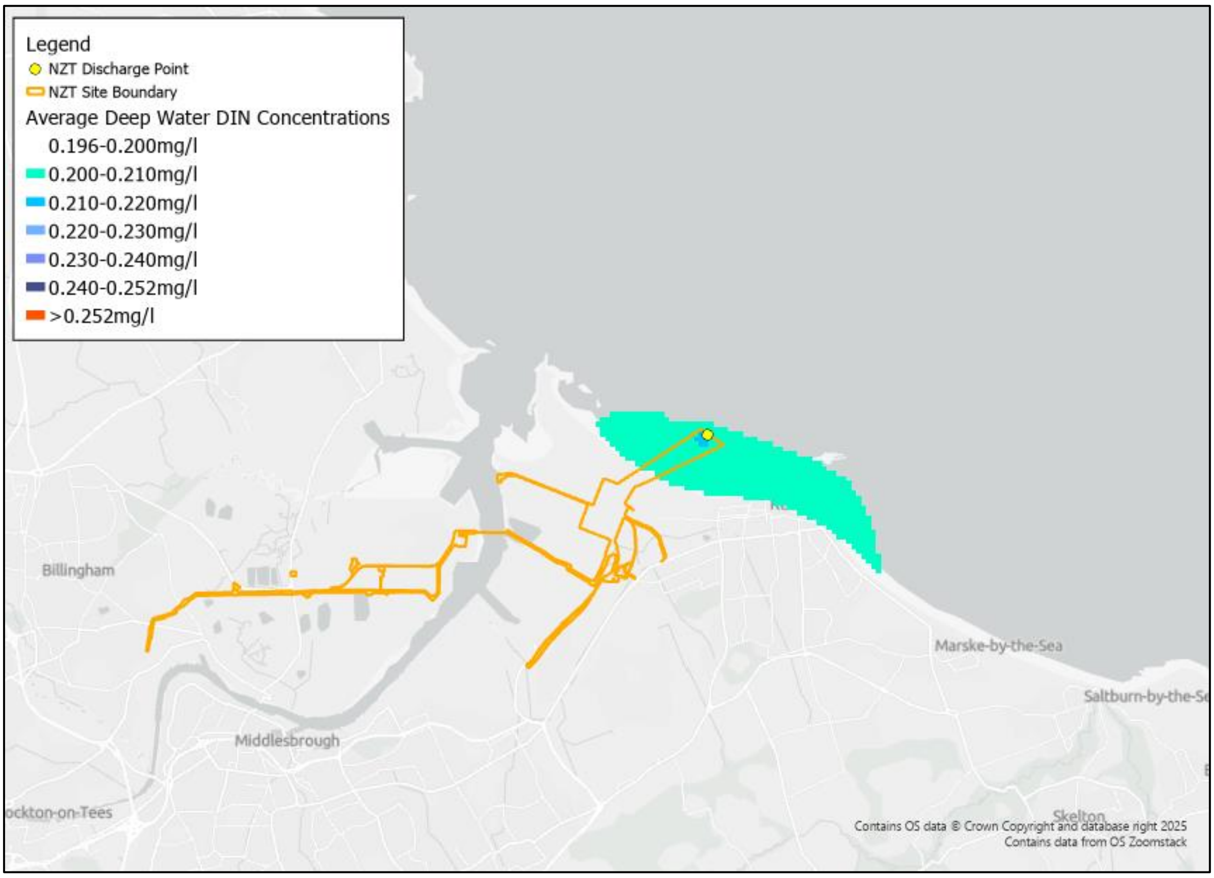


Figure 4-10: Increase in Average DIN Concentration in Tees Bay After Multiple Tidal Cycles (Deep Water Model Layer): NZT Process Effluent Discharges Only

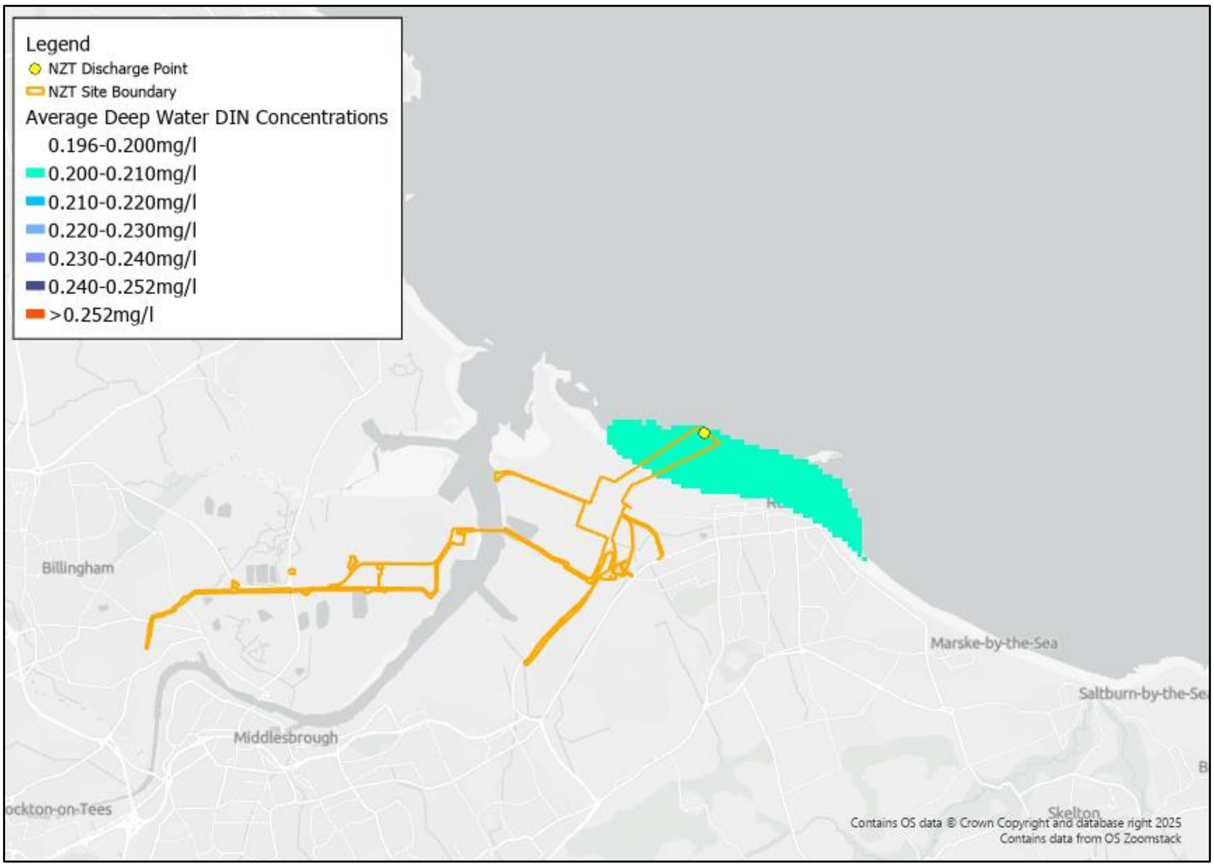


Figure 4-11: Increase in Average DIN Concentration in Tees Bay After Multiple Tidal Cycles (Deep Water Model Layer): NZT Process Effluent Discharges with Surface Water Runoff

4.6.2 Impact on River Tees Estuary

The potential impact of the discharges on ecosystems in the River Tees Estuary and the Seal Sands mudflats has been assessed through modelling the increase in maximum DIN concentrations across Tees Bay and the River Tees estuary area over multiple tidal cycles. The area affected by increased maximum DIN concentrations is shown in Figures 4-13 to 4-16 below. The maps show areas where there may be a measurable increase in the maximum DIN concentration seen in individual samples taken during specific tidal current conditions and the extent of that increase. Results are shown for both the deep water and the surface water layers. The results for each model scenario are summarised as follows:

- Scenario 1 (Proposed Development process effluent discharges only): There is no measurable increase in maximum DIN concentration in the River Tees Estuary at Seal Sands. The maximum increase in maximum deep water DIN concentrations is 0.091 mg/l, exceeding the EQS only in a limited area in the deep water around the discharge point and not extending into the River Tees Estuary where the maximum increase is limited to below 0.004 mg/l. This is not sufficient increase to cause an observable change in estuary ecosystems. The increase in surface water maximum DIN concentration is limited to 0.016 mg/l, at maximum, within Tees Bay and there is no measurable impact on concentrations in the River Tees.
- Scenario 2 (Proposed Development process effluent discharges and surface water runoff): There is no measurable increase in maximum DIN concentration in the River Tees Estuary or at Seal Sands. The deep water maximum DIN concentration close to the Proposed Development outfall increases by less than 0.043 mg/l for maximum DIN concentrations below 0.239 mg/l. The maximum increase in surface water DIN is in the range of 0.004 - 0.016 mg/l.

These results show that there will be no measurable increase in DIN concentration at the designated Seal Sands site in the River Tees Estuary as a result of the Proposed Development discharges. The model results show that measurable increases in DIN in the wider River Tees estuary area would occur only at specific times of the tidal cycle, in very limited areas and within only the deepest water.

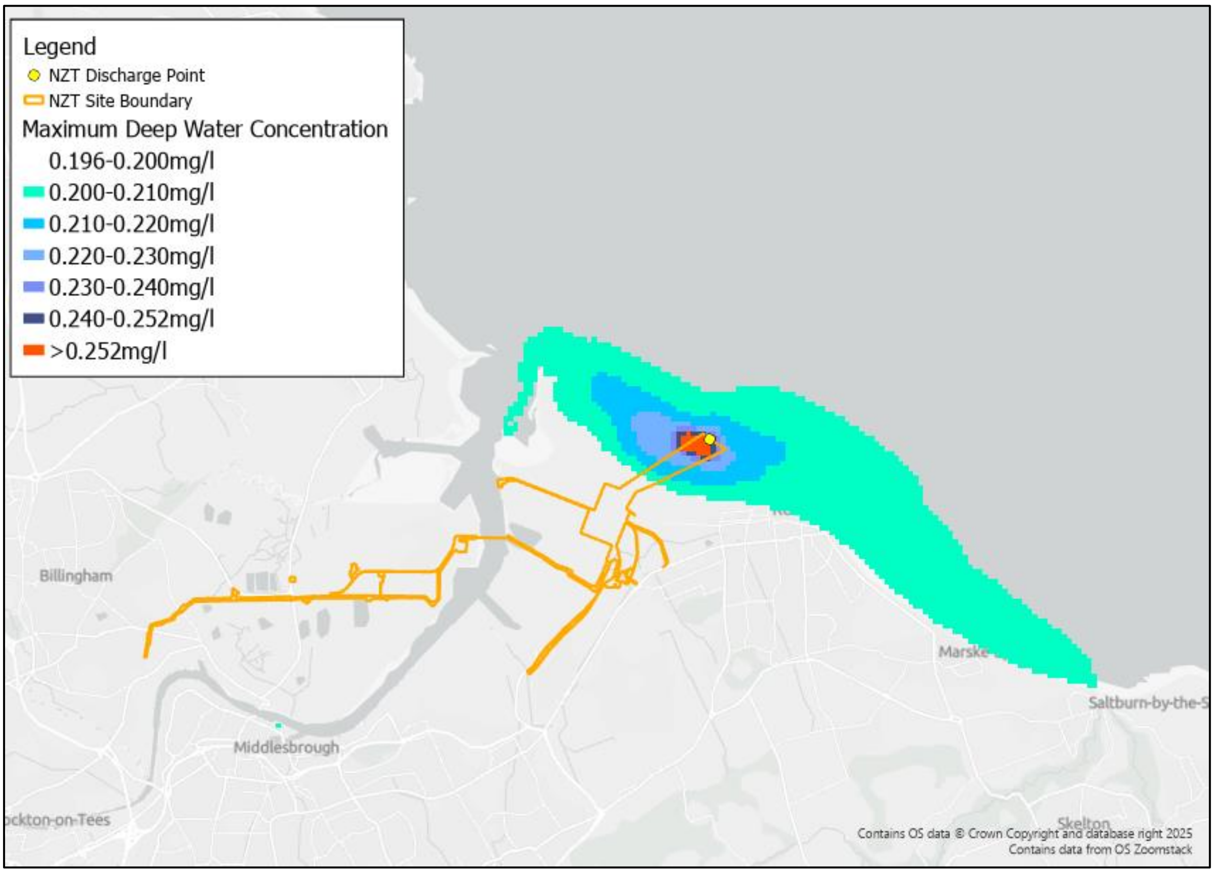


Figure 4-12: Increase in Maximum DIN Concentration in Tees Bay After Multiple Tidal Cycles (Deep Water Model Layer): NZT Process Effluent Discharges Only

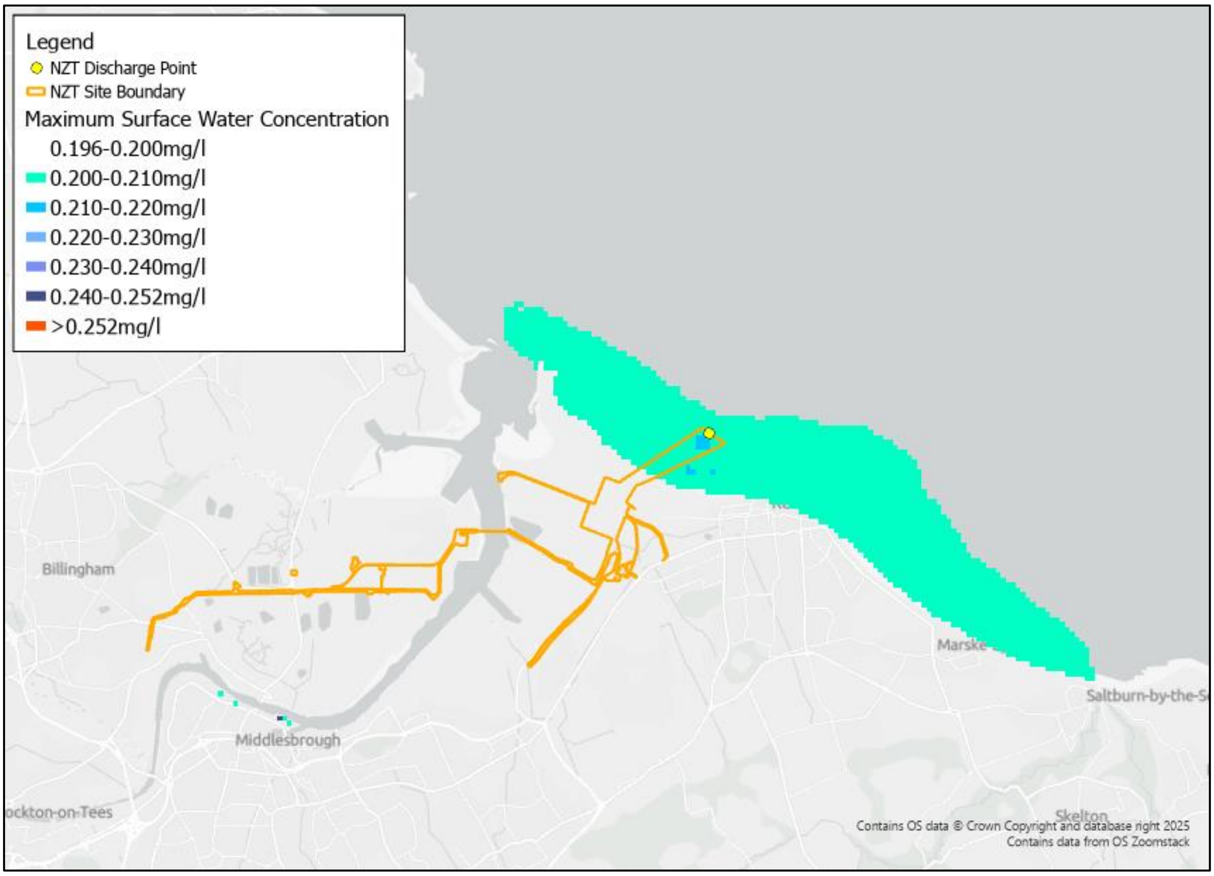


Figure 4-13: Increase in Maximum DIN Concentration in Tees Bay After Multiple Tidal Cycles (Surface Water Model Layer): NZT Process Effluent Discharges Only

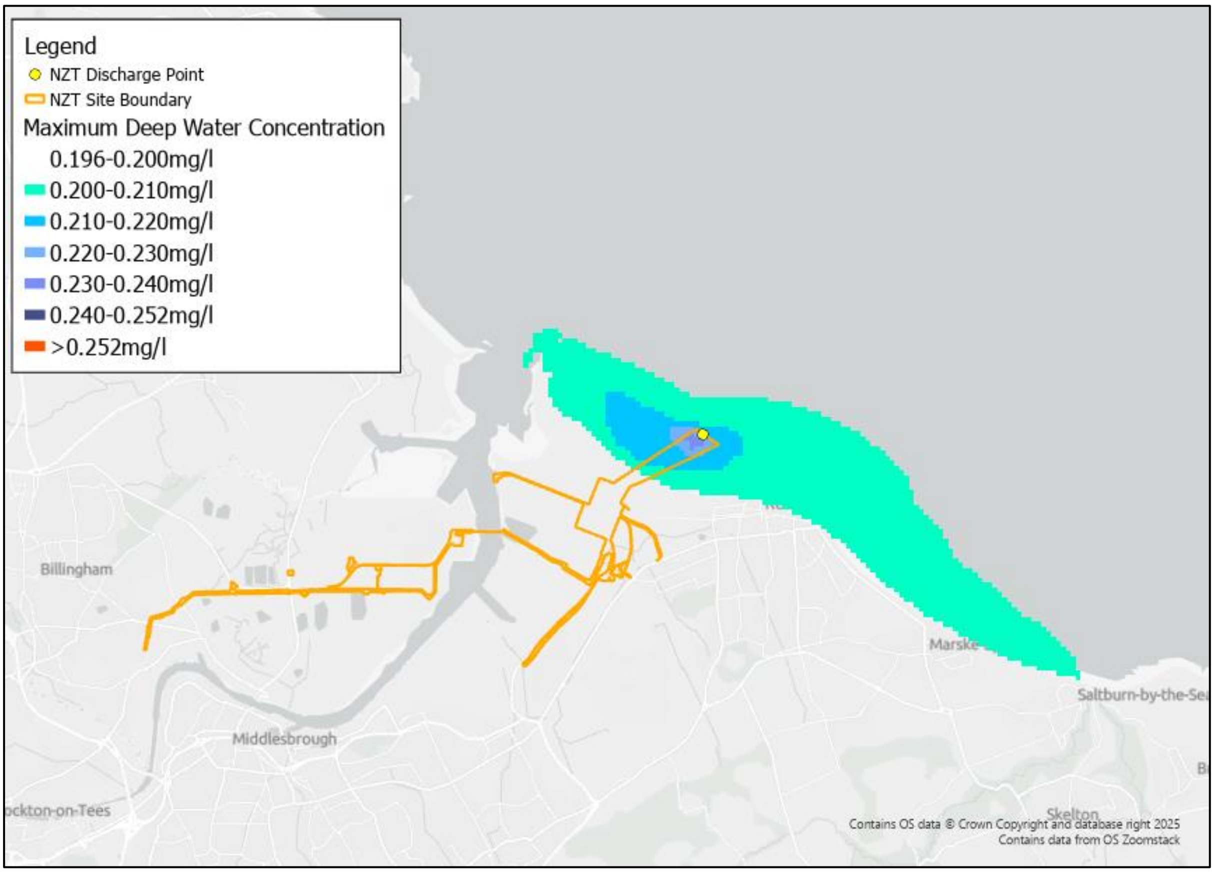


Figure 4-14: Increase in Maximum DIN Concentration in Tees Bay After Multiple Tidal Cycles (Deep Water Model Layer): NZT Process Effluence Discharges with Surface Water

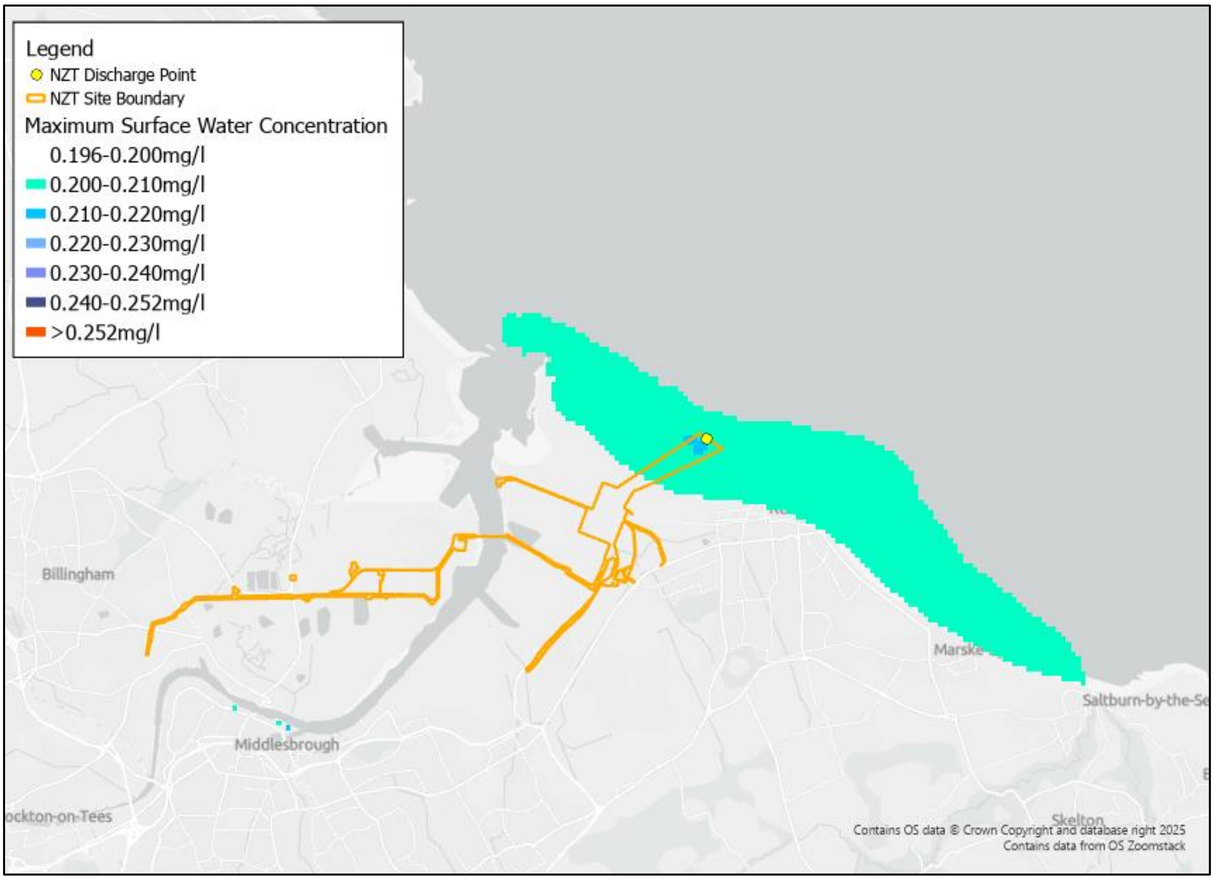


Figure 4-15: Increase in Maximum DIN Concentration in Tees Bay After Multiple Tidal Cycles (Surface Water Model Layer): NZT Process Effluence Discharges with Surface Water

The modelling represents an extreme worst-case simulation of potential DIN increase because:

a) each discharge scenario has been modelled as a continuous discharge throughout the model run period while the discharges from the site are expected to be intermittent in reality.

b) The discharge rates have been set at the design maximum rates throughout the model run period, and are expected to fall during periods of reduced power station utilisation. In particular, the surface water runoff element of the discharge modelled in Scenario 2 will only be present following rainfall and at lower volumes than has been considered in this report which uses the full proposed surface water management system capacity to derive total combined discharge rates.

c) the model assumes continuous discharges at highly conservative effluent concentrations which would require high 95%ile concentrations in the non-tidal River Tees to be sustained throughout.

Given the level of modelled increase in DIN in Tees Bay, the lack of measurable increase in average River Tees Estuary DIN concentrations, and the current model assumptions, no impact on River Tees Estuary DIN concentrations is anticipated as a result of the discharged of effluent or surface water runoff from the Proposed Development.

Further, the purpose of this impact assessment for the River Tees estuary is to support the delivery of nutrient neutrality, i.e. that the annual nitrogen budget of the River Tees estuary should not increase. The overwhelming majority (90% under the condition simulated in this report) of the DIN contained within the NZT effluent has its original source in the non-tidal River Tees. This means that the entire nitrogen mass sourced from the River Tees would have entered the River Tees estuary from upstream in the event that the NZT plant was not constructed – the NZT project changes the route of the nitrogen reaching the estuary only. In fact, additional dilution of the nitrogen within Tees Bay and the minimal extent of ingress on the flood tide seen in Figure 4-12 means that the overall impact of the NZT project on the annual nitrogen loading of the River Tees estuary will be to slightly reduce the annual nitrogen budget.

For additional context, EA data available for the period February 2021 to September 2024 from Sample Point A in the mixing zone at the mouth of the Tees shows that background DIN (not considering the NZT development) averages 0.442mg/l within a range of 0.06mg/l to 1.57mg/l. This variation means that the maximum increase from NZT effluent of 0.004 mg/l in the deep water in the River Tees Estuary during the worst case scenario modelled here represents an insignificant fraction of the background variability.

To assess the potential of the NZT project to increase the annual nitrogen budget of the River Tees estuary it is necessary to consider the impacts of the DIN discharges with respect to only that portion of the overall emitted mass which is generated on the site. Excluding the River Tees contribution when calculating the effluent DIN concentration gives a concentration of 1.9 mg/l with considering process effluent only, or 0.4 mg/l when accounting for maximum surface water contributions. The near field modelling shows that this would dilute to below 0.252 mg/l within 3 m of the outfall at all stages of the tidal cycle and there would be no change in DIN concentration in the River Tees estuary.

Recognising the above, the proposed discharges from NZT are both compatible with the delivery of good status under the Water Framework Directive within Tees Bay, and with the delivery of nutrient neutrality in the River Tees Estuary.

5. Effluent Monitoring Strategy

5.1 Requirements

Schedule 2 Requirement 37 of the DCO requires the development of an Effluent Nutrient Nitrogen Safeguard Scheme. Clause 2(c) of Requirement 37 requires information on wastewater discharge monitoring methods, frequency and locations that will be undertaken pursuant to any environmental permits required by the Proposed Development. The clause is worded as follows:

> *(2) The effluent nutrient nitrogen safeguarding scheme submitted pursuant to paragraph (1) must include the following –*
>
> > *(c) information on the wastewater discharge monitoring methods, frequency and locations that will be undertaken pursuant to any environmental permits required for the authorised development.*

Furthermore, the draft Environmental Permit requires (Requirement I6) that:

> *The Operator shall carry out a monitoring exercise on the final discharge to Tees Bay at emission point W1 when the site is fully operational. The Operator shall monitor the final effluent discharge to Tees Bay at least once a month for at least 12 consecutive months for the full suite of pollutants that have been modelled in the Water Quality Risk Assessment submitted and approved in accordance with PO6 in table S1.4 of this permit. The monitoring shall be carried out in accordance with relevant Environment Agency Guidance:*
>
> - *Monitoring discharges to water: guidance on selecting a monitoring approach;*
> - *Monitoring discharges to water: CEN and ISO monitoring methods;*
> - *Monitoring discharges to water: alternative monitoring methods; and*
> - *Monitoring discharges to water: analytical quality control charts.*

The Environmental Permit Requirement I6 requires monitoring of a wider range of pollutants than solely DIN which is needed for Requirement 37 of the DCO. The details of the wider pollutant suite will be determined at a later stage once the plant design is finalised and the Water Quality Risk Assessment re-modelled (this is required by the Environment Agency at least 6 months prior to commencement of discharges of effluent and surface water). The following section therefore outlines an Effluent Monitoring Strategy for the NZT site with regard to DIN only, in order to satisfy Clause 2(c) of Requirement 37.

5.2 Discharge Parameters

The above modelling is based on the following anticipated maximum effluent flow rate and DIN concentration from the NZT site, and the required monitoring needs to take account of these conditions:

- A maximum process effluent flow rate of 96 l/s (344 m^3/hr)
- A maximum surface water discharge rate of 349 l/s (1256 m^3/hr)
- A combined effluent discharge rate (effluent and surface water) of 444 l/s (1600 m^3/hr)
- An average effluent DIN concentration of 20.0 mg/l (used when modelling process effluent flows only).

Effluent quality and flow rates will be monitored to ensure that the discharges from the NZT site are within this range.

5.3 Monitoring Location

The Environmental Permit requirement I6 states that monitoring is to be undertaken at emission point W1 when the site is fully operational. The location of W1 as shown in the Emission Points Plan in the original Environmental

Permit application is included in Appendix D. Location W1 would also be used for DIN monitoring to fulfil Requirement 37.

At the time of writing, (January 2025) there is not a sufficiently advanced design for the W1 emissions point that would allow for the sampling process to be outlined in detail. However, it is assumed that this would take the form of a storage basin for process and surface water effluent, and that facilities would be included to allow safe and accessible sample collection from this point.

5.4 Monitoring Suite

Requirement 37 Clause 2c of the DCO relates to monitoring of nutrient nitrogen in the Proposed Development effluent. As such, DIN would be monitored to determine whether the discharged effluent had concentrations that are within the range of values shown within the modelling presented in Section 4 of this report.

In order to determine the DIN concentration, the following constituent forms of nitrogen will be monitored:

- Nitrate + Nitrite (i.e. Total Oxidised Nitrogen (TON));
- Ammonia.

The appointed laboratory must be able to undertake the analysis using methods accredited to EN ISO/EIC 17025 (an international standard that specifies the general requirements laboratories need to meet to demonstrate their technical competence) and the MCERTS performance standard[5].

5.5 Monitoring Frequency

Grab samples for laboratory analysis of DIN would be collected from the W1 sampling location on a monthly basis for a minimum of 12 months. This would satisfy the Environment Permit Requirement I6.

The rate of effluent discharge via the W1 location should also be monitored. It is assumed at this stage that suitable flow monitoring equipment will be incorporated into the design of the discharge and outfall point, and that this would meet the two relevant MCERTS standards:

- Minimum requirements for the self-monitoring of effluent flow[6];
- Competency Standard for MCERTS inspectors – effluent flow monitoring[7].

5.6 Monitoring Method

5.6.1 Water Quality Sampling

All water samples for laboratory analysis should then be collected and samples stored and transported in accordance with British Standards (BS) Institution ISO 5667, particularly the following parts:

- BS EN ISO 5667-3:2018 Water quality. Sampling. Preservation and handling of water samples;
- BS EN ISO 5667-14:2016 Water quality. Sampling. Guidance on quality assurance and quality control of environmental water sampling and handling.

The nature of the monitoring site is subject to further design. However, it is anticipated that samples would be collected using an extendable pole from suitable and safe location. Sample water would be decanted into sterilised sample bottles (containing any required preservative) provided by the appointed laboratory. They would then be couriered for next day delivery to the laboratory for analysis whilst being kept at a temperature between 1 and 8°C. Any notable visual observations and olfactory information should also be recorded by the survey team.

For each round of sampling, a duplicate is proposed to be collected for analysis, to provide precision of the analysis to be determined.

[5] Environment Agency (2024) MCERTS standard for organisations sampling and chemically testing water (publishing.service.gov.uk)
[6] Environment Agency (2024) Minimum requirements for self-monitoring of flow: MCERTS performance standard - GOV.UK (www.gov.uk)
[7] Environment Agency (2018) MCERTS: competency standard for inspectors - GOV.UK (www.gov.uk)

5.6.2 Laboratory Analysis

Details on the appropriate analytical methodologies are outlined by the Environment Agency in their guidance on *Monitoring discharges to water*[8,9] and these approaches should be adopted by the appointed laboratory. In summary the potential methodologies are as follows:

- Determination of ammonium nitrogen by flow analysis (CFA and FIA) and spectrometric detection (Limit of Detection (LoD) 0.1 to 1 mg/l depending on instrument configuration);
- Determination of ammonium: manual spectrometric method (LoD 0.2 mg/l);
- Determination of ammonium: distillation and titration method (0.2 mg/l);
- Determination of ammonium: potentiometric method. (0.2 mg/l);
- Determination of nitrite, nitrogen and nitrate nitrogen, and the sum of both by flow analysis (CFA and FIA) and spectrometric detection (LoD for TON 0.2 mg/l and NO2 0.01 mg/l); and
- Determination of nitrite: molecular absorption spectrometric method (LoD 0.002 mg/l).

The DIN concentration in process effluent is anticipated to be 20.0 mg/l (or 4.30 mg/l with inclusion of surface water runoff). The above listed methodologies all have LoDs of 1 mg/l and below for each of the constituent forms of nitrogen outlined above, and so are suitable for confirming whether the effluent DIN concentrations are at the expected levels.

5.6.3 Laboratory Reporting

It should be ensured that the laboratory test report provides the following information when reporting the analytical results to meet Environment Agency requirements:

- Name and address of the laboratory where analysis took place;
- A reference to the method or standard used;
- Any deviations from the standard used, or options employed;
- A full identification of the sample, including date and time taken, date and time received;
- The results of the determinations and expanded uncertainties if requested; and
- Any factors which may have affected the results including recovery factors.

5.6.4 Technical Reporting

Results of the monitoring will be entered into a master spreadsheet on a monthly basis where descriptive analysis and trends will be determined before being recorded in a Technical Report at the completion fo 12 months monitoring. As a minimum data should be presented in a Shewhart Control Chart, in line with Environment Agency requirements[10]. Analysis of duplicates will be undertaken to assess the monitoring precision, and the performance of each analytical method should be reviewed and any deviating samples identified and consequences for the analysis considered. The Technical Report will be issued to the Environment Agency and Natural England upon completion.

[8] Environment Agency (2023) Monitoring discharges to water: CEN and ISO monitoring methods - GOV.UK (www.gov.uk)
[9] Environment Agency (2020) Monitoring discharges to water: alternative monitoring methods - GOV.UK (www.gov.uk)
[10] Environment Agency (2024) Monitoring discharges to water: analytical quality control charts - GOV.UK (www.gov.uk)

6. Summary and Conclusions

This Nutrient Nitrogen Safeguarding Scheme has been produced to fulfil Requirement 37 of the DCO for the Net Zero Teesside Proposed Development. The above report provides details of the finalised design of the effluent discharge point to Tees Bay, near and far field modelling of mixing zones and details of the proposed discharge monitoring methods, frequency and location. Near and far field dispersion modelling has been carried out following the same methodology and datasets as in previously submitted reports and show no net increase in DIN loads within the Tees Estuary at the Seal Sands mud flats. The modelling also shows that the discharge will not impact on the Water Framework Directive status of the Tees Coastal Water, Tees Transitional Waterbody or Tees Estuary.

The above report sets out the ambient data, effluent discharge rates and effluent discharge concentrations used in the dispersion modelling. The complex tidal currents in Tees Bay do not promote ready exchange of water with the open ocean and can result in pollutants accumulating in shallow water areas. The dispersion modelling has therefore considered both immediate dilution at the outfall under key tidal conditions, and wider changes in average and maximum DIN concentrations in Tees Bay and the River Tees Estuary over multiple tidal cycles. The results show that DIN concentrations are diluted to below the EQS within a very short distance from the diffuser, will result in very minor and localised increase in average DIN concentrations and will not impact on maximum concentrations in the River Tees estuary at Seal Sands.

The above report presents an absolute worst-case simulation of impacts on DIN in the receiving waters. This is because:

1) the discharges from the Proposed Development are modelled as continuous at maximum rates and occurring throughout the model run period. Actual discharges are anticipated to be intermittent.

2) effluent concentrations are based on maintaining a high 95%ile DIN concentration in the River Tees raw water supply resulting in final effluent concentrations reaching 20 mg/l continuously. It is unrealistic that raw water concentrations would result in sustained discharge at this concentration.

3) Maximum design process effluent flows are assumed to be sustained throughout the model run period. In addition, the contribution from surface water runoff, when included, has been modelled as continuous and based on the entire design capacity of the drainage systems for the Proposed Development. This contribution will only be present following rainfall and will rarely reach the design capacity of the drainage system.

The results show that the proposed development will not impact on the delivery of good status in terms of winter average DIN concentrations in Tees Bay, as regulated under the Water Framework Directive. Further, the results show that the proposals are compatible with the delivery of nutrient neutrality within the River Tees estuary and will slightly reduce the annual nitrogen loading of this waterbody.

The above report therefore shows that the Proposed Development will comply with Requirement 37 of the DCO. An effluent monitoring strategy has been proposed in order to monitor the ongoing performance and discharges from the site to Tees Bay.

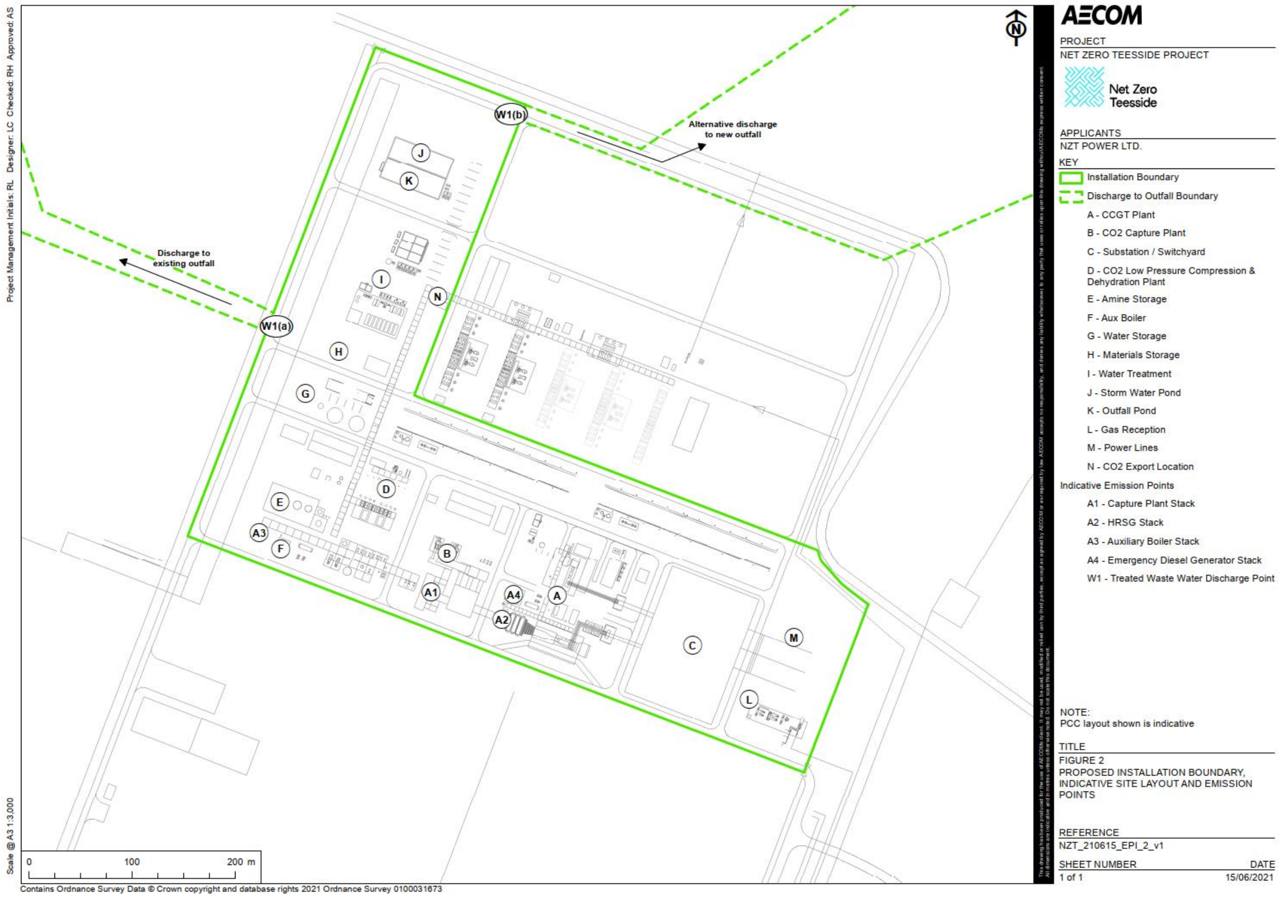
Appendix A Far Field Model Build Report

Appendix B CORMIX Model Log

Appendix C CORMIX Model Files

Appendix D Monitoring Point W1

Monitoring Point W1 is shown below as outlined in the Emission Points Plan in the original Environmental Permit application. Note that the ‘alternative discharge to new outfall’ option (W1b to the north) has been taken forward and will be the monitoring point, with W1a no longer being considered.



Source: NZT Nutrient Nitrogen Briefing Paper aecom.com

Annex B – NZT DCO Appendix 9C WFD Assessment

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Tables

9C. Water Framework Directive Assessment

9.1 Introduction

Background

9.1.1 This Water Framework Directive (WFD) Assessment Report has been provided as part of the Environmental Statement (ES) and specifically, as an Appendix to Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

9.1.2 New developments that have the potential to impact the current or targeted WFD status of a water body are required to assess their compliance against the WFD objectives of the potentially affected water bodies. The Planning Inspectorate's Advice Note Eighteen (PINS, 2017) and the Environment Agency guidance for competing WFD assessments for coastal and transitional waters (Environment Agency, 2017), suggest that a three-stage approach should be adopted as follows:

- Stage 1: WFD Screening;
- Stage 2: WFD Scoping; and
- Stage 3: WFD Impact Assessment.

9.1.3 This report presents the findings of Stages 1-3, which have been undertaken in relation to the Proposed Development.

The Proposed Development

9.1.4 The Proposed Development comprises the construction and operation (including maintenance) of a Carbon Capture Utilisation and Storage (CCUS) facility comprising a gas-fired power station together with equipment required for the capture and compression of carbon dioxide (CO_2) emissions from the generating station. In addition, there is a need for the provision of supporting infrastructure and connections to support the generating station and to facilitate the development of a wider industrial carbon capture network in Teesside, the construction of which also forms part of this project. The project also includes high-pressure compression of CO_2 and a pipeline to export it for off-shore storage.

9.1.5 Whilst the Proposed Development is designed for the future collection and storage of CO_2 from third-party industrial emitters, the capture and compression of third-party CO_2 emissions does not form part of the DCO Application and is not considered in this WFD Assessment but will be the subject of separate consent applications.

9.1.6 The Site is divided into the following areas (described in more detail in Chapter 4: Proposed Development (ES Volume I, Document. Ref. 6.2) and shown on the Figures below which are presented in ES Volume II, Document. Ref. 6.3:

- The Power, Capture and Compressor site (PCC Site) (Figure 3-1);

- Onshore CO_2 Export Corridor (Figure 3-2A);
- Electrical Connection Corridor (Figure 3-2C);
- Water Supply and Discharge Corridors (Figure 3-2D);
- Natural Gas Connection Corridor (Figure 3-2B); and
- CO_2 Gathering Network Corridor (Figure 3-2E).

9.1.7 The PCC Site is located on the south bank of the River Tees, approximately 1.6 km east from the town of Redcar and 1.4 km north-east of Dormanstown. The PCC Site is located within the former Redcar steelworks site, comprising part of the former landholding to the east of the Redcar Bulk Terminal, on the south bank of the River Tees.

9.1.8 The PCC Site, together with the connection corridors for the electrical grid connection, water supply and discharge corridors and the onshore element of the CO_2 Export Pipeline, will be located within the administrative boundary of Redcar and Cleveland Borough Council (RCBC), in the ward of South Bank. Connections to the NGG and the CO_2 Gathering Network are intended to cross the River Tees to land within the administrative boundary of the Stockton on Tees Borough Council (STBC) in Billingham Ward.

9.1.9 The Site boundary extends south of the PCC Site in order to accommodate the Natural Gas Connection Corridor and Electrical Connection Corridor.

9.1.10 The section of the Site comprising the Natural Gas Connection Corridor and CO_2 Gathering Network Corridor extends to the east of the Electrical Connection Corridor. Here the Site boundary extends across the Tees either side of Tees Dock. The Site boundary extends across the chemical works on the western bank of the Tees on reclaimed land to the south of the Seal Sands inter-tidal mudflats. The Natural Gas Connection Corridor extends west as far as the brine field to the east of Cowpen Marsh. The CO_2 Gathering Network then follows existing pipeline routes around the perimeter of Salthome Nature Reserve, and into the industrial area at the eastern extent of Billingham, which includes recycling and recovery centres.

9.1.11 The indicative boundary for the PCC Site currently encompasses an area of approximately 42.5 hectares (ha) within the overall development boundary of 462.0 ha.

9.1.12 The design of the Proposed Development, at this consenting stage of the project, incorporates a degree of flexibility in the dimensions and configurations of buildings and structures to allow for the future selection of the preferred technology and contractor and recognising that the Proposed Development is First Of A Kind for this type of infrastructure project.

9.1.13 In order to ensure a robust assessment of the likely significance of the environmental effects of the Proposed Development, the WFD assessment is being undertaken adopting the principles of the ‘Rochdale Envelope’ approach where appropriate. This involves assessing the maximum (or where relevant, minimum) parameters for the elements where flexibility needs to be retained (such as the building dimensions or operational modes for example). Where this approach is being applied, this is confirmed within this assessment.

9.1.14 Justification for the need to retain flexibility in certain parameters is also outlined in Chapter 4: Proposed Development and in Chapter 6: Alternatives and Design Evolution (ES Volume I, Document Ref. 6.2). As such, this assessment represents a reasonable worst-case assessment of the potential impacts of the Proposed Development at its current stage of design.

9.1.15 Construction of the Proposed Development is detailed in Chapter 5: Construction Programme and Management ES Volume I (Document Ref. 6.2). At this stage in the project development a detailed construction programme is not available as this is normally determined by the Engineering Procurement and Construction (EPC) contractor who has not yet been appointed; however, an indicative construction programme is presented within Chapter 5: Construction Programme and Management (ES Volume I, Document Ref. 6.2).

9.1.16 Should a DCO be granted for the Proposed Development then construction is anticipated to be in late 2022 at the earliest, with operation commencing in 2026 at the earliest.

9.1.17 It is envisaged that the power station and carbon capture plant will have a design life of around 25 years. At the end of the design life, these elements would be assessed for ongoing viability and, if appropriate, be decommissioned as outlined in Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2). It is anticipated that decommissioning of the power station and carbon capture plant will most likely commence at some point after 2051.

9.1.18 The CO_2 Gathering Network and CO_2 Export Pipeline have been designed to operate independently of the power generation and carbon capture plant and will have a design life of circa 40 years.

9.1.19 A number of mitigation features are incorporated into the design of the Proposed Development in order to avoid, minimise and reduce potential adverse impacts on water features and water resources during the operational phase of the Proposed Development, and these are described further below.

Structure of the Report

9.1.20 The structure of this report is set out as follows:

- Section 9.2 provides a summary of the WFD requirements and screening process;
- Section 9.3 describes the assessment methodology;
- Section 9.4 describes baseline conditions;
- Section 9.5 provides the screening assessment for the Tees Estuary transitional waterbody and Tees Coastal waterbody;
- Section 9.6 provides the scoping assessment for the Tees Estuary transitional waterbody and Tees Coastal waterbody;
- Section 9.7 describes the results of the assessment and provides details of possible mitigation and monitoring options to alleviate adverse effects; and
- Section 9.8 presents the conclusions and recommendations.

9.1.21 In addition, this assessment is supported by the following technical annexes:

- Annex A WFD Water Body Assessments Cycle 2;
- Annex B Further WFD Waterbody Description;
- Annex C Surface Water Quality Data;
- Annex D Sediment Quality;
- Annex E Pond 14 Water Quality Monitoring Technical Note;
- Annex F Water Resources Tables; and
- Annex G Water Quality Assessment (Modelling Report, 2022).

9.2 Overview of the Water Framework Directive

Legislative Context

9.2.1 The WFD aims to protect and enhance the quality of the water environment. The WFD is transposed into legislation in England by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[1]. It takes a holistic approach to the sustainable management of water by considering the interactions between surface water (including transitional and coastal waters, rivers, streams and lakes), groundwater and water-dependent ecosystems.

9.2.2 Under the WFD, 'waterbodies' are the basic management units, defined as all or part of a river system or aquifer. Waterbodies form part of a larger 'river basin district' (RBD), for which 'River Basin Management Plans' (RBMPs) are used to summarise baseline conditions and set broad improvement objectives.

9.2.3 In England, the Environment Agency is the competent authority for implementing the WFD, although many objectives will be delivered in partnership with other relevant public bodies and private organisations (for example. local planning authorities, water companies, Rivers Trusts, large private landowners and developers). As part of its regulatory role and statutory consultee on planning applications and environmental permitting (under the Environmental Permitting Regulations (England and Wales) 2010 (as amended)), the Environment Agency must consider whether proposals for new developments have the potential to:

- Cause a deterioration of a waterbody from its current status or potential; and / or
- Prevent future attainment of good status or potential where not already achieved.

9.2.4 In determining whether a development is compliant or non-compliant with the WFD objectives for a water body, the Environment Agency must also consider the conservation objectives of any Protected Areas (i.e. Natura 2000 sites or water dependent Sites of Special Scientific Interest (SSSI)) and adjacent WFD water bodies, where relevant.

[1] Following the United Kingdom's departure from the European Union and completion of the transition period, the requirements of the WFD as implemented in England by national legislation remain applicable until such time as new legislation is passed either revoking or amending the current 2017 WFD Regulations.

Surface Water Body Status

9.2.5 Under the WFD, surface water body status is classified on the basis of chemical and ecological status or potential. Ecological status is assigned to surface water bodies that are natural and considered by the Environment Agency not to have been significantly modified for anthropogenic purposes. The overall objective for natural surface water bodies is to achieve Good Ecological Status and Good Chemical Status. Good Ecological Status represents only a small degree of departure from pristine conditions, which are otherwise known as High Ecological Status. All five status class definitions are provided in Table 9C-1.

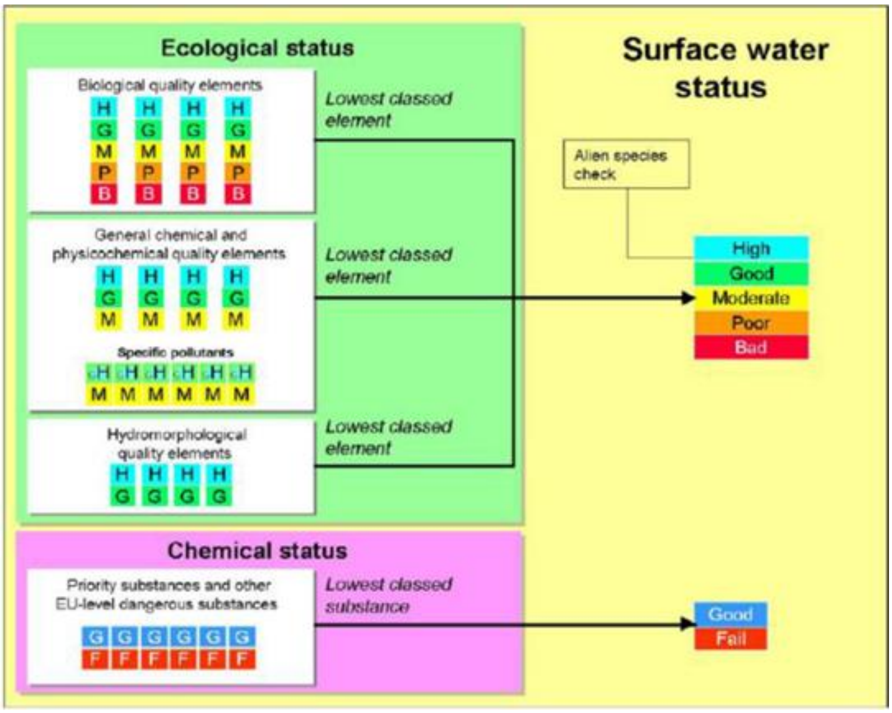
Table 9C- 1 Definition of status in the Water Framework Directive (Environment Agency, 2015)

Status	Definition
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife or fisheries.
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

9.2.6 Ecological potential is assigned to artificial and man-made waterbodies (such as canals), or natural waterbodies that have undergone significant modification; these are termed Heavily Modified Waterbodies (HMWBs). The term 'ecological potential' is used as it may be impossible to achieve good ecological status because of modification for a specific use, such as navigation or flood protection. The ecological potential represents the degree to which the quality of the water body approaches the maximum it could achieve and depends on the classification of WFD parameters and the implementation of mitigation measures identified by the Environment Agency.

9.2.7 Ecological status of water bodies is classified according to relevant biological, physico-chemical, and hydromorphological parameters on a five-point scale as either High, Good, Moderate, Poor or Bad Ecological Status. The classification system is based on a worst-case system 'one-out all-out' system, meaning that the overall ecological status is based on the lowest individual parameter score. This general system is summarised below in Figure 9C-1.

Figure 9C- 1: WFD classification elements for surface waterbody status (Environment Agency, 2015)



Chemical Status

9.2.8 Chemical status is defined by compliance with environmental standards for chemicals that are priority substances and/or priority hazardous substances, in accordance with the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and the Environmental Permitting (England and Wales) (Amendment) Regulations 2016. Chemical Status is assigned on a scale of good or fail. Surface waterbodies are only monitored for priority substances where there are known discharges of these pollutants; otherwise surface waterbodies are reported as being at good chemical status.

Ecological Status or Potential

9.2.9 Ecological status or potential is defined by the overall health or condition of the watercourse. This is assigned on a scale of High, Good, Moderate, Poor or Bad, and on the basis of four classification elements or 'tests' (Environment Agency, 2013), as follows:

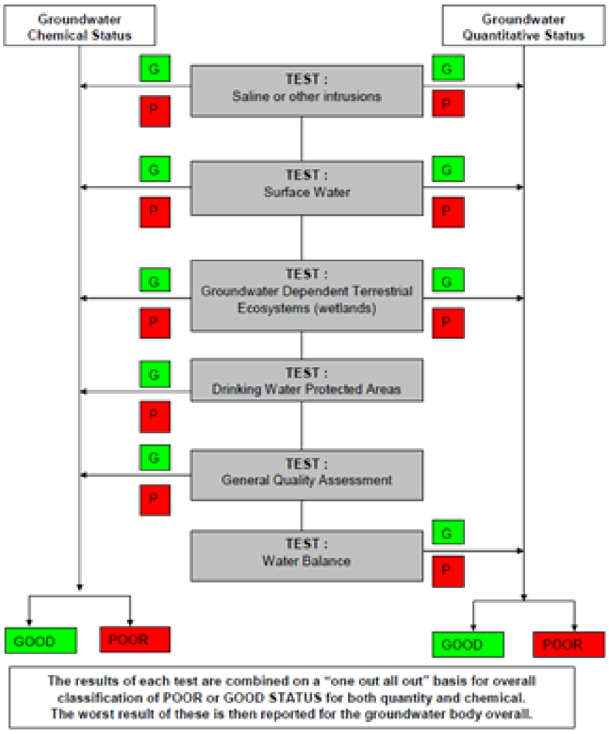
- Biological: this test is designed to assess the status indicated by a biological quality element such as the abundance of fish, invertebrates or algae and by the presence of invasive species. The biological quality elements can influence an overall water body status from Bad through to High.
- Physico-chemical: this test is designed to assess compliance with environmental standards for supporting physicochemical conditions, such as dissolved oxygen, phosphorus and ammonia. The physicochemical elements can only influence an overall water body status from Moderate through to High.

- Specific pollutants: this test is designed to assess compliance with environmental standards for concentrations of specific pollutants, such as zinc, cypermethrin or arsenic. As with the physico-chemical test, the specific pollutant assessment can only influence an overall water body status from Moderate through to High.
- Hydromorphology: for natural, non-HMWBs, this test is undertaken when the biological and physico-chemical tests indicate that a water body may be of High status. It specifically assesses elements such as water flow, sediment composition and movement, continuity, and structure of the habitat against reference or ‘largely undisturbed’ conditions. If the hydromorphological elements do not support High status, then the status of the water body is limited to Good overall status. For artificial or HMWBs, hydromorphological elements are assessed initially to determine which of the biological and physico-chemical elements should be used in the classification of ecological potential. In all cases, assessment of baseline hydromorphological conditions are an important factor in determining possible reasons for classifying biological and physico-chemical elements of a water body as less than Good, and hence in determining what mitigation measures may be required to address these failing waterbodies.

Groundwater Body Status

9.2.10 Under the WFD, groundwater body status is classified on the basis of quantitative and chemical status. Status is assessed primarily using data collected from the Environment Agency monitoring network; therefore, the scale of assessment means that groundwater status is mainly influenced by larger scale effects such as significant abstraction or widespread/diffuse pollution. The worst-case classification is assigned as the overall groundwater body status, in a ‘one-out all-out’ system. This system is summarised in Figure 9C-2.

Figure 9C- 2: WFD Classification Elements for Groundwater Body Status (Environment Agency, 2015)



Quantitative Status

9.2.11 Quantitative status is defined by the quantity of groundwater available as baseflow to watercourses and water-dependent ecosystems, and as 'resource' available for use as drinking water and other consumptive purposes. This is assigned on a scale of Good or Poor, and on the basis of four classification elements or 'tests' as follows:

- Saline or other intrusions: This test is designed to identify groundwater bodies where the intrusion of poor quality water, such as saline water or water of different chemical composition, as a result of groundwater abstraction, is leading to sustained upward trends in pollutant concentrations or significant impact on one or more groundwater abstractions.
- Surface water: This test is designed to identify groundwater bodies where groundwater abstraction is leading to a significant diminution of the ecological status of associated surface waterbodies.
- Groundwater Dependent Terrestrial Ecosystems (GWDTEs): This test is designed to identify groundwater bodies where groundwater abstraction is leading to "significant damage" to associated GWDTEs (with respect to water quantity).
- Water balance: This test is designed to identify groundwater bodies where groundwater abstraction exceeds the 'available groundwater resource', defined as the rate of overall recharge to the groundwater body itself, as

well as the rate of flow required to meet the ecological needs of associated surface waterbodies and GWDTEs.

Chemical Status

9.2.12 Chemical status is defined by the concentrations of a range of key pollutants, by the quality of groundwater feeding into watercourses and water-dependent ecosystems and by the quality of groundwater available for drinking water purposes. This is assigned on a scale of Good or Poor, and on the basis of five classification elements or 'tests' as follows:

- Saline or other intrusions: this test is designed to identify groundwater bodies where the intrusion of poor quality water, such as saline water or water of different chemical composition, as a result of groundwater abstraction is leading to sustained upward trends in pollutant concentrations or significant impact on one or more groundwater abstractions.
- Surface water: this test is designed to identify groundwater bodies where groundwater abstraction is leading to a significant diminution of the chemical status of associated surface waterbodies.
- Groundwater Dependent Terrestrial Ecosystems (GWDTEs): this test is designed to identify groundwater bodies where groundwater abstraction is leading to "significant damage" to associated GWDTE's (with respect to water quality).
- Drinking Water Protected Areas (DrWPAs): this test is designed to identify groundwater bodies failing to meet the DrWPA objectives defined in Article 7 of the WFD or at risk of failing in the future.
- General quality assessment: this test is designed to identify groundwater bodies where widespread deterioration in quality has or will compromise the strategic use of groundwater.

9.3 Assessment Methodology

Introduction

9.3.1 Proposed developments having the potential to impact on current or predicted WFD status are required to assess their compliance against the objectives defined for potentially affected water bodies. As part of its role, the Environment Agency must consider whether proposals for new developments have the potential to:

- Cause a deterioration of a water body from its current status or potential; and/ or
- Prevent future attainment of Good status (or potential where not already achieved).

Assessment Stages

9.3.2 The Planning Inspectorate's Advice Note Eighteen (PINS, 2017) and the Environment Agency guidance for competing WFD assessments for coastal and transitional waters (Environment Agency, 2016) suggest that a three-stage approach is adopted:

- Stage 1: WFD Screening - Identification of the proposed work activities that are to be assessed and determination of which WFD water bodies could potentially be affected through identification of a zone of influence. This step also provides a rationale for any water bodies screened out of the assessment.
- Stage 2: WFD Scoping - For each water body identified in Stage 1, an assessment is carried out to identify the effects and potential risks to quality elements from all activities. The assessment is made taking into consideration embedded mitigation (measures that can reasonably be incorporated into the design of the proposed works) and good practice mitigation (measures that would occur with or without input from the WFD assessment process).
- Stage 3: WFD Impact Assessment - A detailed assessment of the water bodies and activities carried forward from the WFD screening and scoping stages. It involves:
  - The baseline conditions of the concerned water bodies;
  - An assessment of the risk of deterioration (either in isolation or cumulatively);
  - A description of any additional mitigation that is required (if applicable) and how it will be implemented; and,
  - An explanation of any positive contributions to the RBMP objectives proposed, and how they will be delivered.

9.3.3 This report covers Stages 1-3 of the above assessment process.

Defining No Deterioration

9.3.4 No deterioration was defined by the Environment Agency in its Position Paper (Environment Agency, 2013). Steps are required to prevent deterioration of the ecological status, ecological potential and chemical status of surface water and the qualitative status and quantitative status of groundwater.

9.3.5 Originally deterioration was defined by the Environment Agency as deterioration from one status class to a lower one, however following a ruling by the Court of Justice of the European Union (CJEU) in July 2015 (Case C-461/13 on the 1st July 2016 (Bund für Umwelt und Naturschutz Deutschland eV v Bundesrepublik Deutschland)), this has been redefined[2]. The CJEU ruling clarified that:

- ‘Deterioration of the status’ of the relevant waterbody includes a fall by one class of any element of the ‘quality elements’ even if the fall does not result in a change in the classification of the waterbody as a whole;
- ‘Any deterioration’ in quality elements in the lowest class constitutes deterioration; and

[2] As this ruling has been adopted for use in the United Kingdom and precedent has been set, it continues to apply to decision makers regarding the compliance of new projects with the objectives of the WFD.

- Certainty regarding a project's compliance with the Directive is required at the planning consent stage; hence, where deterioration 'may' be caused, derogations under Article 4.7 of the WFD are required at this stage.

9.3.6 Whilst deterioration within a status class does not contravene the requirements of the WFD, (except for Water Supply (Water Quality) (Amendment) Regulations 2017 parameters in drinking water protected areas), the WFD requires that action should be taken to limit within-class deterioration as far as practicable. For groundwater quality, measures must also be taken to reverse any environmentally significant deteriorating trend, whether or not it affects status or potential.

9.3.7 The no deterioration requirements are applied independently to each of the elements coming together to form the water body classification as required by Appendix V of the Water Framework Directive and Article 4 of the Groundwater Daughter Directive. This is transposed into UK legislation by the Groundwater (England and Wales) Regulations 2009.

- Surface water: To manage the risk of deterioration of the biological elements of surface waters, the no deterioration requirements are applied to the environmental standards for the physico-chemical elements, including those for the Moderate/Poor and Poor/Bad boundaries.
- Groundwater: The no deterioration requirements are applied to each of the four component tests for quantitative status and the five component tests for chemical status. The no deterioration requirement may not apply to elements at High status and elements at High status may be permitted to deteriorate to Good status, provided that:
  - The water body's overall status is not High;
  - The RBMP has not set an objective for the water body of High status;
  - The objectives and requirements of other domestic or European Community legislation are complied with; and
  - Action is taken to limit deterioration within High or Good status or potential classes as far as practicable

9.3.8 The no deterioration baseline for each water body is the status that is reported in Annex A.

Surface Water Assessment

9.3.9 Table 9C-2 presents the matrix used to assess the effect of a project on surface water status or potential class. It ranges from a major beneficial effect, a positive change in overall WFD status, through no effect, and down to deterioration in overall status class. The colour coding used in Table 9C-2 is applied to the spreadsheet assessment in Annex B.

Table 9C- 2: Surface Water Assessment Matrix

Effect	Description / Criteria	Outcome
Major beneficial	Impacts that taken on their own or in combination with others have the potential to lead to the improvement in the ecological status or potential of a WFD quality element for the entire waterbody	Increase in status of one or more WFD element giving rise to a predicted rise in status class for that waterbody.
Minor / localised beneficial	Impacts when taken on their own or in combination with others have the potential to lead to a minor localised or temporary improvement that does not affect the overall WFD status of the waterbody or any quality elements	Localised improvement, no change in status of WFD element
Green (no impact)	No measurable change to any quality elements.	No change
Yellow - Localised/ temporary adverse effect	Impacts when taken on their own or in combination with others have the potential to lead to a minor localised or temporary deterioration that does not affect the overall WFD status of the waterbody or any quality elements or prevent improvement. Consideration will be given to mitigation measures such as habitat creation or enhancement measures.	Localised deterioration, no change in status of WFD element when balanced against mitigation measures embedded in the scheme.
Orange - Adverse effect on class of WFD element	Impacts when taken on their own or in combination with others have the potential to lead to the deterioration in the WFD status class of one or more biological quality elements, but not in the overall status of the waterbody. Consideration will be given to mitigation measures such as habitat creation or enhancement measures.	Decrease in status of WFD element when balanced against positive measures embedded in the scheme.
Red – Adverse effect on overall WFD class of waterbody	Impacts when taken on their own or in combination with others have the potential to lead to the deterioration in the ecological status or potential of a WFD quality element, which then lead to a deterioration of status/potential of waterbody.	Decrease in status of overall WFD waterbody status when balanced against positive measures embedded in the scheme.

9.3.10 The assessment has considered all water bodies that may be directly or indirectly affected (adjacent water bodies). It has also considered any Protected Areas as defined by other European Directives such as Special Areas of Conservation (SAC) and Special Protection Areas (SPA), and water dependent SSSIs. Where more stringent (than WFD) standards apply (such as conservation objectives) these have also been considered.

Groundwater Assessment

9.3.11 Table 9C-3 presents the matrix used to assess the effect of a project on groundwater status class. It ranges from a beneficial effect, through no effect, and down to deterioration in overall status class.

Table 9C- 3: Groundwater assessment matrix

Magnitude of Impact of Scheme Element on WFD Element i.e. in individual cells	Effect on WFD Element within the assessment boundary i.e. at end of row	Effect on Status of WFD element at the Groundwater Body Scale
Impacts lead to beneficial effect	Combined impacts have the potential to have a beneficial effect on the WFD element.	Improvement but no change to status of WFD element
No measurable change to groundwater levels or quality.	No measurable change to WFD elements.	No change and no deterioration in status of WFD element
Impacts when taken on their own have the potential to lead to a minor localised or temporary effect	Combined impacts have the potential to lead to a minor localised or temporary adverse effect on the WFD element.	Combined impacts have the potential to lead to a minor localised or temporary effect on the WFD element. No change to status of WFD element and no significant deterioration at groundwater body scale.
Impacts when taken on their own have the potential to lead to a widespread or prolonged effect.	Combined impacts have the potential to have an adverse effect on the WFD element.	Combined impacts have the potential to have an adverse effect on the WFD element, resulting in significant deterioration but no change in status class at groundwater body scale.
Impacts when taken on their own have the potential to lead to a significant effect.	Combined impacts in combination with others have the potential to have a significant adverse effect on the WFD element.	Combined impacts in combination with others have the potential to have an adverse effect on the WFD element AND change its status at the groundwater body scale

Future Status Objectives

9.3.12 RBMPs are used to outline water body pressures and the actions that are required to address them. The future status objective assessment considers the ecological potential of a surface water body and the mitigation measures that defined the ecological potential. Assessments undertaken for the Proposed Development are based on mitigation measures defined in the 2015 RBMP. Information on WFD measures available from the Environment Agency Catchment Data Explorer website (accessed January 2021) has also been reviewed. The assessment considers whether a project has the potential to prevent the implementation or impact the effectiveness of the defined measures.

Regulation 19 Derogations

9.3.13 Where the potential for deterioration of water bodies is identified, and it is not possible to mitigate the impacts to a level where deterioration can be avoided, additional assessment is needed in the context of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 Regulation 19, which covers procedures for derogation.

9.3.14 A failure to prevent deterioration from high status to good status of a body of surface water is not a breach of the environmental objectives set for it under Regulation 19 if:

- The failure is the result of new sustainable development activities, and all practicable steps are taken to mitigate the adverse impact on the status of the waterbody; and
- The reasons for the modifications or alterations, or for the sustainable development activities, are of overriding public interest; or the benefits to the environment and to society of achieving the environmental objectives are outweighed by the benefits of the new modifications or alterations, or of the sustainable development activities, to human health, to the maintenance of human safety, or (in the case of modifications or alterations) to sustainable development; and
- The beneficial objectives served by the modifications or alterations, or by the sustainable development activities, cannot, for reasons of technical feasibility or disproportionate cost, be achieved by other means which are a significantly better option.

Environment Agency Clearing the Waters for All Guidance

9.3.15 Within the PINS Advice Note 18 (PINS, 2017), PINS advise following the approach given in the Environment Agency's Clearing the Waters for All guidance (Environment Agency, 2016) which was developed for estuarine and coastal waters. PINS consider the staged approach equally suitable for rivers, lakes and groundwater projects in England and Wales.

9.3.16 The Environment Agency's guidance on WFD assessment (Environment Agency, 2016) lists the following activities which can be screened out of assessment due to being of low risk:

- A self-service marine licence activity or an accelerated marine licence activity that meets specific conditions;
- Maintaining pumps at pumping stations – if you do it regularly, avoid low dissolved oxygen levels during maintenance and minimise silt movement when restarting the pumps;
- Removing blockages or obstacles like litter or debris within 10m of an existing structure to maintain flow;
- Replacing or removing existing pipes, cables or services crossing over a waterbody – but not including any new structure or supports, or new bed or bank reinforcement; and
- 'Over water' replacement or repairs to, for example bridge, pier and jetty surfaces – if you minimise bank or bed disturbance.

Flood Risk Activity Permit Exemptions

9.3.17 Certain activities on or near waterbodies are exempt from the requirement for Environmental Permits for Flood Risk Activities, and hence would also be considered low risk activities that would unlikely require a WFD assessments, as summarised in Table 9C-4.

Table 9C- 4: Flood Risk Activity Exemptions

Activity	Type of Modification
Low impact maintenance activities (encourage removal of obstructions to fish/eel passage)	Re-pointing (block work structures)
	Void filling ('solid' structures)
	Re-positioning (rock or rubble or block work structures)
	Replacing elements (not whole structure)
	Re-facing
	Skimming/ covering/ grit blasting
	Cleaning and/or painting of a structure
Temporary works	Temporary scaffolding to enable bridge re-pointing
	Temporary clear span bridge with abutments set-back from bank top
	Temporary cofferdam(s) (if eel/ fish passage not impeded)
	Temporary flow diversion (if fish/ eel passage not impeded) such as flumes and porta-dams
	Repair works to bridge or culvert which do not extend the structure, reduce the cross-section of the river or affect the banks or bed of the river, or reduce conveyance
	Excavation of trial pits of boreholes in byelaw margin
	Structural investigation works of a bridge/ culvert/ flood defence such as intrusive tests, non-intrusive surveys
Bridges	Permanent clear span bridge, with abutments set-back from bank top
	Bridge deck/ parapet replacement/ repair works
	Replacing road surface on a bridge
Service crossing	Service crossing below the river bed, installed by directional drilling or micro tunnelling if more than 1.5 m below the natural bed line of the river
	Service crossing over a river. This includes those attached to the parapets of a bridge or encapsulated within the bridge's footpath or road
	Replacement, installation or dismantling of service crossing/ high voltage cable over a river
Other structures	Fishing platforms
	Fish/ eel pass on existing structure (where <2% water body length is impacted)
	Cattle drinks
	Mink rafts
	Fencing (if open panel/ chicken wire) in byelaw margin
	Outfall to a river ≤300 mm diameter

9.3.18 If the project or components of the project meet the above criteria, they may be screened out of any further assessment, although agreement should also be sought from the Environment Agency.

General Approach and Scheme Assumptions

9.3.19 The following provides a description of the scope of works. The assessment is mainly qualitative and based on readily available data and information, including a site survey. It appraises the potential for non-compliance with the core WFD objectives of no deterioration or failure to improve, taking into account Protected Areas and adjacent water bodies.

Desk Study

9.3.20 The assessment is based on a desk study and a site walkover survey. These are summarised below but are described in more detail in the ES Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

9.3.21 A desk study has been undertaken to:

- Review online aerial, historic and Ordnance Survey maps to review historical land uses, channel planform, notable morphological features and any changes to the channel;
- Review WFD classifications, Environment Agency investigation reports, and any mitigation measures proposed to meet Good Ecological Potential; and
- Review background water quality and biological data from online sources and provided directly by the Environment Agency, as well as water quality data collected to inform the baseline for the Proposed Development.

9.3.22 The desk study and site survey has been used as the basis for a qualitative review of the Proposed Development and to determine the components that require assessment of WFD compliance, or where mitigation or further investigation and assessment will be required.

9.3.23 Site walkovers have been undertaken to allow water receptors in the area to be assessed in terms of their character and morphology, and their connectivity to the Proposed Development to be considered in terms of the surrounding topography and adjacent receptors (e.g. nearby sites of ecological importance). More details are given below.

Source-Pathway-Receptor Approach

9.3.24 The impact assessment is based on a source-pathway-receptor model. For an impact on the water environment to exist the following is required

- An impact source (such as the release of polluting chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or the loss or damage to all or part of a water body);
- A receptor that is sensitive to that impact (i.e. waterbodies and the services they support); and
- A pathway by which the two are linked.

9.3.25 The first stage in applying the Source-Pathway-Receptor model is to identify the causes or ‘sources’ of potential impact from a development. The sources have been identified through a review of the details of the Proposed Development, including the size and nature of the development, potential construction methodologies and timescales. The next step in the model is to undertake a review of the potential receptors, that is, the water environment receptors themselves that have the potential to be affected. Water bodies including their attributes have been identified through desk study and site surveys. The last stage of the model is, therefore, to determine if there is a viable exposure pathway or a 'mechanism' linking the source to the receptor. This has been undertaken in the context of local conditions relative to water receptors within the Study Area, such as topography, geology, climatic conditions and the nature of the impact (e.g. the mobility of a liquid pollutant or the proximity to works that may physically impact a water body).

9.3.26 The assessment of the likely significant effects is qualitative, and considers both construction and operation phases, as well as cumulative effects with other developments. This assessment has considered the risk of pollution to surface water bodies directly and indirectly from construction activities. The risk of pollution from road runoff has also been considered such that appropriate measures (SuDS, proprietary treatment devices) could be incorporated into the design of the Proposed Development.

Rochdale Envelope

9.3.27 The assessment contained herein makes use of the 'Rochdale Envelope' approach under the Planning Act (2008). The approach is employed where the nature of the Proposed Development means that some details of the whole project have not been confirmed when the application is submitted, and flexibility is sought to address the uncertainty.

9.3.28 Key principles in the context of the DCO Application process are given in the PINS Advice Note Nine: Using the Rochdale Envelope (The Planning Inspectorate, 2018). This includes the need to outline timescales associated with the flexibility sought, and that the assessment should establish those parameters likely to result in the maximum adverse effect (the reasonable worst-case scenario) and be undertaken accordingly to determine significant effects from the Proposed Development and to allow for the identification of necessary mitigation.

9.3.29 The following are the reasonable worst-case scenario assumptions (maximum parameters) for the purposes of the WFD assessment:

- It is assumed that during construction the Contractor will as a minimum conform to all permit/consent/licence requirements and best practice measures to avoid, reduce and minimise the risk of water pollution or unacceptable physical impacts (without mitigation) on water bodies. Details of this mitigation and best practice standards are described later in this report.
- Water supply will be via an existing Northumbrian Water raw water feed.
- This assessment assumes that a new discharge pipeline will be installed to the south of the existing pipeline (see Figures 3-2D and 5-2, ES Volume II, Document Ref. 6.3). This would be installed adjacent to the CO_2 Export Pipeline and using trenchless techniques (see Chapter 5 Construction Programme and Management, ES Volume I, Document Ref. 6.2). The route has been selected to avoid the sensitive receptors, surface water bodies,

and is along the line of an existing pipeline. At the outfall, the emplacement of a suitable diffuser head would also be required to be placed via a jack-up barge or similar. The footprint of the outfall head and associated scour protection is assumed to be no more than 100 m^2, and would be located at the furthest point along the discharge corridor. Both the re-use of the existing outfall and pipeline, and potential replacement pipeline and outfall head are included within the Site Boundary.

- There are up to nine effluent streams from the Proposed Development:
  1. Clean Surface water
  2. Potentially Contaminated Surface Water – no amine contamination
  3. Potentially Contaminated Surface Water – amine contaminated
  4. Process water from Capture plant DCC (contains ammonia or urea)
  5. Process water from CO_2 compression and dehydration (weak carbonic acid & numerous streams)
  6. Blowdown from cooling towers
  7. Blowdown from steam boilers
  8. Hazardous liquid wastes
  9. Foul Water (sewage)

  These will be either discharged to the Tees Bay with minimal treatment (clean surface water only) or treated on-site (by dosing for example) or at the Brans Sands WwTW before discharge to Tees Bay. The exceptions to this are:

  - amine contaminated water, hazardous liquid wastes, which will be taken off-site by tanker to a specialist treatment plant; and
  - foul water which will be treated at Northumbrian Water's Marske-by-the-Sea treatment plant.

  Process water from the Carbon Capture Plant will be pumped to Bran Sands WwTW with the treated water returned to the site for discharge via the outfall using dedicated pipelines (Work no. 5C, Document Ref. 4.9). In all cases, new discharge limits for the outfall will be sought via an application for an Environmental Permit

- All foul water from welfare facilities will be directed to Northumbrian Water's Marske-by-the-Sea WwTW using existing infrastructure . It is assumed that Northumbrian Water would treat foul water from the development within their consent limits and in accordance with requirements to not cause deterioration or prevent improvement under the WFD or will upgrade their facilities if necessary.

General Limitations and Assumptions

9.3.30 The assessment has been undertaken using available data and the Proposed Development design details at the time of writing. However, there is often a degree of uncertainty as to the exact scale and nature of the environmental impacts, and in such cases the worst-case scenario has been considered.

9.3.31 A Site walkover was undertaken on 22 January 2020 by a surface water quality specialist and hydromorphologist in cold, dry and fair conditions. The walkover focused on surface water bodies in the Study Area, observing their current character and condition, the presence of existing risks and any potential pathways for construction and operational impacts from the Proposed Development. Additional site visits including water quality monitoring of Pond 14 have been undertaken between October 2020 and January 2021 to assess potential impacts to the Teesmouth and Cleveland Coast SSSI relating to potential construction of a new pipeline for the discharge outfall into Tees Bay.

9.3.32 The proposed works are located within the catchment of the Northumbria RBMP (Defra, 2016). The first RBMPs were published in 2009, and the first cycle of planning then took place between 2009 and 2015 when the second RBMPs were published. The second cycle of planning is currently underway (2015 - 2021). The Northumbria RBMP published as part of the 2015 RBMP cycle has been considered in the summary baseline classification information which is presented in Section 9.4. Cycle 3 data that was due in 2021 has yet to be published by the Environment Agency (at the time of writing in August 2022).

9.3.33 Aside, from Pond 14 within Teesmouth and Cleveland Coast SSSI (see Annex E), no water quality monitoring has been undertaken. Background water quality has been determined from the nearest Environment Agency monitoring stations. This has been considered robust enough for the characterisation of water body importance and the determination of impacts on the surface water environment. Water quality data was collected from Pond 14 to assess the risk of atmospheric deposition of nitrogen to this open water pond.

9.3.34 Assumptions relating to the thermal and effluent discharge modelling from the Tees Bay outfall are all outlined in the Net Zero Teesside – Water Quality Assessment (Intermediate Design Stage) (see Annex 14G).

9.3.35 The understanding of drainage arrangements assessed is based on BP supplied data. The drainage strategy will be subject to further development, in consultation with the Environment Agency and Lead Local Flood Authority (LLFA)

9.3.36 The expected treatment performance of different SuDS options is based on advice reported in CIRIA C753 The SuDS Manual (CIRIA, 2016) for use with the Simple Index Approach. This approach gives a number of example land uses which are not all directly applicable to the Proposed Development. Professional judgement has been used when deciding the most appropriate example land use, and what treatment a particular option may provide, taking into account the design of the SuDS feature and whether it is considered to be ‘optimum’ or ‘sub-optimum’ for whatever reason.

9.4 Baseline Information

9.4.1 The relevant baseline physical characteristics of the Study Area and the WFD water features present are described in this section. Please refer to Figure 9-1: WFD Waterbodies and their attributes throughout.

Consultation

9.4.2 The EIA Scoping Addendum Report was submitted in February 2019 and the Scoping Opinion was received in April 2019. The EIA PEI Report was submitted in July 2020 and consultation comments received in September 2020. Responses to all comments relevant to the WFD assessment are outlined in Chapter 9 Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref.6.2).

9.4.3 Further Environment Agency comments have been received as part of the DCO examination, within their relevant representations and also at a meeting held on 1st April 2022. The comments and an overview of the Applicants' responses are outlined in Table 9C-5. This includes the Applicants' responses as submitted to the DCO examination, and also a more recent update from August 2022 where applicable.

Table 9C- 5: Environment Agency relevant representations (where related directly or indirectly to the WFD Assessment)

Relevant Representation	Applicants Response Submitted to Examination and subsequent updates (August 2022)
6.2.8 ES Vol 1 Chapter 8 Air Quality [APP-190] A water quality model needs to be submitted that assesses the impacts of atmospheric deposition rates on the Water Framework Directive (WFD) water bodies and its habitats.	A simple mass balance water quality appraisal for the Tees Coastal WFD waterbody has been undertaken. This indicated that the predicted increase in total nitrogen is so small that there is confidence that atmospheric deposition of nitrogen is an insignificant issue, and no further water quality modelling of this issue is considered necessary. The Environment Agency accepted this at the meeting on the 1 April 2022. The WFD Assessment has been updated to reflect the additional mass balance analysis. Refer to Section 9.7.
6.2.9 ES Vol I Chapter 9 Surface Water, Flood Risk and Water Resources [APP-191] No assessment has been made of the impact to WFD water bodies from effluent. Therefore there is a risk of deterioration to WFD water bodies. The Coastal Modelling Report [APP-321] needs to be updated to assess effluent impacts.	A revised modelling report has been produced and is included in Annex G with findings summarised in Section 9.7 of this report.
6.4.48 ES Vol III Appendix 24C Statement of Combined Effects [APP346] No assessment has been made on atmospheric deposition rates in combination with the water effluent plume from effluent containing Nitrogen to the Tees Bay coastal waterbody. Therefore, insufficient information has been provided to assess the risk of deterioration of the WFD status of the Tees Coastal waterbody. A water quality model should include the effluent discharge and atmospheric deposition impact in combination to the Tees coastal waterbody.	The WFD Assessment has been updated to reflect the additional mass balance analysis regarding deposition of atmospheric nitrogen. Refer to Section 9.7. It should also be noted that there is no WFD classification available for nitrogen for the Tees Coastal WFD waterbody, but nonetheless the insignificant level of deposition identified would not lead to a deterioration in class based on the DIN standards outlined in the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. A revised modelling report has been produced and is included in Annex G with findings summarised in Section 9.7 of this report.
6.4.11 ES Vol III Appendix 9C WFD Assessment [APP-254] WFD Mitigation Measures: The proposal does not appear to include any measures that would enhance or restore any bodies of water The Applicant must demonstrate that the proposal will not jeopardise the delivery of mitigation measures aiming to attain WFD objectives, in particular DIN. The Applicant should also consider how the proposal could protect and enhance the waterbodies within development boundary. The Applicant should also ensure the WFD assessment also considers non-reportable bodies of water potentially	The Proposed Development will no longer discharge any effluent whatsoever to Tees Estuary (Tees transitional WFD waterbody). Process water will be discharged to Tees Bay (with process water other than the blowdown water and condensed water having been treated at Brans Sands WwTW and returned to the Tees Bay outfall). There is also potential that more effluent may be returned to the Tees Bay outfall than is actually derived from the Proposed Development, i.e. other development's effluent may also be discharged to Tees Bay to some extent and thereby lessen DIN pressures on Tees estuary, although this remains to be confirmed and so is not relied upon for the WFD assessment.

affected by the proposal. Groundwater Changes to Hydrogeological regime may impact groundwater.	All waterbodies (including non-reportable waterbodies and WFD groundwater bodies) are considered by the WFD assessment.
6.2.8 ES Vol 1 Chapter 8 Air Quality [APP-190] A water quality model needs to assess the impact of atmospheric deposition rates on the WFD waterbodies and protected features covered under the habitats directive. **6.2.9 ES Vol I Chapter 9 Surface Water, Flood Risk and Water** A water quality model needs to be carried out to assess the impact of these discharges on the WFD elements/ update the coastal modelling report.	The WFD Assessment has been updated to reflect the additional mass balance analysis. Refer to Section 9.7. A revised modelling report has been produced and is included in Annex G with findings summarised in Section 9.7 of this report.
WFD Mitigation Measures:. The Applicant to demonstrate that the proposal will not jeopardise the delivery of mitigation measures aiming to attain WFD objectives, in particular DIN. The Applicant should also consider how the proposal could protect and enhance the waterbodies within development boundary The Applicant should have regard to the mitigation measure opportunities identified in the Tees Estuary Edges Enhancement Study (2018) and consider whether the proposal offers the opportunity for similar measures in other areas.	The Proposed Development will no longer discharge any effluent whatsoever to Tees Estuary (Tees transitional WFD waterbody). There is now only one option being taken forward for the discharge of process effluent, which is discharge to Tees Bay (with process water other than the blowdown water and condensed water having been treated at Brans Sands WwTW and returned to the Tees Bay outfall). There are DCO boundary limitations that will prohibit meaningful enhancement of watercourses crossed by the pipelines. Other enhancement projects in the vicinity of the Scheme have been taken account of within the assessment. The possibility of 'roughing up' rock armour that is likely to be required around the proposed outfall in order that marine flora can better attach to it will also be considered, following a request from the Environment Agency at the consultation meeting on 1st April 2022 (see Section 9.7: Enhancements).
Groundwater: **6.2.10** ES Vol I Chapter 10 Geology and Contaminated Land [APP-092] will need to be updated with aspects of a Hydrogeological Impact Appraisal (HIA) which are additional to the QRA. The conclusions of the HIA should inform the WFD assessment. This should include a CSM (schematic picture) identifying all of the receptors.	No dewatering is proposed.
Requests raised by the Environment Agency at a consultation meeting 1st April 2022	
The EA requested that the WFDa checks whether the Clearing the Waters for All Guidance has been followed in respect to the works to the outfall as thermal and sediment plumes need to be taken into account in the spatial area of impact and not just the physical footprint of the development.	The WFD assessment has followed the Clearing the Waters for All Guidance (Environment Agency, 2016). Exempt activities as outlined in the guidance are considered at the Screening stage (see paragraph 9.5.6 and Table 9C-10). At the Scoping stage (Section 9.6), impacts on hydromorphology, biology (habitats and fish), water quality and protected areas are considered having been derived the scoping criteria in the Clearing the Waters for All Guidance for both Tees Coastal and Tees transitional WFD waterbodies. One of the scoping criteria for biology (habitats) is footprint of thermal and sediment plumes, and this is considered in Table 9C-15 (Tees Bay) and Table 9C-24 (Tees transitional WFD waterbody). Potential impacts from a thermal/sediment plume scoped into the assessment of Tees Coastal waterbody were taken forward into the impact assessment, and are assessed in Section 9.7. We can confirm that thermal and sediment plumes have taken consideration of the spatial area of impact and not just the physical footprint of the development.
The EA noted in the meeting that recent pollution incidents along this section coast mean that there is more of a focus on chemical pollution risks. The EA would like to see further information on the chemical nature of any drilling fluids.	Further information regarding the bentonite drilling fluid and managing the risk of breakout has been included in the construction phase mitigation section of Section 9.7 of this WFD assessment.

Study Area

9.4.4 The main site (the PCC Site) of the Proposed Development (centred on NGR NZ 56738 25104 will be on the south bank of the River Tees, south of Coatham Sands. There are also peripheral elements to the Proposed Development, including connection corridors for the electrical grid connection and the onshore element of the CO_2 transport pipeline.

9.4.5 For the purposes of the WFD assessment, a Study Area of approximately 1 km around the Site has been considered in order to identify surface water bodies that could reasonably be affected by the Proposed Development. However, since watercourses flow and water quality impacts may propagate downstream, where relevant the assessment also considers a wider Study Area of up to 2 km, based on professional judgement. This is considered sufficient given that 2 km would be within the North Sea and so incorporates all upstream receptors. Additional, indirect effects may also occur to other water environment receptors distant from the Study Area through increased demand on potable water supplies and foul water treatment (i.e. consented discharge from Marske-by-the-Sea WwTW for foul flows).

Catchment Characteristics

9.4.6 The PCC Site, part of the former Redcar steelworks, is coastal, being located immediately southwest of Teesmouth, at approximately 4 – 8 m above ordnance datum (AOD). Coatham Sands is immediately to the north and Bran Sands is to the west (see Figure 9.1, ES Volume II, Document Ref. 6.3). The PCC Site is currently industrial, comprising former steelworks structures. The Dormanstown area of Redcar is located southeast of the PCC Site.

9.4.7 The Site boundary extends north of the PCC Site across Coatham Sands into Tees Bay in two locations (for the Water Discharge Pipeline and CO_2 Export Pipeline), and west across the Tees Estuary at the southern extent of Bran Sands (see Figure 9-1, ES Volume II, Document Ref. 6.3). These areas of the Site are included in order to incorporate existing water supply and discharge infrastructure that are to be retained for use by the Proposed Development and also for the Natural Gas Connection Corridor (see Figure 9-1, ES Volume II, Document Ref. 6.3).

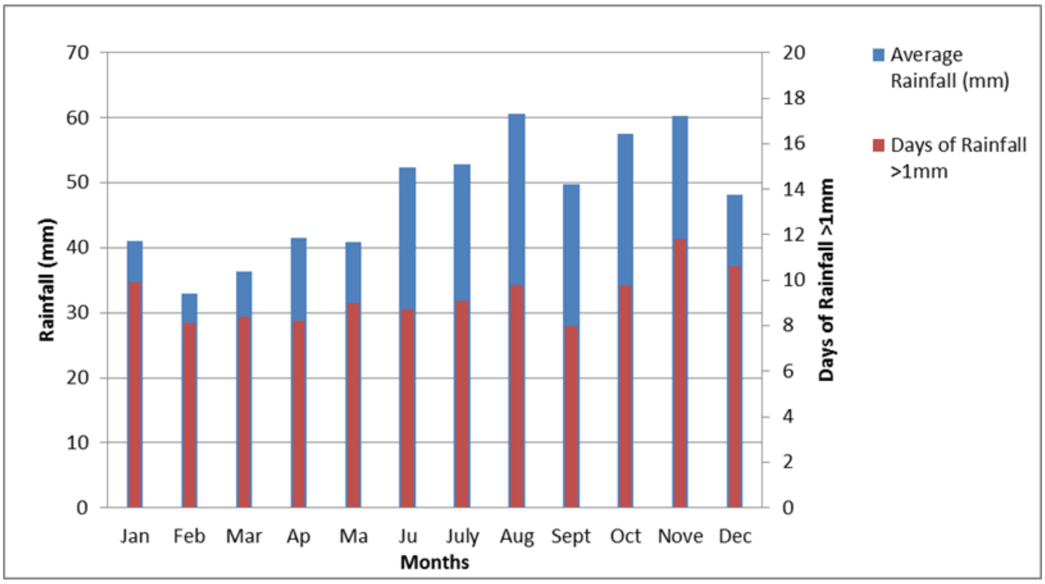
9.4.8 The Site boundary extends south and southwest of the PCC Site in order to accommodate the Natural Gas Connection Corridor, Electrical Connection Corridor and CO_2 Gathering Network Corridor and highways connections for construction traffic.

9.4.9 The section of the Site comprising the Natural Gas Connection Corridor and CO_2 Gathering Network Corridor extends across the Tees adjacent to Dabholm Gut (see Figure 9-1, ES Volume II, Document Ref. 6.3). The Site boundary follows existing pipeline routes around the chemical works on the western bank of the Tees on reclaimed land to the south of the Seal Sands inter-tidal mudflats. The Natural Gas Connection Corridor extends west as far as the existing brine field to the east of Cowpen Marsh. The CO_2 Gathering Network then follows pipelines across Saltholme Nature Reserve, and into the industrial area at the western edge of Haverton Hill, where existing recycling and recovery centres are located. This whole section of the Site is very flat, being between 0 and 10 mAOD. The immediate surroundings include heavy industry on the banks of the Tees, mudflats to the north, marshland at Saltholme and Cowpen Marsh (including Cowpen Bewley Woodland Country Park), and the Tees Estuary itself. There are numerous large standing bodies of water in the marshland areas as well as small watercourses draining towards Seal Sands (which is included within local SSSI and SAC designations).

9.4.10 The nearest weather station on the Met Office website with historical data is located at Stockton-on-Tees, approximately 5.0 km southwest of the eastern extent of the Site, at NGR NZ 43846 19831. Based on the average climate data (for the period 1981 to 2010) for this weather station, it is estimated that the Study Area experiences an average of 574 mm of rainfall per year, with it raining more than 1 mm on around 112 days per year. This is a relatively low level of rainfall for England.

9.4.11 Figure 9C-3 illustrates this data to show how the average rainfall varies throughout the year, with the wettest period being in the late summer to autumn, and driest in late winter to early spring. Average monthly rainfall is generally less than 60 mm throughout the year, except in August and November when it is between 60 mm and 65 mm. February is the driest month with an average of approximately 33 mm between 1981 and 2010.

Figure 9C- 3: Stockton-on-Tees weather station – average rainfall per month (1981-2010) and average days per month with >1mm of rainfall (1981-2010)



Geology and Soils

9.4.12 Full details of geology is provided in Chapter 10: Geology, Hydrogeology and Contaminated Land (ES Volume I, Document Ref. 6.2). In summary, the British Geological Society Geoindex viewer (British Geological Society, n.d.) indicates that the solid geology beneath the study site consists of strata of Jurassic and Triassic age.

9.4.13 Immediately around the River Tees and to the south of Teesmouth the bedrock is Triassic Mercia Mudstone including the northern section of the PCC Site which is also underlain by the Penarth Group (Mudstone). The southern half of the PCC Site is underlain by Jurassic Redcar Mudstone, which also stretches south to beyond the Wilton International Site and underlies the majority of the town of Redcar.

9.4.14 To the north of the Tees Estuary, Mercia Mudstone underlies the Seal Sands Industrial Estate, which overlies the Triassic Sherwood Sandstone Group, which is present beneath Seal Sands, Cowpen Marsh and Saltholme.

9.4.15 Bedrock is overlain by superficial deposits consisting of Tidal Flat Deposits (sand, silt and clay). These are found beneath the Tees Estuary, Teesmouth, Seal Sands, Cowpen Marsh and Saltholme. To the northeast of the Site in the coastal area adjacent to Coatham Sands there are deposits of Beach and Tidal Flat Deposits and Blown Sand. The Lackenby Steelworks, Grangetown and Lazenby are underlain by glaciolacustrine deposits, Redcar is underlain by Devensian Till (diamicton). The northwest of the Study Area towards Cowpen Bewley is underlain by glaciolacustrine deposits. Finally, there are marine beach deposits on the coastline north of Teesmouth.

9.4.16 Defra's Multi-agency geographical information for the countryside (MAGIC) website (Defra, n.d.) indicates that the Sherwood Sandstone to the north of the Tees is classified a Principal Aquifer. These have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

9.4.17 The Mercia Mudstone bedrock deposits surrounding the Tees are classified as a Secondary B aquifer. These are lower permeability strata which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. The Redcar Mudstone to the south of this is Secondary (undifferentiated) aquifer. This has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

9.4.18 The superficial deposits beneath the Site are predominantly classified as a Secondary (undifferentiated) aquifer, and in some cases unproductive (i.e. drift deposits with low permeability that have negligible significance for water supply or river base flow). However, there is an area of Secondary A superficial aquifer beneath the PCC Site and immediately south towards the A1085 and Dormanstown. Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

9.4.19 Cranfield University's Soilscapes website (Cranfield University, n.d.) indicates that the majority of the Study Area either side of the Tees Estuary is underlain by loamy and clayey soils of coastal flats with naturally high groundwater. Beyond this, the southern section of the Lackenby Steelworks is underlain by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soil. The latter is also found in the northern extent of the Study Area north of Haverton Hill and toward Billingham. However, due to past development soil type and structure is likely to have been altered and large areas of Made Ground exist. Finally, sand dune soils are found along the coastal areas to the north of the Study Area.

Water Features

9.4.20 A Site Walkover was undertaken on 22 January 2020 in cold, dry but overcast conditions. Using observations taken on this visit, data from OS mapping and the Environment Agency Catchment Data Explorer website, a summary list of the surface water bodies and where relevant to the assessment, groundwater water bodies, has been compiled. This is shown in Table 9C-6, and watercourses are also presented in Figure 9-1: Surface Water Features and Their Attributes and 9-2: Groundwater Features and Their Attributes (ES Volume II, Document Ref. 6.3). Table 9C-6 also provides an indication of whether the waterbody could be impacted or not by the Proposed Development, and which WFD designated waterbody catchment it is included within. Upstream waterbodies have all been scoped out of the assessment as there is no pathway to impact.

Table 9C- 6: Surface and Groundwater Water bodies Identified Within the Study Area

Water body	Type of waterbody	WFD designation or associated WFD water body (where applicable)	Scoped In / Scoped Out
Tees Bay	Coastal	Tees Coastal Water (GB650301500005)	Scoped In – Receives discharge directly from the Proposed Development and crossed by CO_2 export corridor
Tees Estuary	Watercourse (Main River)	Tees Transitional Waterbody (GB510302509900)	Scoped In – Crossed by the Proposed Development and water may be abstracted from the waterbody for operation under an Environmental Permit
The Fleet	Watercourse (Ordinary)	Tees Estuary (S Bank) (GB1030250723320)	Scoped In - Located within the Site boundary and so has potential to be impacted by construction or operation of the Proposed Development
Main's Dike	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped Out – Located upstream of the Site boundary and so would not be impacted
Mill Race	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped In - Located within the Site boundary and so has potential to be impacted by construction or operation of the Proposed Development (considered within the TEES Transitional WFD waterbody)
Dabholm Gut	Watercourse (Ordinary)	Designated under the TEES Transitional Waterbody (GB510302509900)	Scoped In - Located within the Site boundary and so has potential to be impacted by construction or operation of the Proposed Development (considered within the TEES Transitional WFD waterbody)
Dabholm Beck	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped In - Located within the Site boundary and so has potential to be impacted by construction or operation of the Proposed Development (considered within the TEES Transitional WFD waterbody)
Kettle Beck	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped Out - This watercourse is upstream of any works relating to the Proposed Development and so is scoped out of further assessment.
Kinkerdale Beck	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped Out - This watercourse is upstream of any works relating to the Proposed Development and so is scoped out of further assessment.
Knitting Wife Beck	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped Out - This watercourse is upstream of any works relating to the Proposed Development and so is scoped out of further assessment.
Holme Fleet	Watercourse (Main River)	Tributary of the Tees Transitional WFD Waterbody	Scoped In – The Proposed Development requires pipeline construction adjacent to upstream tributaries of this waterbody, and so

Water body	Type of waterbody	WFD designation or associated WFD water body (where applicable)	Scoped In / Scoped Out
			there is potential for pollutants from construction or operation to be conveyed downstream (considered within the TEES Transitional WFD waterbody)
Belasis Beck	Watercourse (Ordinary)	Tributary of Holme Fleet and therefore associated with the Tees Transitional WFD Waterbody	Scoped In - Crosses the Site boundary and so has potential to be impacted by construction or operation of the Proposed Development (considered within the TEES Transitional WFD waterbody)
Cross Beck	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped Out - This watercourse is upstream of any works relating to the Proposed Development and so is scoped out of further assessment.
Greatham Creek	Watercourse (Main River)	Designated under the Tees Transitional WFD Waterbody	Scoped In - This watercourse is outside the 1 km Study Area but is hydrologically connected by Mucky Fleet and Swallow Fleet and so has potential to be impacted during construction and operation of the Proposed Development (considered within the Tees Transitional WFD waterbody)
Mucky Fleet	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped In - This watercourse is outside the 1 km Study Area but has potential to receive pollutants and sediments during construction and operation of the Proposed Development via upstream watercourses (considered within the Tees Transitional WFD waterbody)
Swallow Fleet	Watercourse (Ordinary)	Tributary of the Tees Transitional WFD Waterbody	Scoped In - This watercourse is not within the Site boundary but has potential to receive pollutants and sediments during construction and operation of the Proposed Development via upstream watercourses (considered within the Tees Transitional WFD waterbody)
Salthome Nature Reservoir Ponds, Brine Reservoirs, Brine Field and refinery ponds	Stillwater	Catchment of Tees Transitional WFD Waterbody	Scoped In – These waterbodies have hydrological connectivity to the Site boundary through upstream tributaries in Saltholme Marsh and so have the potential to be impacted during construction or operation of the Proposed Development (considered within the Tees Transitional WFD waterbody).
Lake at Charlton's Pond Nature Reserve	Stillwater	Catchment of Tees Transitional WFD Waterbody	Scoped Out – This pond is upslope of the Proposed Development and so will not be impacted.
Ponds at Billingham Technology Park	Stillwater	Catchment of Tees Transitional WFD Waterbody	Scoped In – In close proximity to the Site boundary and so have potential to be impacted (considered within the Tees Transitional WFD waterbody).

Water body	Type of waterbody	WFD designation or associated WFD water body (where applicable)	Scoped In / Scoped Out
Ponds within Coatham Dunes and Bran Sands	Stillwater	Catchment of Tees Coastal WFD waterbody	Scoped In – The Site boundary extends over the dunes and includes an open water pond (Pond 14), which is scoped in. The remaining water bodies within the dunes complex are fully vegetated wetlands and so are not included in the assessment.
Ponds at Coatham Marsh	Stillwater	Catchment of Tees Estuary (S Bank)	Scoped In – In close proximity to the Site boundary and so have potential to be impacted (considered within the Tees Transitional WFD waterbody).
Numerous industrial ponds and artificial waterbodies across the area including Lazenby Reservoirs and Salthouse Brine Reservoirs	Stillwater	Catchment of Tees Transitional WFD Waterbody	Scoped In – Numerous ponds are within the Site boundary and could be impacted by construction and operation of the Proposed Development.
Tees Sherwood Sandstone	Groundwater	WFD designation (GB40301G702000)	Scoped In – the Proposed Development is partly underlain by this groundwater body and so it is scoped in.
Tees Mercia Mudstone & Redcar Mudstone	Groundwater	WFD designation (GB40302G701300)	Scoped In – the Proposed Development is partly underlain by this groundwater body and so it is scoped in.

Surface Water Bodies

9.4.21 The Environment Agency's Catchment Data Explorer website (Environment Agency, n.d.a) confirms that the estuarine and coastal water bodies in the Study Area are contained within the Northumbria River Basin District, the Northumbria Transitional and Coastal (TraC) Management Catchment, and the Tees Lower and Estuary TraC Operational Catchment.

9.4.22 The fluvial waterbodies are contained within the Northumbria River Basin District, Tees Management Catchment and Tees Lower and Estuary Operational Catchment.

9.4.23 There are three WFD designated surface waterbodies within the Study Area, and these are described in the following sections. Although these are the WFD reporting reaches, WFD principles and objectives apply to all tributaries of these watercourses. The WFD waterbodies include one coastal water body (Tees Coastal Water), one estuarine water body (Tees transitional water body) and one river (The Fleet - designated as Tees Estuary (S Bank)). The WFD classification for these waterbodies are listed in Table 9C-7 as taken from the Environment Agency's Catchment Data Explorer website (Environment Agency, n.d.a.) alongside observations recorded during the site walkover.

9.4.24 The full no deterioration baseline for each water body is the status that is reported in Annex A.

Table 9C-7: WFD Surface Waterbodies in the Study Area

Waterbody	Ecological Status / Potential	Chemical Status	Overall Target Objective	Hydromorphological Designation	Designated Reach
Tees Coastal Water (GB650301500005)	Moderate Ecological Potential	Fail	Good (2027)	Heavily Modified	The Tees Coastal waterbody stretches from approximately 20 km southeast of Redcar at Boulby, to approximately 13 km northwest of Redcar at Crimdon. It includes a total area of 88.31 km^2.
Site observations: The Tees Coastal waterbody was observed from Coatham Sands between Redcar and Teesmouth. The waterbody is backed by a wide sandy beach and sand dunes and is popular for recreation. Coatham Sands has, in places along its length, been strongly influenced by historical deposition of slag from local ironworks. This means that large parts of the dunes are a mix of slag deposits and natural marine-deposited and subsequently wind-blown sand. Within the sand dune complex are a number of ponds and wetland areas. Discharge infrastructure was not apparent and is presumably buried or only observable at very low tide. One pipe was noted across the beach emanating from the direction of Cleveland Links golf course and the area of Warrenby Industrial Estate and is likely to be for discharges to the Tees. The Teesside Offshore Wind Farm was observed approximately 1.5 km off the coast from Redcar. **Mitigation Measures:** Details of mitigation measures for this waterbody were requested from the Environment Agency but none were provided.					
Tees Transitional Waterbody (GB510302509900)	Moderate Ecological Potential	Fail	Moderate (2015)	Heavily Modified	The Tees Transitional Waterbody extends from the Tees Barrage to the east of Stockton-on-Tees, to Teesmouth. This is a distance of approximately 16 km. It includes a total area of 11.44 km^2. The designation includes the mud and sand flats at Seal Sands,Tees Dock, Greatham Creek and Dabholm Gut, Greatham Creek is the estuarine section of Greatham Beck, which flows from the north of Elwick (NZ 45077 33468) to Seal Sands (NZ 51667 25568) and into the Seaton on Tees Channel. Dabholm Gut is a kilometre-long tidal channel on the east bank of the Tees, left when the land on both sides was reclaimed from the Tees estuary.
Site observations: The Tees waterbody was observed from near the Dabholm Gut on the south bank. At this point the estuary is approximately 455 m wide. The estuary is also a busy route for navigation with docks and jetties on both banks. Land either side of the waterbody is flat, having been largely reclaimed in this area and is currently occupied by various heavy industries. Further details regarding hydrodynamics, tides and sediments are provided later in the baseline. The Dabholm Gut is an artificial channel of around 1km length left following historical land reclamation. Upstream is Dabholm Beck which is formed from the coalescence of numerous small watercourses and drains through an area of freshwater marshland to the northwest of the Wilton International Site (upstream of the tidal limit). Dabholm Beck has a single stem channel is around 3-4 m wide, incised and straight, and lacking bedform features of interest, being indicative of extensive past modification. Reeds surround the channel on both banks and there are several large outfalls that discharge into the channel. At the tidal limit where it becomes Dabholm Gut, the channel widens to approximately 30 m and numerous other active outfalls were observed with relatively high rates of discharge, with some visible foaming suggesting potential presence of agitated chemicals. There are numerous consented discharges here from the adjacent industry, and consents are shown in Figure 9-1: Surface Water Features and Their Attributes (ES Volume II, Document Ref. 6.3). The channel width remains constant up to the confluence with the Tees. At low tide, fine sediments are exposed in the channel and are dark in colour suggesting potential presence of pollutants. During especially high tides anecdotal evidence suggests the channel has been known to overtop onto the adjacent access road. The site is popular with birdlife and is included in the Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI).					

Waterbody	Ecological Status / Potential	Chemical Status	Overall Target Objective	Hydromorphological Designation	Designated Reach
Mitigation Measures: Details of mitigation measures for this waterbody were requested from the Environment Agency but none were provided.					
Tees Estuary (South Bank) (GB103025072332O)	Moderate Ecological Potential	Fail	Good (2027)	Heavily Modified	This watercourse is known on local mapping as The Fleet and is designated from adjacent to Longbeck Lane in Saltburn (NGR NZ 60988 20908). It continues north to the west of Redcar, and then flows west through the industrial works to discharge into Dabholm Gut at NGR NZ 56131 24038.
Site observations: The watercourse was observed in Coatham Marsh Nature Reserve, where the channel has been artificially widened to flow through a pond/wetland area that reduces the rate of flow and likely alters the character of water quality. The channel is culverted beneath a bridge within the nature reserve through an overly constrained arch of around 2 m width, which leads to backing up of flow upstream. The channel is also choked by submerged and emergent macrophytes, the extent of which suggests some enrichment by nutrients. Upstream of the bridge the channel is approximately 8-9 m wide but increases to approximately 25-30 m wide immediately downstream where the channel looks like it may have been artificially constructed for access. There is good connectivity with the floodplain upstream of the culvert but less so downstream. Flows upstream of the culvert may on occasion spill onto the surrounding marsh. Various service crossings were noted over the watercourse near this location. Flow is sluggish as a result of the widespread macrophytes, culverted crossing and overwide nature of the channel. The watercourse flows into Dabholm Gut approximately 2 km downstream of this observation point in the Nature Reserve, although there are expected to be controlling structures before the confluence with Dabholm Gut. A tributary of The Fleet was also observed as it crosses Limerick Road in Dormanstown. This was an artificial, perfectly straight channel of around 5 m width. The bed was smothered in fine sediment and pollution pressures were notable with an oil sheen on the water. There were very few macrophytes and the channel has incised banks, rising steeply 1-2 m abruptly from the channel bed. **Mitigation Measures**: The Environment Agency have outlined mitigation measures to improve this waterbody. These are listed In Annex A Table A4 and include re-opening of culverts, restoring in channel morphological diversity, water level management, implementing appropriate vegetation control, removing obsolete structures, installing fish passes and enhancing structures to improve ecology. None of the mitigation measures are currently in place, except for water level management.					

9.4.25 Within the catchments of the WFD waterbodies outlined in Table 9C-7, there are also a number of named watercourses shown on OS mapping (Bing, n.d.), and these are described in Table 9C-8 (please refer to Figure 9-1: WFD Surface Water Features and Their Attributes (ES Volume II, Document Ref. 6.3) throughout).

Table 9C-8: Other named watercourses in the Study Area that are not defined WFD water bodies

Name	Tributary of	Watercourse Description	Site Observations
Belasis Beck	Holme Fleet (within **Tees Transitional Waterbody catchment**)	Belasis Beck appears to rise from ponds in Belasis Hall Technology Park (NZ 47373 23267) and flows east for 2 km before its confluence with Holme Fleet within Salthome Nature Reserve at NZ 49071 23577.	Belasis Beck was observed in the pastoral fields adjacent to Cowpen Bewley Road, where the main channel appeared to be shallow and wide (~6-7 m). Water levels were high during the site visit and overtopping slightly onto the floodplain. Here the channel flows roughly parallel with an adjacent pipeline, which cuts through the fields either side of the road. Flow was sluggish as a result of the shallow gradient and probable tidal locking. This creates a depositional environment, encouraging the growth of submerged and emergent macrophytes. Although these will take up nutrients during their growth, if they are not removed these are released back into the water column resulting in permanent recycling of nutrients and enriched conditions that support further growth of invasive macrophytes. Sediments are fine with little evidence of any transportation. They are also likely to be contaminated due to the past and current industry in this location. The road crossing appeared largely buried at this location, and flows appeared to be backing up upstream of the road leading to the spillage onto the floodplain. A brown surface scum was observed and was thought to be indicative of organics.
Dabholm Beck	**Tees Transitional Waterbody Catchment**	Dabholm Beck is a drainage channel marked on mapping as flowing northeast above ground for 700 m between NZ 56161 23102 and NZ 56710 23730. It then flows northwest into the tidal Dabholm Cut.	Refer to the Dabholm Gut description under the Tees Transitional Waterbody description above.
Kettle Beck	**Tees Transitional Waterbody Catchment**	Kettle Beck rises at Lazenby Bank and flows approximately 4 km generally north along the edge of the Wilton International Site, beneath the A1085, beneath the Teesside Works	Kettle Beck was observed at the western edge of the Wilton International Site. Here the channel was between 2 and 3 m wide, with an artificial, straightened character. The bed was dominated by fine sediment

Name	Tributary of	Watercourse Description	Site Observations
		(Lackenby), and beyond the A1053 before discharging to the Tees. The exact course of the watercourse is not clear from online mapping north of the A1085 as the watercourse is culverted.	with some isolated very fine gravel accumulations. Submerged macrophytes were abundant and some sections of the channel were shaded by overhanging vegetation and thick riparian vegetation. Flow was impeded by a road culvert at the observation site, which consisted of six small diameter (~0.5 m) pipes. The banks rose steeply from the channel bed and were incised meaning the channel is likely to be disconnected from the floodplain.
Holme Fleet	**Tees Transitional Waterbody Catchment**	Holme Fleet is a marshland channel that meanders between Cowpen Marsh (NZ 50596 24732) and Port Clarence (NZ 50703 21620). It is around 5.6 km in length, and a large number of marshland channels join the Fleet, which also flows through several marshland open waterbodies and reedbeds.	Not visited during the site visit as it is outside of the Site Boundary but still considered where relevant within the Study Area of the assessment.
Kinkerdale Beck	**Tees Transitional Waterbody Catchment**	This watercourse is mapped as a surface waterbody for 320 m at the north-western extent of the Wilton International Site (NZ 56071 20996) and is then in culvert. As such, the source and exact course of the watercourse is not known, although it is known to outfall to the Lackenby Channel.	Kinkerdale Beck is a 2-3 m wide ditch which appears to be fed from an overflow connection from Kettle Beck. It was observed just downstream of Kettle Beck where it has an artificial, straightened character with steep banks. The bed was dominated by fine sediment. Submerged macrophytes were abundant and some sections of the channel were shaded by overhanging vegetation. Water in this section of the channel was largely ponded. Further downstream the watercourse is largely culverted beneath the Wilton International Site.
Knitting Wife Beck	**Tees Transitional Waterbody Catchment**	This watercourse rises just north of the A66 in Grangetown (NZ 55172 20910), before flowing north for approximately 300 m towards the Lackenby Steelworks. The watercourse is then culverted and so the course alignment is unclear but is known to outfall at the Lackenby Channel.	The watercourse was visited as it emerges from an approximately 1 m wide box culvert to the north of the A66. The channel was approximately 1-1.5 m wide, and artificial in nature being straight with steep incised banks rising 2-3 m from the channel bed. Fine sediment accumulations were abundant; the channel was largely overgrown; and this section of the channel largely shaded by overhanging deciduous vegetation. Pollution was evident with red staining on all of the vegetation immediately downstream of the culvert.
Lackenby Channel	**Tees Transitional**	The Lackenby Channel is a drainage cut between the Lackenby steelworks (NZ 55305	Lackenby Channel was not visited during the site visit, but aerial photography available online indicates

Name	Tributary of	Watercourse Description	Site Observations
	Waterbody Catchment	22207) and the eastern bank of the Tees estuary (NZ 54145 23341). It is approximately 1.6 km in length and conveys flows from Knitting Wife Beck, Kinkerdale Beck and Kettle Beck to the Tees.	that it is an artificial, straight channel varying between 10 and 15 m in width. It is likely to be very similar to Dabholm Gut with limited hydromorphological interest.
Main's Dike	**Tees Estuary (S Bank) WFD Waterbody**	Main's Dike watercourse rises from a spring in Wilton Wood to the southeast of the Site at NZ 59328 19741. The watercourse then flows north along the eastern boundary of the Wilton International Site, and into the Mill Race at NZ 57893 22824.	Main's Dike was observed along the eastern edge of the Wilton International Site where it was very straight, around 1 m in width and with steep incised banks rising around 4 m from the channel. The watercourse was heavily shaded, and no macrophytes were observed in the channel at this location although marginal vegetation was dense. The bed was dominated by fine sediment, with some isolated fine gravel patches (e.g. 2-3 cm diameter). Significant sediment accumulations were observed downstream of the Mains Dike Bridge culvert. There was also evidence of some lateral erosion of the banks and the formation of small, alternating fine gravel lateral bars, although the gradient was still shallow and the channel stable.
Mill Race	**Tees Estuary (S Bank) WFD Waterbody**	The course of the Mill Race is unclear as it is largely culverted but appears to emanate from coalescence of ditches and watercourses at NZ 57893 22824, then flows north of the Wilton International Site beneath the A1085. It remerges at NZ 57102 24152 and flows west into The Fleet.	The Mill Race was observed within the Wilton International Site to the south of the A1085. Here the watercourse was overly wide (around 3.5-4 m wide) leading up to a circular culvert of around 2 m diameter, with artificial concrete banks in places. Banks were step and incised. The bed was dominated by fine sediment. There are numerous service crossings of the watercourse at this location. The Mill Race was also observed downstream of the A1085 adjacent to the Trunk Road roundabout where it was 2-3 m wide, very straight, with a bed dominated by fine sediment. Road runoff appears to discharge into the channel.
Mucky Fleet / Swallow Fleet	**Tees Transitional Waterbody Catchment**	Mucky Fleet and Swallow Fleet are meandering channels draining Cowpen Marsh. A large number of marshland channels intersect these channels, which ultimately drain to the Tees Transitional Waterbody.	Not visited during the site visit because they are outside of the Site Boundary but still considered where relevant within the Study Area of the assessment

9.4.26 In addition to the watercourses described in Tables 9C-6 and 9C-7, there are numerous drains and ditches in the Study Area. These are predominantly related to drainage infrastructure in the industrial areas, and many are culverted beneath ground and so their exact course is unclear. These ditches do not have nature conservation designations and due to largely being in culvert are expected to have minimal biodiversity value. In places, the drainage channels are visible above ground and are typically of the order of 0.5-1 m in width, ephemeral (i.e. flowing for only part of the year or only after storms), have artificial engineered and sometimes concrete channels, and thus generally do not support functional flows (i.e. flows with the ability to erode, transport and deposit sediment resulting in the formation of geomorphic bedforms).

9.4.27 There is also a network of small watercourse channels throughout the saltmarsh and wetland area to the south and southwest of Seal Sands. Some of these channels were observed on site from the Saltholme RSPB Nature Reserve, and they are small (1-2 m wide) low gradient, single thread, meandering water bodies that are closely connected to their floodplains.

9.4.28 Other water bodies shown in Figure 9-1: Surface Water Features and Their Attributes (ES Volume II, Document Ref. 6.3) outside of the 1 km Study Area are not included in this assessment where they are upstream of any proposed works and so would not have any pathways through which to be impacted. This includes Skelton Beck, Cross Beck, Spencer Beck, Middle Beck, Marton West Beck, Lustrum Beck, Billingham Beck, Cowbridge Beck, North Burn, Claxton Beck and Greatham Beck.

9.4.29 In total, there are 138 still water bodies within 250 m of the Site boundary (see Chapter 13: Aquatic Ecology of the ES, Volume I), the majority of which are small ponds or artificial standing water bodies. The majority of these on the southeast bank of the Tees are small artificial water bodies and ponds related to the surrounding industrial land use. To the northeast of the Tees there are further artificial and industrial water bodies, such as the large brine reservoirs immediately north of the Site boundary at Saltholme. The surrounding wetlands here also includes several large, interconnecting water bodies which attract a great deal of biodiversity interest, especially birdlife. The ponds within the Site boundary itself are predominantly very small and generally artificial, with the exception being several waterbodies within the South Gare and Coatham Dunes.

9.4.30 The Coatham Dunes ponds have been surveyed (see Annex E) and appear to have formed in depressions in the relatively impermeable historic slag deposits that lie between the PCC Site and the more natural sand dunes that have evolved adjacent to the Tees Bay shoreline. Based on site visits between October 2020 and January 2021, they appear to be predominantly rainwater fed with little influence from tidal variation and groundwater. With the exception of Pond 14 (as numbered in Chapter 13: Aquatic Ecology, ES Volume I, Document Ref. 6.2) all ponds across the dunes have succeeded to become fully vegetated wetlands covered by *Phragmites australis*. Therefore, only Pond 14 will be considered by this assessment.

9.4.31 Further descriptions of the Tees Coastal and Tees Transitional waterbodies are provided in Annex B.

Surface Water Quality

9.4.32 Overall, the Tees Coastal WFD waterbody is at Moderate Ecological Potential (as heavily modified). It is also failing to meet Good Chemical Status under the WFD Cycle 3 classifications (2019) due to Polybrominated diphenyl ethers (PBDEs) and mercury and its compounds. All other Priority Substances, Priority Hazardous Substances, and other pollutants are at Good Status or higher or have not been monitored for the classification. Dissolved inorganic nitrogen (which along with macroalgae and phytoplankton biological quality elements is used to assess nutrient status under a 'weight of evidence' approach) is not monitored for this waterbody and there is no classification for it. Furthermore, all Specific Pollutants were classed as high (including arsenic, chromium (VI), copper, iron, and zinc).

9.4.33 Overall, the Tees Transitional WFD waterbody is at Moderate Ecological Potential (as heavily modified). The Tees Transitional WFD waterbody is at Fail Chemical Status under the WFD Cycle 3 classifications (2019), due to failures for PBDEs, Benzo(g-h-i)perylene, tributyltin compounds, mercury and its compounds, and Cypermethrin (priority). The failure for PBDEs is not attributed to any particular industry, while the tributyltin compounds are attributed to diffuse pollution from contaminated waterbody bed sediments. The reasons for the failure of the other Priority and Priority Hazardous Substances remain under investigation. All Specific Pollutants monitored are at high status. However, DIN is only at moderate status (as is macroalgae, although phytoplankton is good). Point source discharges of foul water from the public sewer system, and from trade and industry, as well as diffuse sources from agriculture in the Tees catchment are the principal sources identified of nitrogen to the Tees Transitional waterbody.

9.4.34 The Tees Estuary (South Bank) waterbody is at Fail Chemical Status under the WFD Cycle 2 classifications (2019), due to failures for Polybrominated diphenyl ethers (PBDEs) and mercury and its compounds (Environment Agency, n.d.a). Priority substances were all at Good Status and Other Pollutants did not require assessment.

9.4.35 Water quality data has been obtained from the Environment Agency's Water Quality Archive (Environment Agency, n.d.c) for the Tees Transitional WFD water body (Tees Estuary). Annual average values for the period 2009-2019 are summarised in Annex C Table C1 for a sampling point close to the mouth of the Tees, and at Smiths Dock, Redcar Jetty, Teesport and the confluence with Dabholm Gut moving upstream (these monitoring locations are also shown on Figure 9-1, ES Volume II, Document Ref.6.3). The parameter values presented in Annex C Table C1 are compared against WFD standards where they apply to transitional waters.

9.4.36 These data indicate only one failure against WFD Environmental Quality Standards (EQS) for transitional waters, which was for tributyltin in Dabholm Gut, although there is some evidence of slightly elevated metal concentrations across the monitoring sites, which is expected given the industrial and urban nature of the area surrounding the estuary mouth and the immediate upstream reaches of the River Tees. Raised tributyltin concentrations are consistent with the WFD 'Fail' classification for this water body.

9.4.37 The Water Quality Archive website (Environment Agency, n.d.c) also provides water quality for other water bodies and sites in close proximity to the Proposed Development, spanning the period 2009-2019 inclusive. A summary table of this data is provided in Annex C Table C2 indicating parameters that were measured and a brief overview of water quality implications. Summary data for these sampling points is shown in Annex C Tables C3-C8.

9.4.38 The data presented in Annex C Table C2 indicates that there remains substantial pollution pressure on the Tees Estuary from existing effluent and pollution discharges (e.g. several failures against EQS in the Wilton Complex effluent), although as noted above the Tees has a large capacity to absorb these pollutants with concentrations of most pollutants being below EQS in the monitored data from the Teesmouth area.

9.4.39 The freshwater streams in the Study Area draining to the River Tees are generally not routinely monitored by the Environment Agency. There is data for Billingham Beck, which is outside of the 1 km Study Area and is upstream of the Site, and so has been scoped out of the assessment as it will not be impacted. However, the watercourse is likely to exhibit similar water quality traits to those in the Study Area given the similar surrounding urban land with heavy industry, low gradients and tide locking effect of the Tees Estuary. The data for this watercourse indicates that certain dissolved metals, including copper and zinc, exceed WFD standards, although the standard for copper is 'bioavailable', which would typically be lower than any measured dissolved copper result. Nitrates and phosphates are also slightly elevated.

9.4.40 Further water quality data for the Study Area is available for Bathing Water areas as designated under the Bathing Waters Directive. In the northeast of the Study Area, Coatham Sands is a designated bathing water (as 'Redcar Coatham'). Water quality at designated bathing water sites in England is assessed by the Environment Agency. From May to September each year, weekly assessments measure current water quality, and at a number of sites daily pollution risk forecasts are issued. Annual ratings classify each site as excellent, good, sufficient or poor based on measurements of *Intestinal enterococci* and *Escherichia coli* taken over a period of up to four years. Redcar Coatham had a 2019 classification of Excellent (Environment Agency n.d.d).

9.4.41 The Environment Agency's Bathing Water Quality website (Environment Agency n.d.a) notes that the Redcar Coatham bathing water is subject to short term pollution caused when heavy rainfall or high tides wash faecal material to the sea from livestock, sewage and urban drainage via rivers and streams, with water quality typically returning to normal after a few days.

9.4.42 The southern extent of the Seaton Carew North Gare Bathing Water is also within 2 km of the Site and also has a classification of Excellent for 2019 (Environment Agency n.d.a).

9.4.43 Numerous investigations of sediment quality have recently been undertaken to support various recent dredging proposals and developments around the Tees Estuary, with samples compared to the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Action Levels for the disposal of dredged material. These give an indication of sediment quality in the Tees

Estuary and Teesmouth areas. A summary is provided in Annex D, and indicates significant historical contamination in the Tees Estuary, which is more concentrated at the margins of the channel and at depth than in surface sediments. In some locations, concentrations of contaminants exceeded CEFAS Action Level 2 and so disposal at sea is not considered suitable in these cases. Refer to Annex D for further details.

9.4.44 The only open water pond within the Coatham Dunes (Pond 14 within the Teesmouth and Cleveland Coast SSSI) has been monitored as part of the assessment in order to determine the potential for impacts from atmospheric deposition of pollutants from the Proposed Development. Pond 14 was monitored on eight occasions between October 2020 and January 2021. In summary, the monitoring indicated that the water is circum-neutral (mean pH 7.67), mean DO values were 106% saturated and 12.72 mg/l suggesting supersaturation (i.e. over 100%) which is often associated with photosynthesis activity during daylight hours, and/or significant aeration.

9.4.45 Mean electrical conductivity was 2250 µS/cm suggesting brackish water. Average ammoniacal nitrogen was recorded at marginally above the laboratory limit of detection (LoD) at 0.05 mg/l. Furthermore, average nitrate values were low (0.2 mg/l) and nitrites were all below the LoD. Total nitrogen had a mean average of 1.10 mg/l.

9.4.46 Certain metals including boron and molybdenum were elevated with recorded mean dissolved values of 503.25 µg/l and 217.75 µg/l respectively, and total values of 494.38 µg/l and 213.88 µg/l respectively. Total iron was also found to be elevated with an average value of 795 µg/l; however dissolved iron was far lower at 30.17 µg/l only slightly above the LoD of 20 µg/l.

9.4.47 Only two samples of polyaromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs) were taken, all of which fell below LoDs. One sample of polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs) and phenols was taken, all of which fell below LoDs. Please refer to Annex E for more details.

Marine Ecology Overview

9.4.48 Full details regarding marine ecology within the Study Area is provided in Chapter 14: Marine Ecology and Nature Conservation (ES, Volume I). A brief summary is provided below.

9.4.49 In terms of fisheries, the Tees Transitional WFD waterbody is an important water body for diadromous fish species which make seasonal migrations between the sea and riverine environment. Salmon (*Salmo salar*), sea trout (*Salmo trutta*), European eel (*Anguilla anguilla*), river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*) are all known to be present and have been identified as Local Priority Species within the Tees Valley BAP. Salmon, river lamprey and sea lamprey are also protected species under Annex II of the Habitats Directive. The River Tees is designated as one of the 64 main salmon rivers in England and Wales.

9.4.50 Estuarine and marine fish communities within the vicinity of the Proposed Development represent a mixed demersal and pelagic fish assemblage typical of the central North Sea. Data on the Environment Agency website indicates that the total number of the monthly combined upstream counts for salmon and sea trout at the Environment Agency fish counter at the Tees Barrage on the Lower Tees have steadily declined in recent years, with total fish counted being 498 (2016), 297 (2017), 217 (2018), 204 (2019) and 328 (2020) (Environment Agency, 2019).

9.4.51 Common shellfish species within inshore waters include edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and velvet swimming crab (*Necora puber*). There are no designated shellfish waters within the vicinity of the Site.

9.4.52 The North Sea and coastal waters around the Site are known to be important for harbour porpoise (*Phocoena phocoena*), which is an Annex II species under the Habitats Directive.

9.4.53 No protected phytoplankton species or invasive non-native species (INNS) were identified during the Environment Agency surveys in the Tees Estuary. However, there is evidence of some forms of taxa being present that cause harmful algal blooms in UK coastal waters. These included: *Alexandrium* spp., *Karenia mikimotoi*, *Dinophysis acuminata*, *Dinophysis acuta*, and *Pseudo-nitzschia* spp. which are all known to cause shellfish poisoning (Defra, 2008). In addition, several taxa known to cause mortality in fish due to physical damage were also recorded; these included *Gymnodinium* spp., *Dictyocha speculum*, *Chaetoceros* spp. and *K. mikimotoi* (Defra, 2008).

9.4.54 No formal monitoring of harmful algal blooms is carried out within the lower Tees estuary or coastal water bodies although the Tees WFD water body which covers the lower reaches of the estuary is classified as having ‘Good’ phytoplankton status, despite Seal Sands being recognised as a sensitive eutrophic area.

9.4.55 With regard to zooplankton, several INNS are known to have been introduced to the North Sea due to human activities and have responded to favourable conditions, but no protected species have been identified.

9.4.56 Results of the Intertidal benthic Phase I and Phase II surveys and subtidal benthic sampling is reported in Chapter 14: Marine Ecology and Nature Conservation (ES, Volume I). Overall, benthic communities were characterised by relatively low abundance, biomass, species richness and diversity. No protected species were identified during the intertidal survey. However two biotopes (EUNIS A5.233 and A5.242 (EEA, 2012)) were identified in the subtidal sampling which qualify as habitats of principal importance being listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and belong to the UK BAP priority habitat type, ‘subtidal sands and gravels’. The only INNS recorded during the benthic surveys was the seaweed wakame (*Undaria pinnatifida*), found in the intertidal zone.

Freshwater Ecology Overview

9.4.57 Full details regarding freshwater ecology within the Study Area are provided in Chapter 13: Aquatic Ecology (ES, Volume I, Document Ref. 6.2). A brief summary is provided below.

9.4.58 There is only one riverine WFD water body within the Site Boundary of the Proposed Development and this is the Tees Estuary South Bank (GB103025072320). Routine WFD monitoring is therefore limited in the area and there is limited availability of aquatic datasets. Those that are available were requested from the Environmental Records and Information Centre (ERIC). Given the limited data available, further aquatic baseline surveys have been undertaken to gather more robust data to inform the assessment.

9.4.59 No notable fish species were recorded within 2 km of the Site boundary within the past three years based on the ERIC data. Site surveys have shown European eel in Dabholm Gut and Pond 3 (see Chapter 13: Aquatic Ecology, ES Volume I, Document Ref. 6.2).

9.4.60 In the past five years there are records of designated aquatic invertebrates being present in ponds associates with Coatham Dunes near Coatham Sands, in Saltholme Nature Reserve, and Cowpen Marsh (see Chapter 13: Aquatic Ecology, ES Volume I, Document Ref. 6.2 for details of species), although none are within the Site boundary. Data requests returned no records for designated aquatic macroinvertebrates species within a 2 km radius from the Site within the past three years. Further surveys have been undertaken to inform the Proposed Development, but no notable species were recorded.

9.4.61 The WFD macroinvertebrate monitoring data provided by the Environment Agency from 2016 for Dabholm Gut (part of the 'Tees Estuary South Bank' WFD waterbody) at NZ 56570 23772 indicates that the water body has very poor quality (Whalley Hawkes Paisley Trigg score of 17.6 to 19.5, Average Score Per Taxa of 3.3 to 3.5, very low diversity) and no species of conservation interest were recorded.

9.4.62 On the basis of available data, there are no notable or protected macrophyte species recorded within the Study Area.

9.4.63 A range of INNS species listed on Schedule 9 of the Wildlife & Countryside Act are recorded in the Study Area, based on data provided by the ERIC. Only one was in the Proposed Development area, which was Nuttall's Waterweed (*Elodea nuttalii*). A range of historical aquatic INNS records were returned for the Study Area by ERIC including water fern (*Azolla filiculoides*), New Zealand pigmyweed (*Crassula helmsii*), parrot's feather (*Myriophyllum aquaticum*), floating pennywort (*Hydrocotyle ranunculoides*) and Canadian waterweed (*Elodea canadensis*). Waterbody surveys for the Proposed Development indicate that the only INNS of concern was floating pennywort, which was identified in the Fleet.

Ecological Protected Areas

9.4.64 Designations within and in close proximity to the Study Area are shown on Figure 9-3: Ecological Designations (ES Volume II, Document Ref. 6.3).

9.4.65 Under the WFD as implemented in England, the objective in respect to ecological Protected Areas (i.e. water depending SPAs and SACs) is to 'protect and, where necessary, improve the status of the water environment to the extent necessary to achieve the conservation objectives that have been established for the protection or improvement of the site's natural habitat types and species of European importance'.

9.4.66 Where a protected area is designated for more than one water-dependent feature, that Protected Area assessment is considered to have been passed when:

- All the water dependent features are assessed as meeting the relevant conservation objectives; or
- If the environmental conditions necessary to achieve conservation objectives have been established and are in place; or
- If any feature was assessed as not meeting these criteria but this was due a failure to achieve a target for an attribute that is clearly not water related.

9.4.67 The following provides a summary of the relevant ecological Protected Areas plus water dependent nationally designated SSSIs, which we have also considered in this assessment.

Teesmouth and Cleveland Coast Special Protection Area (SPA) and Ramsar Site

9.4.68 The coast either side of Teesmouth is also designated as being of international importance as the Teesmouth and Cleveland Coast Special Protection Area (SPA) which is designated under the EU Birds Directive, and the Teesmouth and Cleveland Coast Ramsar site, which is a wetland designated as being of international importance under the Ramsar Convention. The designation is for its important bird populations, and the SPA is a complex of discrete coastal and wetland habitats. These include sandflats, mudflats, rocky foreshore, saltmarsh, sand dunes, wet grassland and freshwater lagoons. The SPA is classified for its breeding Little Tern, passage Sandwich Tern and Redshank, wintering Red Knot and an assemblage of over 20,000 wintering birds. The SPA and Ramsar site both cross the Proposed Development boundary at its northern extent for the water connection corridor.

Nutrient Neutrality

9.4.69 On 16 March 2022, Natural England published advice to Competent Authorities under the Habitats Regulations to advise that Competent Authorities must carefully consider the nutrient impacts of any new plans and projects on habitats sites and whether those impacts may have an adverse effect on the integrity of a habitats site that requires mitigation, including through 'nutrient neutrality'.

9.4.70 In many designated estuarine and freshwater habitats sites, poor water quality due to nutrient enrichment is one of the main reasons for sites being in an unfavourable condition. Excessive levels of nutrients can cause the rapid growth of certain plants through the process of eutrophication. This in turn can lead to reduced biodiversity, and the condition of a site being considered 'unfavourable'.

9.4.71 The Teesmouth and Cleveland Coast SPA/Ramsar was one of the sites notified in March 2022 (for nitrogen only). This is therefore relevant to the WFD assessment by virtue of the Protected Areas assessment and the need to support the conservation objectives of the SPA. An evidence pack released by Natural England to support the need for measures to control nutrient fluxes to the Teesmouth and Cleveland Coast SPA/Ramsar site (Natural England, August 2022) states that the target for the site is to "*restore water quality to mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features*." A WFD 'weight of evidence' approach is used to determine whether the site is meeting standards in terms of nutrient levels based in DIN, macroalgae and phytoplankton, based on data from the Tee Transitional waterbody (not the Tees Coastal waterbody).

9.4.72 As discussed earlier, excess baseline nitrogen from a range of diffuse and point sources (i.e. waste water treatment, trade effluent discharges and agriculture) is already contributing to aspects of this site being in unfavourable condition around the Seal Sands mud flats in particular. The evidence pack (Natural England, August 2022) states that "*algal mats can be observed on intertidal mud and sandflats across the site during the summer months, particularly at Seal Sands, indicating excess nutrient levels*." Furthermore, at a meeting with Natural England on 15th September 2022 to discuss the discharge of treated effluent containing nitrogen from the PCC site, amongst other issues, Natural England confirmed that the features of the habitat currently in unfavourable condition are the mudflats in the vicinity of Seal Sands within the Tees Estuary. Several of the qualifying features of the SPA/Ramsar rely on those habitats and their wading and feeding grounds are being impacted by the growth of algal mats. It was confirmed by Natural England that the focus of their concern is on nutrients reaching those habitat features. Seal Sands lies to the northwest within the outer estuary area and is a shallower and wider area that is surrounded by heavy industry.

9.4.73 As a result, in the absence of any empirically derived threshold by which additional aquatic inputs of nitrogen can be deemed de minimis, the implication of Natural England's nutrient neutrality guidance is that any new development within the Teesmouth and Cleveland Coast SPA/Ramsar catchment that increases nutrients could have potential impacts on features of that SPA/Ramsar and could interfere with the ability of the site to achieve its conservation objectives and thus adversely affect the integrity of the European protected nature conservation site. This has been assessed for the Proposed Development and the results are presented in the Nutrient Nitrogen Briefing Paper (Document Ref. 9.36), the results of which are described later in this WFD assessment.

Sites of Special Scientific Interest

9.4.74 The Water Connection Corridors and the CO_2 Gathering Network (where it crosses the Tees Estuary) cross the Teesmouth and Cleveland Coast SSSI. The Teesmouth and Cleveland Coast SSSI is notified under Section 28C of the Wildlife and Countryside Act 1981 and is of special interest for many nationally important features that occur within and are supported by the wider mosaic of coastal and freshwater habitats. Habitats in the SSSI include sand dunes, saltmarshes, mudflats, rocky and sandy shores, saline lagoons, grazing marshes, reedbeds and freshwater wetlands. The site stretches from Crimdon Dene Mouth in the north, to Marske-by-the-Sea in the south, and inland to Billingham including the entire Tees Estuary upstream to the Tees Barrage.

Groundwater WFD Waterbodies

9.4.75 The ground waterbodies are contained within the Northumbria River Basin District and the Northumbria Groundwater Management Catchment. The Tees Sherwood Sandstone groundwater body is within the Tees Sherwood Sandstone Operational Catchment, and the Tees Mercia Mudstone and Redcar Mudstone waterbody is within the Tees Mercia Mudstone and Redcar Mudstone Operational Catchment.

9.4.76 The Study Area to the east and south of the Tees estuary is wholly within the Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body (GB40302G701300) (Environment Agency, n.d.a). The waterbody is at Poor Overall Status, with Good Quantitative Status, but Poor Chemical Status. The latter is a consequence of Poor Chemical Dependent Surface Water Body Status, due to point source pollution from mining and quarrying sources. The waterbody has an area of 494.57 km^2. The water body objective is Poor Status by 2015. It is not higher due to an unfavourable balance of costs and benefits. One protected area falls within the WFD designation, which is the Tees Mercia Mudstone & Redcar Mudstone (UKGB40302G701300) Drinking Water Protected Area (DWPA).

9.4.77 The Study Area to the west and north of the Tees Estuary is within the Tees Sherwood Sandstone WFD groundwater body (GB40301G702000). The Tees Sherwood Sandstone groundwater body is at Good Overall Status, with Good Quantitative and Chemical Elements. The water body has an area of 293.01 km^2. It has an objective of maintaining Good Status. Protected areas within the designated WFD waterbody are the Tees Sherwood Sandstone (UKGB40301G702000) DWPA and the Low Dindale (G100) Nitrate Vulnerable Zone (NVZ).

9.4.78 The full no deterioration baseline for each groundwater body is outlined in Annex A Tables A5 and A6.

9.4.79 There are no Groundwater Dependent Terrestrial Ecosystems (GWDTE) or Source Protection Zones (SPZ 1 to 3) which are likely to be affected by activities related to the Proposed Development.

Water Resources

9.4.80 The Study Area itself is not within a Drinking Water Protected Area, Drinking Water Safeguard Zone or near any Source Protection Zones.

9.4.81 The following provides information on water activity permits (i.e. discharges), water abstractions and past pollution incidents.

Water Activity Permits

9.4.82 The Envirocheck report (Landmark Information Group, 2019 (and updated digitally in 2021) for the Proposed Development indicates that there are 45 active water permits (i.e. formerly discharge consents) within 250 m of the Proposed Development. Details are provided in Annex F Table F1 and locations are shown in Figure 9-1: Surface Water Features and Their Attributes (ES Volume II, Document Ref. 6.3).

9.4.83 The majority of consented discharges are of treated/untreated sewage effluent from storm tanks, pumping stations, and combined sewer overflows (both private and water company). There are also a significant number of trade effluent, process/chemical and cooling water discharges in the Study Area, reflecting the industrial land uses. Finally, there are two active discharges for raised mine/groundwater where past activity is still having present day water quality impacts.

Abstractions

9.4.84 Data provided by the Environment Agency indicates that there are 18 licensed water abstractions within 2 km of the Site, which are presented in Annex F Table F2 and the water attributes plan (presented in Figure 9-1: Surface Water Features and Their Attributes, ES Volume II, Document Ref. 6.3).

9.4.85 Twelve abstractions are for groundwater from the underlying Triassic Sherwood Sandstone to the north and west of the Tees Estuary. They are predominantly for industrial, commercial and public service use. There are also groundwater abstractions for water supply.

9.4.86 There are six surface water abstractions, from both the Tees and Holme Fleet. Again, the predominant use is the industrial, commercial and public service sector, with one abstraction also for power generation.

9.4.87 Details on private water supplies have been requested from the local authorities. Redcar and Cleveland Borough Council and Stockton-on-Tees Borough Council have confirmed that there are no private water supplies in the Study Area in their respective administrative areas.

Water Pollution Incidents

9.4.88 The Envirocheck report (Landmark Information Group, 2019) for the Proposed Development indicates that there have been four water pollution incidents of Category 3 (minor) or worse within 250 m of the Site within the last 10 years. Details are given in Annex F Table F3 and locations are shown in Figure 9-1: Surface Water Features and Their Attributes (ES Volume II, Document Ref. 6.3).

9.4.89 The recorded pollution incidents have impacted the Tees Estuary, Dabholm Gut and a tributary of the Fleet. They have been related to pollution from oils, crude sewage and contaminated water associated with firefighting runoff.

Future Baseline

Construction (2022)

9.4.90 The future baseline has been determined qualitatively by considering the possibility of changes in the attributes that are considered when deciding the importance of water bodies in the Study Area.

9.4.91 Generally, there is an improving trend in water quality and the environmental health of waterways in the UK since the commencement of significant investment in sewage treatment in the 1990s, the adoption of the WFD from 2003, and the application of ever more stringent planning policies. In terms of water quality impacts, the future baseline assumes that all WFD water bodies achieve their planned target status by 2027.

9.4.92 It is likely that through the action of new legislative requirements and ever more stringent planning policy and regulation, that the health of the water environment will continue to improve post-2027, although there are significant challenges such as adapting to a changing climate and pressures of population growth that could have a retarding impact. It is also difficult to forecast these changes with any certainty.

9.4.93 Under the WFD, The Tees Coastal water body has an objective of achieving Good Ecological Potential by 2027, the Tees transitional waterbody has an objective of achieving Moderate Ecological Potential by 2015, and the Tees S Bank (Estuary) WFD waterbody has an objective of achieving Good Ecological Potential by 2027. It is assumed that these objectives would still be achieved following the completion of the Proposed Development notwithstanding the potential effects of construction of the development.

9.4.94 There are additional significant challenges such as adapting to a changing climate (i.e. in general drier summers, wetter winters and an increased frequency of significant storms are forecast for the UK) and the pressures of population / economic growth that could have a retarding effect on the water environment if it is not managed carefully through the design of projects, mitigation, and the maintenance of those mitigating solutions. However, again it is difficult to forecast these changes with any certainty.

9.4.95 The assessment of the importance of water bodies takes into account a large range of attributes and does not focus solely on water quality. This assessment takes into account other attributes such as scale, nature conservation designations, fish habitat type, the presence of protected species, social and economic uses. For some of these attributes, it is unlikely that they will change in the future (e.g. water body size, whether a river is likely to support cyprinid or salmonid fish populations, the presence of a designated nature conservation site or bathing water).

Operation (2026)

9.4.96 The same future baseline conditions expected during construction will apply to the operation phase (i.e. all WFD targets are met, improving water quality, no change in the presence and status of designated sites).

9.4.97 The wider area around the PCC Site is allocated in the local plan for industrial development, and if the Proposed Development was not progressed, then another form of development would likely take its place or it is assumed that the Site would be left in its current state.

9.5 Screening Assessment

9.5.1 In Table 9C-6 waterbodies within the Study Area but upstream of the Proposed Development were scoped out of further assessment. In this section a screening assessment is undertaken to determine whether there is a potential pathway by which those remaining waterbodies in the Study Area could be impacted, and whether there are any exempt activities related to the construction or operation of the Proposed Development that do not require assessment.

9.5.2 The 'Proposed Development' section of this report within Section 9.1: Introduction provides a description of the Proposed Development from which all potential pathways to an impact and Zones of Influence (ZOIs) have been identified. In accordance with the WFD, potential for impacts on Protected Areas have also been considered, with those within 2 km of the proposed works screened in for further consideration. Further details of the Proposed Development are set out in Chapter 4: Proposed Development (ES Volume I, Document Ref.6.2) and Figures 3-2A to 3-2F (ES Volume II, Document Ref.6.3).

9.5.3 The following WFD waterbodies were identified in the baseline as relevant to the screening and further assessment:

- Tees Coastal water body (GB650301500005);
- Tees Transitional water body (GB510302509900);
- Tees Estuary (S Bank) water body (GB103025072332O);
- Tees Mercia Mudstone & Redcar Mudstone groundwater body (GB40302G701300); and
- Tees Sherwood Sandstone WFD groundwater body (GB40301G702000).

Zone of Influence

9.5.4 WFD waterbodies have been screened into this assessment using a ZoI approach and on the basis of whether they are a designated WFD waterbody within the ZoI and so could be directly or indirectly impacted.

9.5.5 Table 9C-9 sets out the pathways to an effect, the extent of the ZoI and the water bodies that are directly within the ZoI.

Table 9C- 9: ZoIs and relevant WFD water bodies

Potential pathway	ZoI and basis for determination	Relevant water bodies	Adjacent water bodies
Construction works adjacent to, on the banks of, and within watercourses can be a direct source of fine sediment mobilisation, and this sediment could contain contaminants given the past industrial activities at the Proposed Development Site. This would include works within watercourses for outfall points, pipeline installation beneath or adjacent to watercourses, or any excavations or construction with potential to runoff to watercourses.	All watercourses within and immediately adjacent to the Proposed Development Site or boundary could be impacted by runoff containing fine sediment during construction. These include the Tees Estuary (S Bank), Tees Transitional and Tees Coastal WFD waterbodies and their tributaries. Given dilution and dispersal potential in the tidal Tees Transitional and Tees Coastal waterbodies, a zone of influence up to 1km downstream of the Proposed Development in Tees Coastal WFD	Tees Estuary (S Bank) WFD water body (including the Mill Race) Tees Coastal WFD water body Tees Transitional WFD waterbody (including Dabholm Gut and Belasis Beck) A number of unnamed drainage ditches.	All watercourses in the Study Area drain to Tees Coastal WFD waterbody, and so there are no additional downstream receptors.

Potential pathway	ZoI and basis for determination	Relevant water bodies	Adjacent water bodies
	waterbody is appropriate.		
The potential requirement for a new water discharge pipeline and outfall head in Tees Coastal waterbody (including use of a jack up barge or similar during construction) would cause some mobilisation of fine sediments during its installation, which may propagate fine sediment into the water column.	The Zone of Influence for mobilised sediments in the Tees Coastal waterbody is not expected to be greater than 1 km downstream or upstream of the jack up barge location as a worst case, given the dynamic nature of this transitional water.	Tees Coastal WFD waterbody	No adjacent receptors given scale of Tees Coastal water body
During construction, fuel, hydraulic fluids, solvents, grouts, paints and detergents and other potentially polluting substances will be stored and / or used on Site. Leaks and spillages of these substances could pollute the nearby surface watercourses or groundwater if their use or removal is not carefully controlled and spillages enter existing flow pathways or water bodies directly.	All watercourses or groundwater within or immediately adjacent to the Proposed Development Site or boundary could be impacted by accidental spillages during construction. These include the Tees Estuary (S Bank), Tees Transitional and Tees Coastal WFD surface waterbodies and their tributaries, and the Tees Mercia Mudstone & Redcar Mudstone and Tees Sherwood Sandstone groundwater bodies. Given dilution and dispersal potential in the tidal Tees Transitional and Tees Coastal waterbodies, a zone of influence up to 1km downstream of the Proposed Development in Tees Coastal WFD waterbody is appropriate.	Tees Estuary (S Bank) WFD waterbody (including the Mill Race) Tees Coastal WFD waterbody Tees Transitional WFD waterbody (including Dabholm Gut and Belasis Beck) Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body Tees Sherwood Sandstone WFD groundwater body A number of unnamed drainage ditches	All watercourses in the Study Area drain to Tees Coastal WFD waterbody, and so there are no additional downstream surface water receptors. Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body Tees Sherwood Sandstone WFD groundwater body
Excavations, cuttings or piling required during construction of the Proposed Development have the potential to intercept groundwater and may	Groundwater bodies directly beneath the Proposed Development Site.	Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body Tees Sherwood Sandstone WFD groundwater body	Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body Tees Sherwood Sandstone WFD groundwater body

Potential pathway	ZoI and basis for determination	Relevant water bodies	Adjacent water bodies
create a pathway for pollutants to be transferred to groundwater if not mitigated.			
Physical modification of waterbodies which may have adverse morphological impacts (including scour, deposition and habitat loss)	The immediate footprint and environs of waterbodies that will be directly physically altered (within which any scour affects would be expected to occur). Morphological impacts would be to the Tees Coastal waterbody for potential installation of a new outfall head for the water discharge pipeline.	Tees Coastal WFD waterbody	Not applicable, this pathway relates to morphology of the bed of the waterbody that is directly impacted
Surface water runoff from the Site during operation could contain various diffuse urban pollutants given the industrial nature of the site. A drainage strategy will be in place to manage the rate and quality of the runoff (including the use of SuDS) prior to discharge to Tees Bay.	All surface water runoff is to be discharged to the Tees Bay (Tees Coastal WFD water body), via attenuation for flows and water quality. The ZoI for Tees Coastal water body is not expected to be greater than 1 km downstream or upstream of the outfall location as a reasonable worst case, given the dynamic nature of this water.	Tees Coastal WFD waterbody	No adjacent receptors given scale of Tees Coastal water body
Cooling and process water from the Proposed Development may be discharged to Tees Bay and/or Tees Transitional waterbodies after treatment. There is potential for the effluent discharge to impact biological quality elements directly and indirectly (e.g. through creating a barrier to fish movement) .	Cooling water is to be abstracted from the River Tees but will be concentrated in the system prior to discharge to the bay. The majority of process water runoff is to be discharged to Tees Bay. The proportion that will contain high levels of ammonia will be treated at Bran Sands WwTW and discharged to the Tees Estuary via Dabholm Gut. To maintain nutrient neutrality a back flow of final treated effluent to	Tees Coastal WFD waterbody Tees Transitional WFD waterbody	No adjacent receptors given scale of Tees Coastal and Tees Transitional waterbodies

Potential pathway	ZoI and basis for determination	Relevant water bodies	Adjacent water bodies
	an equivalent load of nitrogen will be returned to the PCC site for discharge to the bay with the objective of maintaining nutrient neutrality. In addition, under certain conditions it is possible that effluent discharged to the bay may migrate into the dredged channel in the mouth of the Tees estuary on the incoming tide.		
Foul water will be treated at Northumbrian Water treatment plant at Marske-by-the-Sea, which discharges to Tees Bay	Given that any treated effluent from a wastewater treatment works would be subject to an Environmental Permit, the ZoI should be small. A reasonable worst-case scenario would be 1 km downstream from the outfall in the receiving waterbody.	Tees Coastal WFD waterbody	No adjacent receptors given scale of Tees Coastal water body

Screening against Clearing the Waters for All Guidance exemptions

9.5.6 In accordance with Environment Agency Clearing the Water guidance (Environment Agency, 2016), a scoping assessment is not required if the proposed activity meets any one of several criteria that indicate the activity is low risk. The screening criteria are listed in Table 9C-10, alongside assessment of whether the Proposed Development meets the criteria.

Table 9C- 10: Screening criteria from the Environment Agency Clearing the Waters for All Guidance

Screening Criteria	Screening Assessment
A self-service marine licence activity or an accelerated marine licence activity that meets specific conditions	The Proposed Development is not applicable for a self-service or accelerated marine licence activity
Maintaining pumps at pumping stations – if you do it regularly, avoid low dissolved oxygen levels during maintenance and minimise silt movement when restarting the pumps	Not applicable
Removing blockages or obstacles like litter or debris within 10 m of an existing structure to maintain flow	Not applicable

Screening Criteria		Screening Assessment
Replacing or removing existing pipes, cables or services crossing over a waterbody – but not including any new structure or supports, or new bed or bank reinforcement		The Proposed Development will require new crossings over (or under) waterbodies rather than replacement or removal, and so is not exempt from further assessment.
'Over water' replacement or repairs to, for example bridge, pier and jetty surfaces – if you minimise bank or bed disturbance		The Proposed Development will require new crossings over (or under) waterbodies rather than replacement or removal, and so is not exempt from further assessment.
The activity was carried out during 2009 to 2014 and a WFD assessment was undertaken. The WFD assessment does not need repeating unless:	You've since changed how you carry out that activity, including method, size or scale, volume, depth, location or timings	Not applicable
	There's been a pollution incident since your activity was last carried out	

9.5.7 The Proposed Development does not meet any of the criteria assessed in Table 9C- , therefore a scoping assessment is required.

Flood Risk Activity Exemptions

9.5.8 The Proposed Development can also be screened against the list of Flood Risk Activity exemptions detailed in Table 9C-4.

9.5.9 Service crossings over a main river can be exempt from needing a Flood Risk Activity Permit where certain conditions are met. This includes those attached to the parapets of a bridge or encapsulated within the bridge's footpath or road. The Proposed Development includes numerous pipeline crossings of watercourses, for example for the CO_2 Gathering Network and electrical connection corridors. These are comparable to a 'service crossing over a river' and do not involve any direct works to the river channel, and so it is considered appropriate that this exemption is applied where relevant.

9.6 Scoping Assessment

9.6.1 A scoping assessment is required to determine which coastal and estuarine receptors may be impacted by the Proposed Development, and therefore need to be assessed in the WFD impact assessment. These receptors are defined in accordance with the Environment Agency Clearing the Waters for All Guidance (Environment Agency, 2016 updated 2017) and are based on the water body's quality elements; the receptors include:

- Hydromorphology;

- Water quality;
- Biology – habitats;
- Biology – fish; and
- Protected Areas.

9.6.2 The scoping assessment also considers Invasive Non-Native Species (INNS).

9.6.3 As the scoping assessment outlined in the Clearing the Waters for All Guidance is designed for coastal and estuarine waterbodies it is applied here to the Tees Coastal and Tees Transitional waterbodies only. The fluvial (Tees Estuary (S Bank)) and groundwater bodies (Tees Mercia Mudstone & Redcar Mudstone and Tees Sherwood Sandstone) are taken forward for further assessment on the basis of the screening assessment presented in Section 9.5.

Tees Coastal Waterbody

9.6.4 The footprint of the Proposed Development falls partially within the catchment of the Tees Coastal WFD waterbody, with some works directly within the waterbody (i.e. installation of a new outfall) and other works adjacent to the waterbody. There is also the potential for an effluent plume from the proposed discharge of cooling water and treated process water to Tees Bay.

9.6.5 The Tees Coastal waterbody is a HMWB that is currently at Moderate Ecological Potential. It has an objective of Good Ecological Potential by 2027 (see Annex A) meaning that both the no deterioration and failure to improve WFD objectives are relevant (plus the Protected Areas assessment). However, there are currently no mitigation measures identified in the Northumbria RBMP for this water body and thus it is not possible to determine whether or not the Proposed Development is compatible. In addition, the reasons for not being at Good Ecological Potential are due to chemical substances that will not be emitted by the Proposed Development. Therefore, there is no requirement for any 'failure to prevent improvement' assessment.

Hydromorphology

9.6.6 Hydromorphology refers to the physical characteristics of waterbodies. Hydromorphological quality elements include the size, shape and structure of the waterbody, and the flow and quantity of water and sediment. Impacts on hydromorphology include changes to morphological conditions (for example variation in the structure of the seabed and intertidal zone) and tidal patterns (for example dominant currents, freshwater flow and wave exposure). Hydromorphology is only a WFD quality element for high status waterbodies, but significantly influences other elements, particularly biological ones, and thus is an important part of the assessment.

9.6.7 The proposed works have the potential to affect hydromorphological quality elements in the Tees Coastal waterbody through the construction of a potential new outfall and water discharge pipeline should the existing outfall be unsuitable. The pipeline would be installed by trenchless technologies techniques beneath the dunes at Coatham Sands adjacent to the CO_2 Export

Pipeline and beneath the seabed to the outfall. At the outfall, the emplacement of a suitable discharge head would be required to be placed via a jack-up barge or similar.

9.6.8 These activities may impact the waterbody by altering the morphology of the sea bed as a result of the lowering of the jack-up-barge legs and emplacement of the outfall head causing disturbance that may lead to localised scour, as well as the loss of a section of the sea bed to the new structrure. This could alter local flow properties to result in local bed or erosion and scour.

9.6.9 The scoping assessment of the potential effects to hydromorphology is provided in Table 9C-11. The risk criteria in the table is taken from the Environment Agency guidance on WFD assessment for estuarine and coastal waters (Environment Agency, 2017).

Table 9C-11: Scoping assessment of risks to hydromorphology

Risk	Requires Impact Assessment	Impact Assessment Not Required	Hydromorphology risk issue(s)
Could impact on the hydromorphology (e.g. morphology or tidal patterns) of a water body at high status		✓ (waterbody not at high status)	N/A
Could significantly impact the hydromorphology (i.e. bed morphology and substrate) of any water body	✓		Proposed activities could adversely impact the morphology of the seabed and local sediment dynamics during installation of the alternative to existing water discharge pipeline and outfall head (if required).
Activity is in a water body that is heavily modified for the same use as your activity	✓		Proposed activities could adversely impact the morphology of Tees Coastal waterbody, a designated heavily modified waterbody

Water Quality – Physico-chemical Quality Elements

9.6.10 Impacts to ecological water quality relates to effects on any of the following: Water clarity, temperature, salinity, oxygen levels, nutrients, microbial patterns for longer than a spring neap tidal cycle (approximately 14 days). In addition to the above, if the water body has a history of harmful algae or a phytoplankton status of Moderate, Poor or Bad, this will need to be considered.

9.6.11 The potential installation of the outfall head within Tees Coastal waterbody for the water discharge pipeline could impact water quality temporarily through mobilisation of fine sediments into the water column. There is also potential for chemical spillages and runoff containing contaminants should plant be operated off a jack-up barge (or similar) during construction at the outfall point.

9.6.12 During operation, if not mitigated there could be impacts on Tees Coastal waterbody ecological status from discharges of treated process water containing sources of nitrogen and water with an elevated temperature that has been used in the cooling system (although these would only be allowed under an Environmental Permit). Diffuse urban pollutants in surface water runoff, or as a result of accidental chemical spillages, may also lead to impacts although dilution would likely be significant in the bay and surface water will pass through conventional treatment measures and a pond prior to discharge from the site.

9.6.13 Phytoplankton status has not been classified for the Tees Coastal waterbody. There is also no monitoring of harmful algae, which it is assumed to indicate that this is not a particular risk for this waterbody. As such, further consideration of phytoplankton and harmful algae has been scoped out from further consideration in the WFD impact assessment, summarised in Table 9C-12.

Table 9C-12: Scoping assessment of risks to physico-chemical quality elements

Risk	Requires Impact Assessment	Impact Assessment Not Required	Water Quality Risk Issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	✓		Impacts on Tees Coastal waterbody from mobilisation of sediments, diffuse urban pollutants in surface water runoff or process water effluent, or as a result of accidental spillages, which are discharged via the outfall to Tees Bay.
Is in a water body with a phytoplankton status of moderate, poor or bad		✓	There is no monitoring of harmful algae, which it is assumed to indicate that this is not a particular risk for this water body. As such, further consideration of phytoplankton and harmful algae has been scoped out from further consideration in the WFD impact assessment
Is in a water body with a history of harmful algae		✓	N/A as per above comment. In 2021 there was an unusual mass mortality event of crustaceans in the bay and NE coastline, the causes of which remain uncertain, one possible cause may have been an episodic algal bloom (although chemical poisoning from disturbed dredged contaminated sediments has been suggested as another option).

Water Quality – Chemical Status

9.6.14 As for physico-chemical status, the potential installation of the outfall head within the Tees Coastal water body for the water discharge pipeline could impact water quality temporarily during construction through mobilisation of sediments into the water column, which may contain contaminants deposited from the existing outfall from the former Redcar steelworks on the Proposed Development site, as well as the wider surrounding industrial area. There is also potential for chemical spillages and runoff containing contaminants should a jack-up barge (or similar) be used during construction at the outfall point.

9.6.15 During operation, if not mitigated, there could be impacts on Tees Coastal waterbody ecological status from discharges of treated process water containing sources of nitrogen and water with an elevated temperature that has been used in the cooling system (although these would be regulated under an Environmental Permit). Diffuse urban pollutants in surface water runoff, or as a result of accidental chemical spillages, may also lead to impacts although dilution would likely be significant in the bay and surface water will pass through conventional treatment measures and a pond prior to discharge from the site.

9.6.16 The scoping assessment for chemical status is summarised in Table 9C-13.

Table 9C-13: Scoping assessment of risks to chemical status

Risk	Requires Impact Assessment	Impact Assessment Not Required	Water Quality risk issue(s)
The chemicals are on the Environmental Quality Standards Directive (EQSD) list	✓		Potential for a range of chemicals to be discharged to Tees Coastal water body from diffuse urban pollutants in surface water runoff or process water effluent, or as a result of accidental spillages, which could be discharged via the outfall to Tees Bay, if not mitigated. The source of cooling water will be from the non-tidal River Tees upstream of the Tees Barrage (Tees Dock) via an abstraction point used by NWL. The water may contain chemicals that are included as Priority Hazardous Substances, Priority Substances and other pollutants under the WFD. Although they would be discharged naturally to the bay, they will become concentrated by five times within the cooling system and then discharged via the new outfall.
It disturbs sediment with contaminants above CEFAS Action Level 1	✓		Potential for sediment at the outfall location to contain contaminants above CEFAS Action Level 1.

Biology - Habitats

9.6.17 A number of habitats have been highlighted in the Environment Agency Clearing the Waters for All Guidance (Environment Agency, 2016 updated 2017) as being of higher and lower sensitivity based on their resistance to, and recovery rate, from human pressures. Table 9C-14 outlines the higher and lower sensitivity habitats associated with the Tees Coastal waterbody (based on the Environment Agency WFD waterbody summary table), which have the potential to be impacted during construction by direct habitat loss, physical disturbance and changes in water quality (e.g. a sediment plume relating to outfall construction), or during operation by discharges from the outfall causing thermal plumes or chemical changes in water quality including nutrient enrichment (which may also include deposition via aerial emissions from the Proposed Development). The location of lower and higher sensitivity habitats are also shown on Figure 9-4.

Table 9C-14: Higher and Lower Sensitivity Habitats found in the Tees Coastal water body

Higher Sensitivity Habitats	Area (ha)	Lower Sensitivity Habitats	Area (ha)
Mussel beds (including blue and horse mussel)	121.98	Cobbles, gravel and shingle	3.36
Subtidal kelp beds	175.17	Intertidal soft sediment	845.53
		Rocky shore	184.33
		Subtidal rocky reef	7170.03
		Subtidal soft sediments	1219.64

9.6.18 Habitats should be included as part of the WFD impact assessment if the footprint of the activity meets any of the following (Environment Agency, 2016), noting that this also includes the footprint of thermal, sediment or effluent plumes:

- 0.5 km^2 or larger in area within the estuarine or coastal water body;
- 1% or more of the water body's area; and
- Within 500 m of any higher sensitivity habitat or covering 1% or more of any lower sensitivity habitat area.

9.6.19 Magic Map (Defra, n.d.a) has been used to confirm the proximity of the noted sensitive habitats to the proposed works. The Site boundary directly cross Lower Sensitivity Habitat (Intertidal Soft Sediment, Subtidal Soft Sediment and Subtidal Rock Reef). The nearest Higher Sensitivity Habitat (Mussel beds and subtidal kelp beds) are located around South Gare and on rocky substrate off Redcar.

9.6.20 In accordance with this EA guidance, the habitats outlined in Table 9C-15 have been scoped into the WFD impact assessment on account of the potential sediment, chemical or thermal plume to be produced by the Proposed Development.

Table 9C-15: Scoping assessment of risks to biological habitat

Footprint is:	Requires Impact Assessment	Impact Assessment Not Required	Biological habitat risk issue(s)
0.5 km^2 or larger	✓		Although the physical footprint of activity is not expected to be this large, with the only physical footprint on the seabed being the outfall point (c.100 m^2 maximum area), chemical effluent plume may be larger and therefore this has been scoped in.
1% or more of the waterbody's area	✓		Although the physical footprint of activity is not expected to be this large, with the only physical footprint on the seabed being the outfall point (c.100 m^2 maximum area), chemical effluent plume may be larger and therefore this has been scoped in.
Within 500 m of any higher sensitivity habitat	✓		The areas of higher sensitivity habitat (mussel beds and subtidal kelp beds) around South Gare and on rocky substrate just off Redcar are predicted to be within the ZoI of the DIN effluent plume from the new outfall location. However, the physical footprint of activity is not expected to be large, with the only physical footprint on the seabed being the outfall point and rock armour, which is estimated to be only 100 m^2. The location of the outfall does not impact higher sensitivity habitats based on a review of online data.
1% or more of any lower sensitivity habitat	✓		The lower sensitivity habitat is extensive along the coastal zone and across the Tees Coastal waterbody area. However, the predicted ZoI for changes in DIN from the discharge of process water is fairly large and so it has been scoped into the assessment. As above, the physical footprint of activity is not expected to be large, with the only physical footprint on the seabed being the outfall point and rock armour, which is estimated to be only 100 m^2. The location of the outfall does not impact lower sensitivity habitats based on a review of online data.

Fish

9.6.21 The Tees Coastal water body is known to support several nationally and internationally protected migratory fish species, including salmon, sea trout, European eel, river lamprey and sea lamprey. This water body also supports a range of estuarine and marine demersal and pelagic fish taxa which are of national and international importance, such as cod (*Gadus morhua*), herring (*Clupea herengus*), and whiting (*Merlangius merlangus*).

9.6.22 The potential physical disturbance of the bed associated with works to install a new water discharge outfall (if required), could affect fish within the waterbody with potential impacts including habitat loss, water quality deterioration, underwater sound and visual stimuli. Similarly, there could be operational impacts such as the release of a thermal plume from process water which could affect fish movement or contaminants in surface water runoff or process water discharge that may affect fish population health in the short term (construction works and risk of chemical spillages or failures in long term treatment systems) or longer term (spillages and routine discharges from the development). The scoping assessment of risk to fish is provided in Table 9C-16.

Table 9C-16: Scoping assessment of risks to biological fish

Risk	Requires Impact Assessment	Impact Assessment Not Required	Biological fish risk issue(s)
Could impact on normal fish behaviour like movement, migration, or spawning (e.g. creating a physical barrier, noise, chemical change or change in depth or flow)	✓		Proposed construction works could cause: a chemical change in the waterbody through disturbance of fine sediment that may be contaminated, generation of underwater noise, changes in visual stimuli (such as artificial light), release of a thermal discharge plume or pollutants in surface water runoff or discharge of process water effluent to the water body.
Could cause entrainment or impingement of fish	✓		This could occur during use of plant off a jack-up-barge (or similar) for installation of the outfall.

WFD Protected Areas

9.6.23 The location of the Proposed Development in relation to the following WFD Protected Areas has been considered:

- Special areas of conservation (SAC);
- Special protection areas (SPA);
- Shellfish waters;
- Bathing waters; and
- Nutrient sensitive areas.

9.6.24 The outcome of the scoping assessment for WFD protected areas is shown in Table 9C-17.

Table 9C-17: Scoping assessment of WFD Protected Areas

Risk	Requires Impact Assessment	Impact Assessment Not Required	Biological fish risk issue(s)
Activity is within 2 km of any WFD protected area	✓		Activity is within 2 km of WFD protected areas. It overlaps Teesmouth and Cleveland Coast SPA and Redcar and Coatham Bathing Waters.

Invasive non-native species

9.6.25 INNS harm the environment. They can be small and hard to spot so are easily spread on damp equipment and clothing. If the Proposed Development risks introducing or spreading invasive non-native species this should be included in the WFD impact assessment. The risks of introducing or spreading INNS includes marine vessels, marine plant, construction materials or equipment being used that have come from, have been used in or have travelled through other water bodies and activities that help spread existing INNS either within the immediate water body or to other waterbodies.

9.6.26 The scoping assessment of risks from INNS is summarised in Table 9C-18.

Table 9C-18: Scoping assessment of risks from INNS

Risk	Requires Impact Assessment	Impact Assessment Not Required	Biological fish risk issue(s)
Activity may introduce or spread INNS to a water body	✓		Marine plant and vessels (e.g. jack-up barge) may be required for installation of new outfall head and have the potential to introduce INNS to the Site and wider water body as biofouling or from the discharge of ballast and bilge water. INNS may also be introduced via the addition of construction materials, such as the rock armouring / scour protection to be placed around the outfall head.

Summary

9.6.27 A summary of the receptors and relevant WFD quality elements that have been scoped into the WFD impact assessment for the Tees Coastal is shown in Table 9C-19.

Table 9C-19: Scoping outcome for the Tees Coastal water body

Receptor	Relevant WFD quality element(s)	Potential risk to receptor
Hydromorphology	Hydromorphological elements	Proposed activities could impact the morphology of the seabed and local sediment dynamics
Water Quality	Physico-chemical and chemical water quality elements	Impacts from mobilisation of sediments, diffuse urban pollutants in surface water runoff or process water effluent, or as a result of accidental spillages, which are discharged via the outfall to Tees Bay.
Biology: Habitats	Habitats and benthic invertebrates	Potential temporary sediment plume during construction or thermal/chemical plume during operation.
Biology: Fish	Fish	Fish behaviour could be affected by chemical or thermal change in the water body, as well as changes in visual stimuli (such as artificial light), underwater noise and physical disturbance.
Protected areas	N/A	Activity is within 2 km of WFD Protected Areas (i.e. it overlaps Teesmouth and Cleveland Coast SPA and Redcar and Coatham Bathing Waters).

9.6.28 INNS will also be considered within the assessment.

Tees Transitional Water body

9.6.29 The footprint of the Proposed Development falls partially within the catchment of the Tees Transitional WFD water body (i.e. the Tees Estuary). There will be a crossing beneath the Tees Transitional water body for the CO_2 Gathering Network, but this will use the existing Sembcorp No. 2 Tunnel. Some treated process water will be discharged to the estuary via the Dabholm Gut and treatment at Bran Sands WwTW. To maintain nutrient neutrality a return flow with an equivalent load of nitrogen will be discharged to the bay via the PCC site and new outfall. Water quality modelling (Annex G shows that discharges of nitrogen from the proposed new outfall may create a plume that would slightly enter the mouth of the estuary, although the change compared to background average concentrations would be very small.

9.6.30 The Tees Transitional waterbody is a HMWB that is currently at Moderate Ecological Potential. There are currently no mitigation measures identified in the Northumbria RBMP for this water body. Furthermore, the waterbody is at its target objective of Moderate Ecological Potential by 2015. Therefore, there is no requirement to consider the objective of not preventing improvement in status class.

Hydromorphology

9.6.31 The Proposed Development will not have any hydromorphology impacts given that crossings of the Tees Estuary have been screened out above, and there are no other direct impacts to the waterbody or its upstream tributaries.

9.6.32 The scoping assessment of the potential effects to hydromorphology is provided in Table 9C-20.

Table 9C-20: Scoping assessment of risks to hydromorphology

Risk	Requires Impact Assessment	Impact Assessment Not Required	Hydromorphology risk issue(s)
Could impact on the hydromorphology (e.g. morphology or tidal patterns) of a water body at high status			N/A
Could significantly impact the hydromorphology (i.e. bed morphology and substrate) of any water body			N/A
Activity is in a water body that is heavily modified for the same use as your activity			N/A

Water Quality – Physico-chemical Quality Elements

9.6.33 Across the wider Site there will be works in close proximity to Dabholm Gut, The Fleet (Tees Estuary (S Bank)), The Mill Race, Lackenby Channel, Knitting Wife Beck, Kinkerdale Beck, Belasis Beck and minor tributaries of these watercourses for the Natural Gas Connection Corridor, Electrical Connection Corridor, CO_2 Gathering Network. There would be the potential for conveyance of fine sediment and chemical spillages to any of these water bodies through uncontrolled site runoff or through any existing drains that discharge to these watercourses, if not mitigated. All of these water bodies discharge to Tees Estuary, where there is potential for a cumulative impact in terms of fine sediment impacts or chemical spillages on water quality.

9.6.34 Phytoplankton Status is Good for the Tees Transitional waterbody. There is no monitoring of harmful algae, which it is assumed to indicate that this is not a particular risk for this water body. As such, further consideration of phytoplankton and harmful algae has been scoped out from further consideration in the WFD impact assessment, summarised in Table 9C-21.

Table 9C-21: Scoping assessment of risks to physico-chemical quality elements

Risk	Requires Impact Assessment	Impact Assessment Not Required	Water Quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	✓		Impacts from mobilisation of sediments, surface water runoff containing contaminants (including to tributaries of the water body) or as a result of accidental spillages. In addition, treated process water will be discharged to the estuary via the Dabholm Gut and treatment at Bran Sands WwTW. To maintain nutrient neutrality a return flow with an equivalent load of nitrogen will be discharged to the bay via the PCC site

			and new outfall. Water quality shows that discharges of nitrogen from the proposed new outfall may create a plume that would slightly enter the mouth of the estuary, at depth, within the dredged channel, although the change compared to background average concentrations would be small.
Is in a waterbody with a phytoplankton status of moderate, poor or bad		✓	Phytoplankton is at Good Status
Is in a waterbody with a history of harmful algae		✓	There is no monitoring of harmful algae, which it is assumed to indicate that this is not a particular risk for this water body. As such, further consideration of phytoplankton and harmful algae has been scoped out from further consideration in the WFD impact assessment.

Water Quality – Chemical Status

9.6.35 As for physico-chemical status, there is potential for chemical spillages and runoff containing contaminants from upstream tributaries, which discharge to the waterbody and also intersect the Site. Water quality modelling has also shown that under certain circumstances there is potential for the effluent plume (for DIN) to enter the mouth of the estuary, at depth within the dredged channel.

9.6.36 The scoping assessment for chemical status is summarised in Table 9C-22.

Table 9C-22: Scoping assessment of risks to Chemical Status

Risk	Requires Impact Assessment	Impact Assessment Not Required	Water Quality risk issue(s)
The chemicals are on the Environmental Quality Standards Directive (EQSD) list	✓		Potential for a range of chemicals to be discharged to Tees Transitional waterbody indirectly from 'spill over' into the estuary from the bay. Surface water runoff will be to the bay via an attenuation pond.
It disturbs sediment with contaminants above CEFAS Action Level 1		✓	No direct works to the Tees Estuary or upstream tributaries, and so no disturbance of sediment anticipated.

Biology - Habitats

9.6.37 Table 9C-23 outlines the higher and lower sensitivity habitats associated with the Tees Transitional water body (based on the Environment Agency WFD waterbody summary table). The location of lower and higher sensitivity habitats are also shown on Figure 9-4.

Table 9C-23: Higher and Lower Sensitivity Habitats found in the Tees Transitional waterbody

Higher Sensitivity Habitats	Area (ha)	Lower Sensitivity Habitats	Area (ha)
Saltmarsh	46.24	Cobbles, gravel and shingle	0.77
Subtidal kelp beds	4.13	Intertidal soft sediment	400.13
		Rocky shore	26.93
		Subtidal rocky reef	4.13
		Subtidal soft sediments	610.31

9.6.38 Magic Map (DEFRA) has been used to confirm the proximity of the noted sensitive habitats to the proposed works.

9.6.39 Habitats should be included as part of the WFD impact assessment if the footprint of the activity is any of the following (Environment Agency, 2016), noting that this also includes the footprint of thermal or sediment plumes:

- 0.5 km^2 or larger;
- 1% or more of the water body's area;
- Within 500 m of any higher sensitivity habitat or 1% or more of any lower sensitivity habitat.

9.6.40 In accordance with this guidance the habitats outlined in Table 9C-24 have been scoped out of the WFD impact assessment as they do not meet the above criteria.

Table 9C-24: Scoping assessment of risks to biological habitat

Footprint is:	Requires Impact Assessment	Impact Assessment Not Required	Biological habitat risk issue(s)
0.5 km^2 or larger	✓		Any plume relating to runoff laden with fine sediment would not cover this size area, given no direct works to any upstream watercourse is planned. However, the area affected by any increase in DIN in the estuary is expected to be greater than 0.5 km^2.
1% or more of the water body's area	✓		Any plume relating to runoff laden with fine sediment would not cover this size area, given no direct works to any upstream watercourse is planned.
Within 500 m of any higher sensitivity habitat	✓		The areas of higher sensitivity habitat (mussel beds and subtidal kelp beds) around South Gare and on rocky substrate just off Redcar are predicted to be within the ZoI of the DIN effluent plume from the new outfall location.
1% or more of any lower sensitivity habitat	✓		Lower sensitivity habitat in the Tees Transitional water body area includes: Gravel and cobbles, intertidal soft sediment, rocky shore, subtidal rocky reef and subtidal soft

sediment. The area affected by increased DIN levels is expected to cover more than 1 % of these habitat areas.

Fish

9.6.41 The Tees Transitional water body is known to support several nationally and internationally protected migratory fish species (e.g. salmon, sea trout, European eel, river lamprey and sea lamprey), whilst also supporting a range of national and international important estuarine and marine demersal and pelagic fish taxa.

9.6.42 Release of a pollutants from runoff or spillages during construction could affect fish population health. The scoping assessment of risk to fish is provided in Table 9C-25.

Table 9C-25: Scoping assessment of risks to biological fish

Risk	Requires Impact Assessment	Impact Assessment Not Required	Biological fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary	✓		Proposed construction works could cause a chemical change in the water body through disturbance of fine sediment or chemical spillages, which could adversely impact fish health if not mitigated
Could impact on normal fish behaviour like movement, migration, or spawning (e.g. creating a physical barrier, noise, chemical change or change in depth or flow)		✓	Any impact is not considered sufficient is scale to have such an effect given that no direct works are planned to watercourses that would mobilise large amounts of fine sediment.
Could cause entrainment or impingement of fish		✓	No activities proposed that would have this impact.

WFD Protected Areas

9.6.43 The location of the proposed works in relation to the following WFD protected areas has been considered:

- Special areas of conservation (SAC);
- Special protection areas (SPA);
- Shellfish waters;
- Bathing waters; and
- Nutrient sensitive areas.

9.6.44 The outcome of the scoping assessment for WFD protected areas is shown in Table 9C-26.

Table 9C-26: Scoping assessment of risks WFD Protected Areas

Risk	Requires Impact Assessment	Impact Assessment Not Required	Biological fish risk issue(s)
Activity is within 2 km of any WFD protected area	✓		Activity is within 2 km of WFD protected areas – Teesmouth and Cleveland Coast Special Protection Area SPA and a Eutrophic Coastal Sensitive Area (designated under the Urban Wastewater Treatment Directive).

Invasive non-native species

9.6.45 The scoping assessment of risks from INNS is summarised in Table 9C-27.

Table 9C-27: Scoping assessment of risks from INNS

Risk	Requires Impact Assessment	Impact Assessment Not Required	INNS Summary
Activity may introduce or spread INNS to a water body		✓	No direct works within the channel of Tees Estuary nor its upstream tributaries, and so no INNS impact anticipated to this waterbody

Summary

9.6.46 A summary of the receptors and relevant WFD quality elements that have been scoped into the WFD impact assessment for the Tees Coastal is shown in Table 9C-28.

Table 9C-28: Scoping outcome for the Tees Coastal waterbody

Receptor	Relevant WFD quality element(s)	Potential risk to receptor
Hydromorphology	Hydromorphological elements	No Risk
Water Quality	Physico-chemical and chemical water quality elements	Potential for conveyance of fine sediment and chemical spillages to Tees Transitional waterbody or its upstream tributaries or through any existing drains that discharge to these watercourses, if not mitigated
Biology: Habitats	Habitats and benthic invertebrates	Water quality modelling presented in Annex G shows that water with increased DIN due to discharges from the new outfall will enter the estuary mouth, albeit at only low levels of change compared to ambient conditions, and at depth (i.e. not at the surface; plume is pulled into the dredged channel only).
Biology: Fish	Fish	Fine sediment and chemical spillages could impact fish species if not mitigated.
Protected areas	N/A	Fine sediment and chemical spillages could impact fish species if not mitigated.

9.6.47 INNS will also be considered within the assessment.

9.7 WFD Assessment

No Deterioration Assessment

9.7.1 The first stage of the assessment is to consider the likely impact of the Proposed Development on WFD parameters and whether it is likely to cause deterioration of any WFD quality elements or prevent Environment Agency mitigation measures from being implemented.

9.7.2 The appraisal of these two WFD objectives is considered under the following sub-sections.

Potential Construction Phase Impacts

9.7.3 During the construction phase the following surface and ground water environmental impacts may occur, if appropriate mitigation is not applied:

- Temporary impacts on surface water quality due to deposition or spillage of soils, sediments, oils, fuels or other construction chemicals, or through mobilisation of contamination following disturbance of contaminants in sediments, ground or groundwater, or through uncontrolled site run off;
- Temporary impacts on sediment dynamics and morphology in Tees Bay as a result of the potential installation of new water discharge pipeline and associated outfall head and associated use of marine plant (e.g. jack-up barge);
- Remedial works, including disturbance and / or removal of the ground and groundwater which could potentially remove, relocate or mobilise potential existing contaminants (e.g. during foundation construction, earthworks and excavations);
- Creation of new 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 a groundwater aquifer; and
- Changes to the hydrogeological regime (e.g. dewatering activities) may impact groundwater.

9.7.4 Prior to construction works commencing, a Ground Investigation and testing followed by a Quantitative Risk Assessment and development of a Remediation Strategy will be completed, as described in ES Chapter 10: Geology and Hydrogeology (ES, Volume I). This will be in accordance with CLR11 Model Procedures for the Management of Contaminated Land (Environment Agency, 2004), BS10175:2011+ A2:2017 Investigation of Potentially Contaminated Sites: Code of Practice (British Standards Institute, 2013b) and the Environment Agency’s GPLC1 Guiding Principles for Land Contamination in Assessing Risks to Controlled Waters (Environment Agency, 2010).

9.7.5 Construction activities such as earthworks, excavations, site preparation, levelling and grading operations result in the disturbance of soils. Exposed soil is more vulnerable to erosion during rainfall events due to loosening and removal of vegetation to bind it, compaction and increased runoff rates. Surface runoff from such areas can contain excessive quantities of fine sediment, which may eventually be transported to watercourses where it can result in adverse impacts on water quality, flora and fauna.

9.7.6 Construction works within, along the banks and across watercourses can also be a direct source of fine sediment mobilisation, and this sediment could contain contaminants given the past heavy industrial activities on this Site and the limited erosion and conveyance ability of these watercourses.. Potential need for installation of a new offshore outfall (if the existing pipeline is not in a sufficient state of repair) could also lead to the disturbance and mobilisation of historical contamination that may be found at depth in sediments within Tees Bay.

9.7.7 Other potential sources of fine sediment during construction works include water runoff from earth stockpiles, dewatering of excavations (surface and groundwater), mud deposited on site and local access roads, and that which is generated by the construction works themselves or from vehicle washing.

9.7.8 Generally, excessive fine sediment in runoff is chemically inert and affects the water environment through smothering riverbeds and plants, temporarily changing water quality (e.g. increased turbidity and reduced photosynthesis) and causing physical and physiological adverse impacts on aquatic organisms (such as abrasion, irritation). However, given the past industrial activity on the PCC Site and potentially elsewhere across the Study Area, there may also be the potential for acute and chronic toxic effects to aquatic organisms and possibly a risk to other water uses (e.g. bathing waters).

9.7.9 There is a requirement for works within Tees Bay for the discharge outfall and CO_2 Export pipeline. There may also be works in close proximity to The Fleet (Tees Estuary (S Bank)), The Mill Race, Lackenby Channel and Belasis Beck for the Natural Gas Connection Corridor, Electrical Connection Corridor, CO_2 Gathering Network. There would be the potential for conveyance of fine sediment, debris and any contamination during these construction works to any of these water bodies or downstream water bodies and receptors.

9.7.10 During construction, fuel, hydraulic fluids, solvents, grouts, paints and detergents and other potentially polluting substances will be stored and / or used on site. There may also be substantial volumes of stagnant water or other liquid/chemical substances within existing drainage and other redundant process infrastructure on the Site. Leaks and spillages of these substances could pollute the nearby surface watercourses if their use or removal is not carefully controlled and spillages enter existing flow pathways or waterbodies directly. Like excessive fine sediment in construction site runoff, the risk is greatest where works occur close to and within waterbodies.

9.7.11 To allow such substances to enter a watercourse could be in breach of the Environmental Permitting (England and Wales) Regulations 2016 and the Water Resources Act 1991 (as amended). Therefore, measures to control the storage, handling and disposal of such substances will need to be in place prior to and during construction.

Construction Phase Mitigation

Surface Water

9.7.12 During construction water pollution may occur directly from spillages of polluting substances into waterbodies, or indirectly by being conveyed in runoff from hardstanding, other sealed surfaces or from construction machinery. Construction works will require the dismantling and removal of existing drainage infrastructure that may also contain liquid chemicals and wastewater. Fine sediment may also be disturbed in waterbodies directly or also wash off working areas and hardstanding (including approach roads) into waterbodies indirectly via existing drainage systems or overland. Due to past industrial activity, this sediment may not be inert and may potentially contain contamination that could be harmful to the aquatic environment. However, potential impacts to the water environment during the construction phase would tend to be temporary and short term.

9.7.13 Prior to construction starting on Site, a Final Construction Environmental Management Plan (CEMP) will be prepared by the Contractor. The CEMP would outline the measures necessary to avoid, prevent and reduce adverse effects where possible upon the local surface water (and groundwater) environment. A Framework CEMP is provided in the Environmental Statement (se Appendix 5A in ES Volume III, Document Ref. 6.4).

9.7.14 The Final CEMP will need to be reviewed, revised and updated as the project progresses towards construction to ensure all potential impacts and residual effects are considered and addressed as far as practicable, in keeping with available good practice at that point in time. The principles of the mitigation measures set out below are the minimum standards that the Contractor will implement. However, it is acknowledged that for some issues, there are multiple ways in which they may be addressed. In addition, the methods of dealing with pollutant risk will need to be continually reviewed on Site and adapted as construction works progress in response to different types of work, weather conditions and locations of work.

9.7.15 The Final CEMP will be standard procedure for the Proposed Development and will describe the principles for the protection of the water environment during construction. The CEMP will be supported by a Water Management Plan (WMP) that will be included as a technical appendix. The WMP will provide greater detail regarding the mitigation to be implemented to protect the water environment from adverse impacts during construction.

9.7.16 The potential for adverse impacts would be avoided, minimised and reduced by the adoption of the general mitigation measures which are outlined in the following sections and described in the WMP and CEMP.

Good Practice Guidance

9.7.17 The following relevant GPPs have been released to date on the NetRegs website (NetRegs, n.d.) and are listed below. While these are not regulatory guidance in England where the UK government website outlines regulatory requirements, it remains a useful resource for best practice:

- GPP1: Understanding your environmental responsibilities – good environmental practices;

- GPP 2: Above ground oil storage;
- GPP3: Use and design of oil separators in surface water drainage systems;
- GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
- GPP 5: Works and maintenance in or near water;
- GPP 8: Safe storage and disposal of used oils;
- GPP 13: Vehicle washing and cleaning;
- GPP 19: Vehicles: Service and Repair;
- GPP 20: Dewatering underground ducts and chambers;
- GPP 21: Pollution Incident Response Plans;
- GPP22: Dealing with spills; and
- GPP26: Safe storage – drums and intermediate bulk containers.

9.7.18 Where new GPPs are yet to be published, previous Pollution Prevention Guidance (PPG) still provide useful advice on the management of construction to avoid, minimise and reduce environmental impacts, although they should not be relied upon to provide accurate details of the current legal and regulatory requirements and processes. Construction phase operations would be carried out in accordance with guidance contained within the following PPG:

- PPG6: Working at construction and demolition sites (Environment Agency, 2012);
- PPG7: Safe storage – the safe operation of refuelling facilities (Environment Agency, 2011); and
- PPG18: Managing fire water and major spillages (Environment Agency, 2000).

9.7.19 Additional good practice guidance for mitigation to protect the water environment can be found in the following key CIRIA documents and British Standards Institute documents:

- British Standards Institute (2009) BS6031:2009 Code of Practice for Earth Works (British Standards Institute, 2009);
- British Standards Institute (2013) BS8582 Code of Practice for Surface Water Management of Development Sites (British Standards Institute, 2013a);
- C753 (2015) The SuDS Manual (second edition) (CIRIA, 2015a);
- C744 (2015) Coastal and marine environmental site guide (second edition) (CIRIA, 2015b);
- C741 (2015) Environmental good practice on site guide (fourth edition) (CIRIA, 2015c);

- C648 (2006) Control of water pollution from linear construction projects, technical guidance (CIRIA, 2006);
- C609 (2004) Sustainable Drainage Systems, hydraulic, structural and water quality advice (CIRIA, 2004); and
- C532 (2001) Control of water pollution from construction sites – Guidance for consultants and contractors (CIRIA, 2001).

Management of Construction Site Runoff

9.7.20 The measures outlined below, which will be included in the Framework CEMP and the WMP (to accompany the Final CEMP), may be required for the management of fine sediment in surface water runoff as a result of the construction activities:

- Reasonably practicable measures will be taken to prevent the deposition of fine sediment or other material in, and the pollution by sediment of, any existing waterbody, arising from construction activities. The measures will accord with the principles set out in industry guidelines including the CIRIA report 'C532: Control of water pollution from construction sites' (CIRIA, 2001). Measures may include use and maintenance of temporary lagoons, tanks, seeding / covering of earth stockpiles, earth bunds, straw bales and sandbag walls, proprietary measures (e.g. lamella clarifiers or contained chemical treatment) and fabric silt fences or silt screens as well as consideration of the type of plant used.
- A temporary drainage system will be developed to prevent runoff contaminated with fine particulates from entering surface water drains without treatment. This will include identifying all land drains and water bodies on the Site and ensuring that they are adequately protected using drain covers, sandbags, earth bunds, geotextile silt fences, straw bales, or proprietary treatment (e.g. lamella clarifiers). Discharge to such water bodies (directly or indirectly) will only be made with the permission of the Environment Agency (or Northumbrian Water if to the public foul sewer) and with the necessary treatment measures implemented.
- Where possible, earthworks will be undertaken during the drier months of the year and will avoid periods of wet weather, if possible, to minimise the risk of generating runoff contaminated with fine particulates. However, it is likely that some working during wet weather periods will be unavoidable, in which case mitigation measures will be implemented to control fine sediment laden runoff.
- To protect waterbodies from fine sediment runoff, topsoil/subsoil will be stored a minimum of 20 m from any waterbody on flat lying land (and further if the ground is sloping, subject to a site risk assessment and observational monitoring) and not within the fluvial floodplain. Where this is not possible, and it is to be stockpiled for longer than a two-week period, the material will either be covered with geotextile mats or seeded to promote vegetation growth. In all situations, runoff from the stockpile will be prevented from draining to a watercourse without prior treatment. If located where there is a risk of tidal flooding or within fluvial Flood Zone 2, additional measures will be provided to reduce the risk of erosion (e.g.

by protecting the base using spaced out concrete blocks, pegged in geotextile sheets, etc.).

- Appropriately sized runoff storage areas for the settlement of excessive fine particulates in runoff will be provided. It is likely that treated water will then be pumped under a temporary Water Activity Permit from the Environment Agency or agreed with Northumbrian Water to an existing Treatment Works (assumed to be treated at the Brans Sands WwTW).
- Mud deposits will be controlled at entry and exit points to the Site using wheel washing facilities and / or road sweepers operating during earthworks activities or other times as considered necessary.
- Equipment and plant are to be washed out and cleaned in designated areas within the Site compound where runoff can be isolated for treatment before discharge to surface water drainage under appropriate consent and / or agreement with Environment Agency and / or Northumbrian Water, or otherwise removed from site for appropriate disposal at a licensed waste facility.
- Debris and other material will be prevented from entering surface water drainage, through maintenance of a clean and tidy site, provision of clearly labelled waste receptacles, grid covers and the presence of site security fencing.
- The WMP will include details of pre, during and post-construction water quality monitoring. This will be based on a combination of visual observations, frequent in situ testing using water quality probes, and periodic sampling for laboratory analysis.

Management of Spillage Risk

9.7.21 The measures outlined below may be implemented to manage the risk of accidental spillages on site and potential conveyance to nearby waterbodies via surface runoff or land drains. The measures relating to the control of spillages and leaks will be included in the WMP and CEMP and adopted during the construction works:

- Fuel will be stored and used in accordance with the Control of Substances Hazardous to Health Regulations 2002, and the Control of Pollution (Oil Storage) (England) Regulations 2001. Particular care will be taken with the delivery and use of concrete and cement as it is highly corrosive and alkaline.
- Fuel and other potentially polluting chemicals will either be in self bunded leak proof containers or stored in a secure impermeable and bunded area (minimum capacity of 110% of the capacity of the containers).
- Any plant, machinery or vehicles will be regularly inspected and maintained to ensure they are in good working order and clean for use in a sensitive environment. This maintenance is to take place off site if possible or only at designated areas within the Site compound. Only construction equipment and vehicles free of all oil/fuel leaks will be permitted on site. Drip trays will be placed below static mechanical plant.

- All washing down of vehicles and equipment will take place in designated areas and wash water will be prevented from passing untreated into watercourses.
- All refuelling, oiling and greasing will take place above drip trays or on an impermeable surface which provides protection to underground strata and watercourses, and away from drains as far as reasonably practicable. Vehicles will not be left unattended during refuelling.
- As far as reasonably practicable, only biodegradable hydraulic oils will be used in equipment working in or over watercourses. All fixed plant used on the Site will be self-bunded. Mobile plant is to be in good working order, kept clean and fitted with plant 'nappies' at all times.
- A Pollution Prevention Plan will be prepared and included alongside the CEMP. Spill kits and oil absorbent material will be carried by mobile plant and located at high risk locations across the Site and regularly topped up. All construction workers will receive spill response training and toolbox talks.
- The Site will be secure to prevent any vandalism that could lead to a pollution incident.
- Construction waste / debris are to be prevented from entering any surface water drainage or water body.
- Surface water drains on roads or within the construction compound will be identified and, where there is a risk that fine particulates or spillages could enter them, the drains will be protected (e.g. using covers or sandbags).
- Suitable facilities for concrete wash water (e.g. geotextile wrapped sealed skip, container or earth bunded area) will be adequately contained, prevented from entering any drain, and removed from the Site for appropriate disposal at a suitably permitted waste facility.
- Water quality monitoring of potentially impacted watercourses will be undertaken to ensure that pollution events can be detected against baseline conditions and can be dealt with effectively.

9.7.22 In addition, any site welfare facilities will be appropriately managed, and all foul waste disposed of by a licensed contractor to a suitably permitted facility.

Management of Risks to Groundwater

9.7.23 Construction phase mitigation measures in relation to the hydrogeological environment are summarised here, where different to the measures described above:

- Prior to the design and construction of the project, a GI will be undertaken to assess the degree to which the Site is contaminated and identify the potential impacts this may have to site users and the environment. The findings will feed into the detailed design process and the CEMP will be updated and implemented in order to mitigate the effect of potential impacts of the Proposed Development during construction so that appropriate measures are taken.

- Should the GI prove the need for piling or soil mixing to take place, the construction methodology will be assessed 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' bedrock Aquifers. If piling is required, low noise piling techniques will be adopted where possible.
- If during the course of the development any contamination is found which has not been previously identified, an appropriate risk assessment will be prepared. Any actions resulting from the risk assessment will be agreed with the Local Planning Authorities / Environment Agency / Natural England along with any remedial measures. Contamination assessment will be in accordance with the CIRIA C552 - Contamination Land Risk Assessment, A Guide to Good Practice and the Model Procedures for the Management of Contaminated Land, CLR11 (Environment Agency, 2004). These remedial measures will be adopted as part of the Proposed Development.

Treated Water Outfall

9.7.24 Although still operational for small discharges, the existing outfall from the former steelworks is believed to not be suitable for long term use for this Proposed Development. A new pipeline (estimated 0.8 m diameter) would therefore be installed adjacent to the CO_2 Export Pipeline as shown on ES Figure 3-2A (ES Volume II (Document Ref. 6.3)). This would be installed using trenchless techniques from the PCC Site beneath Coatham Dunes and Sands and out to Tees Bay. Construction would be carried out at the same time as the CO_2 Export Pipeline (see below).

9.7.25 The emplacement of a new outfall head for the new water discharge pipeline would involve the following potential activities:

- Preliminary dredge;
- Final assembly, float and positioning of the outfall head;
- A flood and sink exercise or similar works to position the outfall head;
- Either piling or pin drilling to secure the outfall head;
- The positioning of rock armouring/scour protection around the outfall head (assumed worst-case volume of rock armour 250 m^3 equating to an area on 100 m^2);
- Final assembly, pipeline jointing, connections, fabrication and ancillary commissioning works to install a safe and fit for purpose discharge pipeline; and
- The presence of vessels such as work boat(s) and/or barge(s) to support the installation process.

9.7.26 It is intended to roughen the surface rock armour around the proposed outfall in order that marine flora can better attach to it, following a request from the Environment Agency at the meeting on 1st April 2022.

9.7.27 The use of trenchless technologies beneath the foreshore would minimise direct impact to the sea bed and associated sediment mobilisation and scour but would require presence of a jack-up barge seaward of the South Gare dune complex, a punch-hole / break-out through the seabed at the intended discharge point and connection into an outfall head (if design required it), and the presence of vessels such as work boat(s) and/or barge(s) to support the refurbishment process.

9.7.28 Appropriate licences and permits will be obtained from the Environment Agency and Marine Management Organisation with regards to discharges and construction of the outfall pipeline within Tees Bay, and all conditions would be adhered to. Best practice construction approaches would be adopted.

Construction of CO_2 Export Pipeline

9.7.29 Construction of the CO_2 Export Pipeline) from the Compressor Station) across Coatham Dunes and Coatham Sands to Mean Low Water Springs (MLWS) (including into the Teesmouth and Cleveland Coast SPA/Ramsar and the Teesmouth and Cleveland Coast SSSI) will be undertaken using trenchless technologies beneath through the dunes and sands and out into Tees Bay.

9.7.30 The corridor within which the CO_2 Export Pipeline will run as shown on Figure 3-2A (ES Volume II, Document Ref. 6.3). The CO_2 Export Pipeline will extend beyond MLWS. The export pipeline would be extended beyond this point to connect to the off-shore storage facility, however, consent for this section below MLWS of the pipeline is not being sought as a part of the DCO Application.

Construction of CO_2 Gathering Network

9.7.31 The CO_2 Gathering Network will be an above ground pipeline installed utilising existing support infrastructure (i.e. existing pipe racks, sleeper tracks, culverts and pipe bridges), where feasible. In the event that a pipe rack is at capacity, the pipe rack will be extended to accommodate the additional line. Alterations will not be any lower than the lowest pipe or soffit of the existing structure, so as to avoid any increase in flood risk. The proposed routing for the CO_2 Gathering Network pipelines are shown on Figure 3-2E: Development Areas (ES Volume II, Document Ref. 6.3). No new crossings of watercourses are required with the exception of Tees Estuary.

9.7.32 The CO_2 Gathering Network will also cross the Tees Transitional water body using an existing utilities tunnel.

Construction of Electrical Connection Corridor

9.7.33 The Electrical Connection between the Electricity Generating Station and National Grid's Tod Point sub-station would comprise up 275 kV electrical cables and control system cables which would be installed below ground. The corridor within which the Electrical Connection Corridor will run is shown on Figure 3-2C: Development Areas (ES Volume II, Document Ref. 6.3).

9.7.34 As with the CO_2 Gathering Network, no open-cut crossings of watercourses are required.

Drilling Fluids

9.7.35 The drilling fluid to be used during trenchless installations comprises of bentonite as the primary base (a mined clay) which is delivered to site as a dried and finely ground powder. This is rehydrated in a temporary mix tank with potable water. In addition to the bentonite, the drilling fluid contains carefully chosen additives to control its rheological properties.

9.7.36 Bentonite is a naturally occurring material, is recyclable, has a non-hazardous rating on Materials Safety Data Sheets and is on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR).

9.7.37 The drilling fluid would consist of a low concentration bentonite-water mixture. Depending on the formation to be drilled through, the concentration would be between 13 and 35 litres per cubic metre of water.

9.7.38 Other drilling materials that might be required will be CEFAS or Offshore Chemical Notification Scheme (OCNS) rated. The OCNS scheme is regulated in the UK by the Department for Business, Energy & Industrial Strategy (BEIS) using scientific and environmental advice from CEFAS.

Risk of Bentonite Breakout / Frac Out

9.7.39 In some circumstances drilling fluids can ‘breakout’ onto the ground surface and thereby potentially cause pollution of watercourses. Surface breakout most commonly occurs within the first 30 m from entry and a capable contractor will avoid this in the majority of cases. It can occur due to the initial hole trajectory being shallow and not yet at the optimum drill depth as identified within cross-section drawings and design.

9.7.40 The contractor will have a person walking the drill alignment (onshore) as far as reasonably practicable (within agreed site boundaries) checking for signs of a breakout. If detected the drilling is stopped immediately and the spill contained and removed.

9.7.41 The contractor will maintain a stock of ready filled sandbags on site to contain a breakout if it occurs, and a small pump with flexible hose to pump the bentonite back to the entry pit.

9.7.42 Drilling fluid can sometimes break out of the bore in cases of highly fissured clay, gravels or where there are large, interconnected fissures in the ground. Breakouts may also occur where man made features are present (e.g. old boreholes). In the event of egress of drilling fluid from the bore it is only likely to reach ground level where there is a continuous path available to the surface.

9.7.43 The risk of a bentonite breakout during drilling cannot be fully assessed beforehand. However, any decrease in the mud volume returning to the entry pit will trigger the need for personnel to closely monitor the area around the drilling head. For this reason, a close watching brief during drilling activities and a detailed Contingency Plan (included in the Breakout / Frack Out Management Plan) is essential to ensure that any drilling fluid breakout is contained, bunded and pumped back to the entry pit with minimum disturbance to the surrounding environment.

9.7.44 In the offshore environment, the drill is expected to require a jack-up barge with a drill rig located on it, which works in tandem with an onshore drill rig. The drill and fluids are controlled by a continuous casing from the jack-up barge to a depth within the seabed that shall be designed to ensure loss of fluid is not possible. It is most likely that the casing pipe shall be hammered into the seabed until refusal is met thus ensuring the weaker non cohesive layers are cased through and the deeper homogenous layer is entered before the drill head exits the casing.

9.7.45 Key mitigation measures for minimising breakout include:

- Detailed design of the landfall, showing geological layers and intended drill path;
- Ensuring HDD design has sufficient depth below surface for the expected ground conditions;
- Ground stabilisation prior to drilling;
- Casing through weaker cohesive layers;
- Hydro fracture analysis and calculation;
- Monitoring of drilling fluid returns and volumes to warn of inadequate hole cleaning;
- Drilling fluid to be of sufficient viscosity and properties for the ground being drilled; and
- Real time downhole annular pressure monitoring to warn of over pressurising by drilling fluid.

9.7.46 These mitigation measures will be outlined in a detailed management plan, methodology and risk assessment. Detailed reporting and monitoring will be undertaken during the course of the works, the nature of which will be outlined in the breakout plan.

Water Quality Monitoring

9.7.47 During construction it is proposed to undertake a water quality monitoring programme to ensure that mitigation measures are operating as planned and preventing pollution. This is standard practice for construction works of this type, and full details will be outlined in the WMP (accompanying the Final CEMP). The purpose of the monitoring programme will also be to ensure that should pollution occur it is identified as quickly as possible and appropriate action is taken in line with a Pollution Prevention Plan.

9.7.48 The water quality monitoring programme will be developed by the Principal Contractor in consultation with the Environment Agency and Marine Management Organisation during the process of obtaining environmental permits/licences for works affecting, or for temporary discharges to, watercourses within the Site.

Construction Phase Assessment

Tees Coastal Waterbody (Tees Bay)

Surface Water Quality – Suspended Fine Sediment

9.7.49 A new water discharge pipeline and outfall adjacent to the CO_2 Export Pipeline will be constructed as shown on Figure 3-2A: Development Areas (ES Volume II, Document Ref. 6.3). The water discharge and CO_2 Export pipelines would be installed beneath the seabed using trenchless technologies and thereby largely avoiding sediment disturbance. The discharge pipeline would then be connected to a new outfall head, positioning of which would involve a flood and sink exercise, potential piling or pin drilling and installation of rock armour / scour protection. A jack-up-barge or similar would be used during construction (e.g. for positioning a drill rig).

9.7.50 Emplacement of the outfall head, lowering of the jack-up-barge legs (or similar) and installation of drill casing has the potential to temporarily disturb sediment on the seabed of the Tees Coastal water body. Increased suspended sediment concentrations would result in a temporary increase in the turbidity of the water column and could potentially (subject to sediment properties and chemical composition) cause an oxygen demand within the sediment plume.

9.7.51 However, it is considered that any sediment plume arising from this construction activity poses a limited risk to water quality as open seas have a large capacity to accommodate an increase in oxygen demand, and fish and mammals are able to avoid the plume. Furthermore, the relatively shallow inshore of the North Sea is a naturally turbid environment. There is, however, potential to have a short-term impact on the 'Redcar Coatham' Bathing Water for works around the discharge point, and so works to the outfall head may require short-term restrictions on bathing.

9.7.52 Construction works on the PCC Site itself, including installation of new drainage infrastructure has the potential to mobilise sediments e.g. soils exposed during excavations or levelling, which could be directed to Tees Bay through existing drainage infrastructure. However, implementation of best practice construction approaches, as outlined above, including measures outlined in the Final CEMP would mitigate for this.

9.7.53 Overall, given that the construction phase mitigation measures described above would be in place, it is considered that there would be a very localised and temporary minor impact to the Tees Coastal water body due to works to the potential new outfall head. This would not be significant at the water body scale and any sediment plume would be very quickly dispersed by the prevailing hydrodynamic conditions. As such, no reduction in any WFD element would occur due to suspended fine sediments, nor any non-compliance with WFD objectives for the water body.

Surface Water Quality – Chemical Spillages

9.7.54 If appropriate mitigation measures are implemented as described in 'Construction Phase Mitigation' above, including water quality monitoring and a frac out plan and risk assessment, then the risk of chemical spillages to the Tees Coastal water body would be minor. The main risk would result from working directly over and within the waterbody itself for installation of the water discharge pipeline outfall head, and the requirement for use of associated marine plant and jack-up-barge (or similar), from which spillages of fuels, oils and other chemicals could occur. Frac out from the trenchless drilling could potentially occur although the risk is controlled through the mitigation measures outlined above. As previously described, the impact to Tees Bay would not occur if the existing pipeline and outfall can be used.

9.7.55 There is also an indirect risk of spillages entering the water body from works undertaken at the PCC Site, whereby any spillages that enter the existing drainage infrastructure could discharge to Tees Bay through the existing outfall tunnel. Overall, this impact is considered minor given the mitigation outlined above, including best practice measures in the Final CEMP, and the fact that Tees Coastal water body has a large capacity to dilute and disperse pollutants. No reduction in any WFD element would therefore be anticipated from chemical spillages, or any prevention of future improvement.

Marine Ecology

9.7.56 The following construction activities have the potential to result in permanent and temporary direct loss and physical disturbance of subtidal sandflat habitat in the Tees Coastal water body. These include:

- Dredging of a pocket for emplacement of the outfall head;
- The installation of rock armouring / scour protection around the outfall head;
- Creation of breakout points within the foreshore using trenchless technologies for the water discharge pipeline and the CO_2 Export pipeline; and
- Anchoring, grounding or positioning of work boat(s) and /or barge(s) on the seabed to support the construction works.

9.7.57 Soft sediment habitats characterise much of the footprint of the marine construction works including subtidal sandflats, which are representative of Annex I habitat and are also afforded national conservation protection. Soft sediment habitats are, according to the Marine Life Information Network's (MarLIN) Marine Evidence Based Sensitivity Assessment (MARESA), known to be highly resilient to direct physical disturbance arising from substrate loss and penetration (e.g. from anchoring or grounding of vessels).

9.7.58 Following temporary loss and physical disturbance of subtidal habitats, including Annex I subtidal sandflat habitat, recovery would be expected to occur over reasonable timescales (i.e. <5 years) within this area following completion of construction. The habitats known to be present are well adapted to regular natural disturbance from for example, storm events. Furthermore, the spatial extent of impact would be small and highly localised to the marine construction works.

9.7.59 However, any habitat can be regarded as intolerant of permanent loss. Emplacement of the outfall head and installation of the associated rock armouring / scour protection would result in a direct localised but permanent subtidal habitat loss, along with loss of the associated infaunal and epifaunal communities under the footprint of the structure.

9.7.60 The exact volume of rock armouring required for protection of the outfall is as a worst-case, expected to be around 250 m^3. This presents a significant surface area for colonisation by flora (e.g. algae) and fauna (e.g. barnacles, tube worms, sea squirts and soft corals such as *Alcyonium digitatum*). Following placement and during the remaining construction phase and into the operational phase, a succession in the benthic communities associated with this structure is likely to be observed, transitioning from early colonisers (e.g. diatoms, filamentous algae and barnacles) to a climax community. In terms of biomass, this newly available food resource can be expected to offset to some extent the loss of infauna habitats. It is also proposed to roughen the surface of the rock armour installed around the proposed outfall in order to enable marine flora to better attach to it and encourage this succession process to occur.

9.7.61 Whilst construction of the Proposed Development can be expected to alter the extent, distribution and structure of habitats and communities under the footprint of the marine works, these adverse impacts are only predicted to occur at the local level. In the context of the availability of similar habitat across the wider WFD water body, the impact of direct loss and physical disturbance to subtidal habitats and communities under the footprint of the marine construction works is predicted to be not significant.

9.7.62 The area under the footprint of the marine construction works and outfall head is not considered to provide particularly important functional habitat for most fish and shellfish. The only exception is sandeel (*Ammodytes* spp.) as there is evidence to suggest that this species utilises inshore areas as a nursery ground (see Appendix 14B: Fisheries and Fish Ecology (ES Report, Volume III, Document Ref. 6.4)). This species exhibits a degree of site fidelity and is therefore likely to be more vulnerable to habitat disturbance than other fish species.

9.7.63 Nonetheless, the majority of species and life stages known to be present in the area are mobile and would be able to move away from the area of disturbance. Owing to the prevalence of the same or similar habitats within the area, fish and shellfish are expected to be relatively tolerant of displacement. Recovery of species populations and habitat function under the footprint of the temporary marine construction works would also be expected. This includes the recolonisation of suitable sediments by sandeels following completion of the works. Overall, the sensitivity of fish and shellfish to direct loss and physical disturbance is considered to be low.

9.7.64 Increased suspended sediment concentrations from the construction works associated with the Proposed Development has the potential to result in smothering and physical disturbance of benthic habitats. However, the subtidal habitats and communities known to be present around the intake are considered to have a medium sensitivity to smothering and scouring effects (see Chapter 14: Marine Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2)). However, any contaminated sediments which are disturbed during the construction phase would be expected to disperse, settle out and be potentially further redistributed over a wide area and thus, the potential for impact to marine ecological receptors would be limited. Given the mitigation, no adverse impact is anticipated at the water body scale.

9.7.65 Mobile fish species or life stages would be expected to move away from unfavourable conditions and would be capable of returning to an area once adverse conditions had abated. Although demersal life stages are less able to adapt to adverse levels of turbidity and deposition, many are known to be reasonably tolerant of smothering. Sandeel are adapted to live in highly dynamic environments characterised by mobile sediments and variable turbidity and so there is considered limited potential for physiological damage (e.g. disruption to feeding or respiratory) or mortality of adult, juvenile or larval sandeel. Taking into consideration the design mitigation, the resultant nature of potential impacts to fish and shellfish from increased turbidity and deposition (i.e. small in extent, temporary and short-term) and the low sensitivity of fish and shellfish to increased turbidity and smothering means that there is no significant impact at the water body scale.

9.7.66 An assessment of the potential impact of underwater sounds during construction on fish is presented in ES Chapter 14: Marine Ecology and Nature Conservation (ES Volume I, Document Ref.6.2). This could include sounds relating to drilling of pin piles for installation of the outfall head, rock placement on the seabed, marine vessel movements. None of the construction activities are expected to occur for longer than 12 hours and in many cases are unlikely to occur continuously for more than a few hours. Also, the fish with high hearing sensitivity are pelagic species, highly mobile and free-ranging and so unlikely to remain within the impact zone. Thus, no injurious impacts in fish are anticipated. Overall, behavioural disturbance to fish from continuous sound sources would be localised, short-term and intermittent.

9.7.67 In terms of visual stimuli, changes may occur from land and marine-based construction activities (such as artificial lighting) which could lead to behavioural responses in fish and shellfish taxa who are photoreceptive. However, any changes would be highly localised to the construction works or Site and therefore the spatial extent of any disturbance would be small. The majority of lighting, plant and personnel would also be mobile and so any effect would be temporary, short-term and intermittent.

9.7.68 Given the above discussion, there is not anticipated to be any deterioration in any WFD ecological element as a result of the construction works within the Tees Coastal water body, or prevention of future objectives being met.

Introduction and Spread of Invasive Non-Native Species

9.7.69 INNS have the potential to out-compete native species with possible detrimental impacts to native habitats via species loss, modifications to ecosystems and the introduction of disease and pathogens leading to mortality.

9.7.70 Marine plant and vessels required for construction of the Proposed Development represents the most likely pathway for the introduction of INNS, either from biofouling or from the discharge of ballast water and bilge water. However, INNS may also be introduced via construction materials (e.g. placement of rock armouring required around the outfall head). The introduction of hard artificial structures also has the potential to facilitate the colonisation of INNS as these are known to disproportionately favour non-native species compared to naturally occurring hard-bottom species due to the absence of competition and predation. New substrates or structures can also serve as 'stepping stones' in otherwise inhospitable areas, which can assist with the expansion of species distributions.

9.7.71 All project vessels shall adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments with the aim of preventing the spread of marine INNS.

9.7.72 All project vessels shall adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines).

9.7.73 Given adherence to these guidelines, the risk of introduction and spread of INNS through ballast water exchange and biofouling would be reduced and therefore the probability of transmission is low. Given the relatively small volume of rock armouring which would be required to protect the treated water outfall head, the risk of INNS transmission on this material is also low.

9.7.74 The prevalence of existing INNS within the vicinity of the Site is limited and none appear to be detrimental to native species habitats, diversity or ecosystem functioning. Given the limited extent of loss and physical disturbance to habitats and species, and volume of artificial substrate added during construction, the risk of existing or new INNS becoming established or proliferating to an extent that would cause ecological harm is considered to be very low and will not cause detriment or prevent future improvement of the WFD water body.

Morphological Impacts

9.7.75 A new water discharge pipeline and outfall consisting of a diffuser head weighed down with rock armour will be installed in Tees Bay as previously described. The water discharge and CO_2 Export pipeline will be installed beneath the seabed using trenchless technologies until close to the position of the diffuser head, thereby mitigating any morphological impact. Such impacts would be limited to the loss of an area of the subtidal seabed for the outfall structure itself and potential sediment disturbance beneath the jack-up-barge legs. Given the dynamic nature of the water body with significant sediment transport, any disturbance beneath the jack-up-barge legs would be restored naturally in under five years as described above. However, there will be permanent loss of seabed beneath the outfall head itself and adjacent scour protection and rock armouring. This is anticipated to be an area of 100 m^2 as a worst case scenario. The morphological loss of a small area of the seabed is insignificant at the scale of the WFD water body (88 km^2), and so is not considered to cause a deterioration or prevention of future improvement.

Tees Transitional Waterbody (Tees Estuary)

Surface Water Quality – Suspended Fine Sediment

9.7.76 Across the wider Site there will be works in close proximity to Dabholm Gut, The Fleet (Tees Estuary (S Bank)), The Mill Race, Lackenby Channel, Belasis Beck and minor tributaries of these watercourses for the Natural Gas Connection Corridor, Electrical Connection Corridor and CO_2 Gathering Network. There would be the potential for conveyance of fine sediment to any of these water bodies through uncontrolled site runoff or through any existing drains that discharge to these watercourses, if not mitigated. All of these water bodies discharge to Tees Estuary, where there is potential for a cumulative impact in terms of fine sediment impacts on water quality.

9.7.77 Measures to manage formation of excessive sediment in runoff and to provide treatment prior to discharge will be implemented as described in the Final CEMP and WMP. This would include implementation of a temporary site drainage system. Given this mitigation, any residual impact would be temporary and minor within the waterbodies directly affected and are not significant to the Tees Estuary at the WFD waterbody scale, particularly given the dispersal and diluting potential of the estuary.

9.7.78 Overall, no reduction in any WFD element in the Tees Estuary is anticipated due to suspended fine sediments, nor any non-compliance with WFD objectives. As such, there would be no subsequent impact on other WFD elements including status of fish and protected areas.

Surface Water Quality – Chemical Spillages

9.7.79 There is also an indirect risk of spillages entering the waterbody from works undertaken across the wider Site, whereby uncontrolled site runoff enters watercourses (or on-line ponds) and pollutants propagate downstream to the Tees Estuary. However, this risk is considered minor given the mitigation outlined above, including best practice measures in the CEMP, and the fact that Tees Transitional water body has a large capacity to dilute and disperse pollutants. No reduction in any WFD element would therefore be anticipated from chemical spillages, or any prevention of future improvement. If appropriate mitigation measures are implemented as described in 'Construction Phase Mitigation' above, including water quality monitoring, then the risk of chemical spillages to the Tees Transitional waterbody and its upstream tributaries would be low. As such, there would be no subsequent impact on other WFD elements including status of fish and protected areas.

Morphological Impacts

9.7.80 No morphological impacts are anticipated to any of the tributaries of the Tees Estuary catchment. No open-trench crossings are required for any of the required connection corridors (Natural Gas Connection Corridor, Electrical Connection Corridor, CO_2 Gathering Network) and so there would be no disturbance of river beds. Where crossings are needed these are to use existing pipe racks, sleeper tracks, culverts and existing pipe bridges, service crossings of this nature are an exempt activity. As such there is no morphological impact to watercourses, and no deterioration or prevention of improvement in morphology for the wider WFD waterbody.

Tees Estuary (S Bank) Water body (The Fleet)

Surface Water Quality – Suspended Fine Sediment

9.7.81 There will be works undertaken in close proximity to the Tees Estuary (S Bank) water body and its tributary The Mill Race and several unnamed ditches for the Natural Gas Connection Corridor, Electrical Connection Corridor and CO_2 Gathering Network. However, there are no direct works to these watercourses for crossings or outfalls.

9.7.82 During works in close proximity to the above watercourses, there would be the potential for conveyance of fine sediment to any of these water bodies through uncontrolled site runoff or through any existing drains that discharge to these watercourses, if not mitigated.

9.7.83 Measures to manage formation of excessive sediment in runoff and to provide treatment prior to discharge will be implemented as described in a Final CEMP and WMP. This would include implementation of a temporary site drainage system. Given this mitigation, any residual impact would be negligible within the water bodies directly affected and are not significant to the Tees Estuary (S Bank) at the WFD waterbody scale, particularly given the dispersal and diluting potential of this river.

9.7.84 Overall, no reduction in any WFD element in the Tees Estuary (S Bank) is anticipated due to suspended fine sediments, nor any non-compliance with WFD objectives.

Surface Water Quality – Chemical Spillages

9.7.85 If appropriate mitigation measures are implemented as described in 'Construction Phase Mitigation' above, including water quality monitoring, then the risk of chemical spillages to the Tees Estuary (S Bank) waterbody would be minor. The main risk would result from working immediately adjacent to the river (and its tributaries such as The Mill Race), and for work over the river to install the new pipe bridge. During this work there is potential for spillages of fuels, oils and other chemicals.

9.7.86 There is also an indirect risk of spillages entering the water body from works undertaken across the wider Site, whereby uncontrolled site runoff enters watercourses (or on-line ponds) and pollutants propagate downstream to the Tees Estuary (S Bank) waterbody. However, this risk is considered negligible given the mitigation outlined above, including best practice measures in the Final CEMP. No reduction in any WFD element would therefore be anticipated from chemical spillages, or any prevention of future improvement.

Aquatic Ecology

9.7.87 Works associated with construction of the connection corridors could result in runoff laden with fine sediment or containing pollutants into the water body as described above. This could potentially lead to temporary adverse effects on aquatic ecology in the Tees Estuary (S Bank) and its tributaries, if not mitigated. However, given the implementation of the best practise mitigation described in 'Construction Phase Mitigation' above, including the Final CEMP, temporary site drainage systems and spillage controls and response protocols, then the risk is temporary and minor to aquatic ecology. No adverse effect to any of the ecological WFD parameter would be anticipated or prevention of future improvement.

Morphology Impacts

9.7.88 There are no morphological impacts predicted to the Tees Estuary (S Bank) water body as there are no direct works proposed to the river or its tributaries.

Tees Mercia Mudstone & Redcar Mudstone WFD groundwater body & Tees Sherwood Sandstone WFD groundwater body

9.7.89 During construction works there is the potential for impact to ground water through the creation of new pathways, or exacerbation of existing pathways that may open or modify potential pollutant linkages (e.g. from piling foundations). Excavation of cuttings may liberate groundwater in the form of seepages from any areas of permeable ground or superficial deposits (sands, clays, gravels) that are intercepted. This liberated groundwater may not be suitable for discharge without treatment of contaminants. There is also potential for underlying groundwater to be contaminated from spillages associated with vehicles, construction materials and storage of fuels, oils and other chemicals. Leakage of drilling fluids during HDD works also represents a potential source of pollution to the groundwater body.

9.7.90 Appropriate working practices, plans and equipment required to deal with dewatering of groundwater would be included in the Final CEMP and WMP. This would also outline pollution control measures, such as the need for all fuel and chemical storage areas to be bunded. Foundations and services will be designed and constructed to prevent the creation of pathways for the migration of contaminants and will be constructed of materials that are suitable for the ground conditions and designed use. For example, below ground connection corridor pipelines would be designed in accordance with current good practice and applicable guidance to ensure pipes are protected from potential impacts associated with contamination. All waters removed from excavations by dewatering will be discharged appropriately, subject to the relevant licences being obtained.

9.7.91 If during the course of the development any contamination is found which has not been previously identified, an appropriate risk assessment will be prepared. Any actions resulting from the risk assessment will be agreed with the Local Planning Authorities / Environment Agency / Natural England along with any remedial measures. These remedial measures will be adopted as part of the Proposed Development.

9.7.92 The need for piling works will be assessed. Any piling works required would be planned in accordance with best practice guidance '*Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, EA National Groundwater & Contaminated Land Centre Report NC/99/73* (Environment Agency, 2001). Any piling operations required would be subject to a works risk assessment and any potential to cause pollution to the aquifer would be covered by measures to be detailed in piling method statements. Similarly, a drilling fluid break out plan and risk assessment would be prepared to manage the risk during HDD works, and best practice mitigation would be applied as outlined earlier in the chapter.

9.7.93 With the implementation of the mitigation measures to be described in the Final CEMP, WMP and Chapter 10: Geology and Hydrogeology of the ES (Volume I), any residual impacts to the groundwater body would be temporary and minor, and would not be significant at the water body scale. The Proposed Development is therefore compliant with the WFD objectives for these two water bodies during construction.

Potential Operation Phase Impacts

9.7.94 During the operation phase the following potential water environment impacts may occur, if appropriate mitigation is not applied:

- Impacts on receiving water bodies from diffuse urban pollutants in surface water runoff, or as a result of accidental spillages;
- Changes in water quality within Tees Bay from operational discharges from the PCC Site including the discharge of treated process wastewater and water from the cooling system;
- Potential nutrient enrichment of ponds located adjacent to the PCC Site from atmospheric deposition of nitrogen emitted from the Power and Capture Plant (see Chapter 8: Air Quality and Chapter 12: Terrestrial Ecology, ES, Volume I); and
- Impacts on morphology of waterbodies.

Operation Phase Mitigation

9.7.95 A number of mitigation features would be incorporated into the design of the Proposed Development in order to avoid, minimise and reduce potential adverse impacts on water features, water resource and flood risk. These features are described in the following sections.

9.7.96 The Power-Capture & Compression (PCC) site at STDC will need to have access to an effluent treatment and disposal route and this will need to be permitted for the final development approval with the Environment Agency and local authorities prior to construction of the development. The types of effluent that will be seen as part of the project development during its operating life will be:

- Clean Surface water;
- Potentially Contaminated Surface Water – no amine contamination;
- Potentially Contaminated Surface Water – amine contaminated;
- Process water from Capture plant DCC (contains ammonia or urea);
- Process water from CO_2 compression and dehydration (weak carbonic acid & numerous streams);
- Blowdown from cooling towers;
- Blowdown from steam boilers;
- Hazardous liquid wastes; and
- Foul Water (sewage).

9.7.97 These will be managed as follows:

- Clean surface water which can be discharged with minimal treatment;
- Potentially contaminated surface water (no amine contamination), process water (except from the Carbon Capture Plant) and blowdown which can be discharged following onsite treatment (e.g. dosing);

- Process water from the Carbon Capture plant DCC ammonia or urea) which can be discharged following treatment at Brans Sands WwTW (and discharged to Dabholm Gut although a flow of final treated effluent with an equivalent load of nitrogen that was sent to the WwTW will be returned to the site for discharge to Tees Bay to maintain nutrient neutrality);
- Wastes requiring off-site treatment or disposal (hazardous liquid wastes including amine contaminated water); and
- Foul water will be treated at Northumbrian Water's Marske-by-the-Sea treatment plant.

Surface Water Drainage

9.7.98 A new surface water drainage network and management system will be provided for the PCC Site that will provide adequate interception, conveyance and treatment of surface water runoff from buildings and hardstanding. The connection corridors will not require drainage. As surface water discharge will be to Tees Bay via the Water Discharge Corridor, no attenuation capacity is required.

9.7.99 Due to the nature of the Proposed Development it is likely that a range of different diffuse pollutant types may be present, with concentrations of these pollutants varying depending on many factors. However, this risk will be offset by the fact that the Site is an existing brownfield site that is currently not operating (i.e. surface water from the Site may already contain diffuse pollutants). Prior to development the site will need to be cleared and any remedial works required undertaken.

9.7.100 The drainage strategy for the PCC will be defined in consultation with the Environment Agency, the LLFA (RCBC and STBC) and Northumberland Water as the project progresses, taking into account the findings of the Flood Risk Assessment (FRA) and water quality assessment. The proposed drainage system is to include the use of sustainable drainage systems (SuDS) to provide treatment of runoff to ensure potential adverse effects on water quality are avoided.

9.7.101 The key objectives of the site drainage system are to provide a drainage system which is inherently safe and protects the local environment and the outfall in Tees Bay from accidental discharges of oil, chemicals or run-off from firefighting effluent. Clean water, storm water and firewater drainage are segregated from contaminated water through the minimisation of paved areas and use of rain shelters. Gravity drainage is also used wherever practicable.

Handling and Disposal of Chemicals

9.7.102 There are a number of chemicals utilised within the facility that cannot be discharged to the site outfall (see Table 9C-29). There is no site wide chemical drainage and all chemical drainage and spills are to be contained locally for off-site disposal. Drainage of small volumes from equipment for maintenance shall be to containers/drums and be disposed of appropriately off-site.

9.7.103 Areas for chemical injection packages and storage tanks shall be paved and kerbed/bunded to ensure that spillages and leaks from chemical dosing packages and associated intermediate storage tanks can always be contained. To minimise rainwater collection where practicable and safe to do so these chemical injection packages and intermediate storage tanks shall be located indoors or be provided with a rain shelter if outdoors.

Table 9C-29: Chemical injection packages and intermediate storage tanks (day tanks) anticipated to be used by the Proposed Development

Power Plant Area	Capture Plant Area	Water Treatment Plant Area	Cooling Tower Area
Ammonia Phosphate Oxygen scavenger	Sodium hydroxide	Biocide Anti-scalant Sodium meta-bisulphate Sulphuric acid Sodium hydroxide Phosphoric acid Polyelectrolyte Molasses	Biocide Bio-dispersant Corrosion inhibitor

9.7.104 Any chemical spillages that might occur on hard standing in the kerbed/bunded areas will be manually cleaned up and disposed of off-site in accordance with the operational sites Environmental Management System (EMS).

9.7.105 Road vehicle unloading shall be within kerbed/bunded areas with controlled discharge which shall be arranged to provide the capacity to contain accidental release of a full tanker. Each area shall be provided with a small air-driven pump to allow clean stormwater that may build up within the bunded areas to be pumped away to a Potentially Contaminated Surface Water (PCSW) drainage system, described later on in this section.

9.7.106 Pumps handling fluids with the potential to contaminate which are not located within a bunded area shall be provided with a drip tray that is routed via a tundish to a local sump.

Open Drainage System

9.7.107 The open drain collection systems within the facility have two routes for disposal, either 1) via the existing or new site outfall to Tees Bay; or 2) via vacuum truck for off-site disposal at a suitably licensed waste facility. Only uncontaminated surface run-off free from any elevated levels of chemical or particulate pollutants when compared to what might be expected in normal surface water runoff (i.e. 'clean'), will be discharged directly to Tees Bay (via a SuDS treatment train). Chemicals, such as amine and diesel shall be contained within bunded areas and disposed of off-site to a suitably licensed waste facility via vacuum truck. The open drainage system will be designed to manage:

- Clean surface water runoff;
- Potentially contaminated surface water runoff;
- Power plant surface water drainage;
- Carbon plant area surface water drainage;

- Common utilities area surface water drainage;
- Diesel generator, tankage area and central chemical storage area;
- Surface water drainage; and
- Firewater run-off collection.

9.7.108 A Surface Water Maintenance and Management Plan will be provided with the Final CEMP detailing the requirements of access and frequency for maintaining the different SuDS and surface water features proposed on the Site. The maintenance regime must be properly implemented to ensure all treatment measures and processes operate as intended for the lifetime of the Proposed Development, and to avoid issues such as blockages which could lead to flooding.

9.7.109 The maintenance required for SuDS and drainage networks will be based on standard guidance and practice. Requirements for maintenance and management of vegetated drainage systems (e.g. ponds) are described in The SuDS Manual (CIRIA, 2015a) and DMRB CD532 (Highways Agency, 2020). Furthermore, it is expected that silt / oil alarms will be fitted on all interceptors and water storage facilities to alert operators when they require emptying. The drainage strategy should also outline the consequences for the drainage system should the Proposed Development close or be decommissioned.

Amine Drainage Systems

9.7.110 Amine utilised in the Capture Plant shall not be discharged to any open drain systems or to the outfall to Tees Bay. Disposal of degraded amine will be via vacuum tanker and off-site disposal at a suitably permitted waste facility.

9.7.111 Surface water run-off from uncovered external paved areas containing amine equipment, which during normal operation is expected to result in chemical drips, leaks and minor spill and which could be contaminated, shall be located within minimised local kerbed areas and be routed to the amine drain vessel.

Foul Water Drainage

9.7.112 Sanitary waste from welfare facilities in the administration and control building, workshop and warehouse building and gatehouse will be drained via conventional foul sewer sumps and be pumped off-site to the Northumbrian Water foul sewer connection for treatment at Marske-by-the-Sea WwTW.

9.7.113 The Teesmouth & Cleveland Coast SPA/Ramsar catchment was listed by Natural England in March 2022 as a catchment within which new developments would be expected to demonstrate nutrient neutrality in order to address eutrophication in the habitats site. However, this does not include foul wastewater from places of employment as it is assumed that workers likely live in the catchment and thus any wastewater produced is already part of the catchments base loading.

9.7.114 Regardless of above, foul wastewater from the Proposed Development when in operation will discharge to Marske-by-the-Sea WwTW, which is located further along the coast to the southeast where marine currents tend to be further to the southeast. This has been demonstrated by simple drogue modelling of releases from the WwTW outfall. This modelling indicates that there is a shallow bathymetric feature to the west of the Marske-by-the-Sea outfall which effects the currents. As a result, the net drift of effluent from the WwTW over a tidal cycle is towards the east for both neap and spring tides, whereas the SPA/Ramsar site is to the northwest. As such, there would be no increase in nutrient loading to the Teesmouth and Cleveland Coast SPA/Ramsar relating to foul water from the Proposed Development.

Process Water Drainage

9.7.115 Process waste waters may be generated on Site from various activities, notably those described below:

- Turbines;
- Heat recovery steam generator;
- Heat recovery steam generator blowdown;
- Direct contact cooler (dcc) blowdown;
- Compression and dehydration water; and
- Cooling tower blowdown.

9.7.116 Cooling water and some process water that is suitable for direct discharge from the Proposed Development will be emitted to Tees Bay via the new pipeline and outfall. Process water from the Carbon Capture and Storage Plan (DCC Blowdown) that may contain high levels of ammonia will be directed to the adjacent Bran Sands WwTW via a pipeline for treatment to an appropriate standard, and from where it will be discharged to the Dabholm Gut. However, a volume of final treated effluent equivalent to the load of nitrogen in the original flow to Bran Sands WwTW from the Proposed Development will be returned for discharge to Tees Bay via the new pipeline. There remains the possibility that further on-site treatment could be provided if it is required by the Environment Agency before cooling water and process water is discharged to Tees Bay. The need for this can be informed by further water quality modelling on the final effluent parameters post-FEED. This principally relates to the potential impact of DIN in the discharges from the Proposed Development. Therefore, the DCO will include a requirement for a Nutrient Nitrogen Safeguarding Scheme to be prepared before any part of the authorised development other than the permitted preliminary works can commence.

9.7.117 It is anticipated that the wastewater environmental regulatory emission limit values (ELVs) that apply within the Environmental Permit shall be in-line with the target Best Available Technology (BAT) Associated Emission Levels (AELs) from wastewater treatment plants treating effluent from chemicals sites, or processes as identified within the BAT Reference Document for Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector (2016) (otherwise known as the CWW BREF) and its associated BAT Conclusions document. If the project Environmental Risk Assessment shows that significant impact could occur with the plant discharging at the BAT-AEL concentrations, tighter emission limits could subsequently be applied.

9.7.118 Following treatment, process water that is to be directed to the outfall would flow via the outfall retention pond upstream of the outfall to Tees Bay. The retention pond would provide sufficient residence time to allow equalisation and for operators to take action should water quality deteriorate.

Management of Hazardous Substances on Site

9.7.119 The use of the chemical products at the Site will follow the product specific environmental guidelines, as well as the legislative requirements set out in the Control of Substances Hazardous to Health Regulations (COSHH (2002) and Control of Major Accident Hazards (COMAH) Regulations (2015).

9.7.120 A site Emergency Response Plan (prepared for Regulation 9 of the COMAH Regulations) will be in place for dealing with emergency situations involving loss of containment of hazardous substances. This will detail how to contain and control incidents to minimise the effects and limit danger to persons, the environment and property. As described above, all aspects of the drainage system that have the potential to receive contaminants include containment provision to contain chemical spillage on Site and upstream the site outfall to Tees Bay.

9.7.121 Further guidance to be consulted in development of the site Emergency Response Plan will include:

- HS(G)191 Emergency planning for major accidents. Control of Major Accident Hazards Regulations 1999 (Health and Safety Executive, 1999);
- HS(G)71 Chemical warehousing: the storage of packaged dangerous substances (Health and Safety Executive, 1992); and
- BS 5908: Fire and explosion precautions at premises handling flammable gases, liquids and dusts. Code of practice for precautions against fire and explosion in chemical plants, chemical storage and similar premises (British Standards Institute, 1990).

9.7.122 All products are to be labelled with their hazard ratings so that the user is aware of any potential risks to the environment. Provided they follow the label instructions, the risks are well controlled. Only well trained, certificated and staff experienced in the use of the various chemical products will be allowed access.

Water Demand

9.7.123 There is a significant clean water requirement for the Proposed Development comprising:

- Cooling water make-up;
- Fire water;
- Utility stations;
- Boiler feed water make-up; and
- Amine solution make-up.

9.7.124 Water will be supplied by Northumbrian Water for the Proposed Development. The Proposed Development will include a WTP for treated water and demineralised water.

Tees Coastal Waterbody

Surface Water Routine Runoff and Accidental Spillages

9.7.125 The Proposed Development is an industrial site with constant use of a range of fuels, oils and other chemicals. There is potential for these to be mobilised by surface water runoff and to discharge into the Tees Coastal waterbody via the new drainage pipeline and outfall. Surface water runoff may therefore contain a range of pollutants that could lead to chronic adverse impacts on the receiving watercourses in terms of their physicochemical and ecological status, although it should be noted that there is a large capacity for dilution and dispersal in this water body. There is also a risk that a significant chemical spillage or pollution incident occurs on the Site, thereby impacting the Tees Coastal water body.

9.7.126 These potential impacts are proposed to be managed and treated by appropriate measures as summarised in 'Operation Phase Mitigation' above. All potentially contaminated surface water runoff is to be discharged to a balancing pond prior to oily water treatment using an oil interceptor, and then discharged to the Tees Bay outfall via a further retention pond. A SuDS CIRIA C753 SuDS Manual Simple Index Assessment of the treatment train is provided in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2). This indicates that the assessment does not currently pass due to proprietary treatment systems such as oil interceptors not being considered within the Simple Index Assessment as the performance varies between available products. However, provided that a product with sufficient treatment potential is selected in consultation with the Environment Agency and LLFA, then the treatment train will be suitable to avoid adverse water quality impacts to Tees Coastal waterbody, and hence subsequent effects on ecological receptors.

9.7.127 A Surface Water Maintenance and Management Plan will be prepared during the detailed design phase to describes the requirements for access and frequency for maintaining drainage infrastructure proposed on the Site. The maintenance regime must be fully implemented throughout the lifetime of the Proposed Development to avoid issues such as blockages which could lead to flooding, or failure of the spillage containment and pollution prevention systems.

9.7.128 Provisions for dealing with chemical spillages and firewater include kerbed / bunded areas, valves, sluices and interception sumps for isolating spillages or contaminated water. Water quality monitoring will be regularly undertaken by the site's Operator confirm the quality of any water in bunded areas, sumps or tanks to ensure that it is suitable for discharge from the site to the Tees Bay, or otherwise is taken by tanker for off-site disposal at a suitably licenced waste water facility. An Emergency Response Plan would also be prepared and implemented as part of the sites EMS. Should any spillage occur that results in the pollution of Controlled Waters, then the Environment Agency would immediately be informed, or Northumbrian Water should it impact the foul water system. Further details regarding the surface water drainage system are outlined above under 'Operation Phase Mitigation'.

9.7.129 Given that the Drainage Strategy will have to meet standards required by the Environmental Permit (with an associated Environment Agency H1 Risk

Assessment) and the expected local policy requirements, and that measures are in place for dealing with spillages and firewater and for treating regular surface water runoff, then a negligible impact is predicted to the Tees Coastal water body during operation. As such, no deterioration in any WFD element or prevention of future improvement is predicted from surface water runoff or chemical spillages.

Impacts of Process Discharges

Cooling Water System – Impacts of Thermal Discharges

9.7.130 Cooling water from the PCC will discharge to the Tees Coastal waterbody under an Environmental Permit. If water is not sufficiently cooled it could create a thermal barrier to fish passage, especially salmon and lamprey, and have other environmental consequences on the designated coastal sites in terms of ecosystem dynamics and assemblages.

9.7.131 To better understand the consequences of this discharge of cooling water, near-field thermal discharge modelling and assessment has been undertaken (see Annex G Net Zero Teesside - Water Quality Assessment, Intermediate Design Stage - Discharge Option (2022) (henceforth referred to as the 'modelling report).

9.7.132 The set-up for the near-field modelling, including the ambient conditions at proposed new outfall location, the key characteristics of the effluent water body, the geometrics of the discharge point, and the results of the sensitivity analysis is discussed in full detail within the modelling report presented in Annex G. This is a revised version of the thermal modelling originally submitted as Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref 6.4) of the DCO. This assessment was based on an early design stage and assumed a very worst case effluent flow and temperature of 1.37 m^3/s and 30ºC. This assessment has now been superseded and the results have been presented to Natural England and the Environment Agency in meetings in October 2022.

9.7.133 The new modelling assessment is based on more refined scheme information and assesses just the new outfall option only (as further assessment of the current outfall has now confirmed that its use would not be efficient or desirable from a hydraulic perspective). However, as the scheme is still in the front end engineering design stage (FEED) into watercourses, there remains the possibility of changes to the current effluent flow, temperature and quality estimates. For this reason the current modelling report is 'intermediate' and a final assessment will need to be undertaken at a later design stage post-DCO consent. This final assessment will be secured through a requirement in the DCO. To account for this uncertainty at this stage, the modelling report has adopted reasonable worst case parameters and thus is considered conservative. The Environment Agency and Natural England have been consulted on the modelling approach.

9.7.134 Near-field modelling to assess the potential for thermal impacts on the Tees Coastal waterbody have been assessed using CORMIX software. The results are presented in terms of the distance from the outfall over which temperature in the mixing zone falls to less than 3ºC above the ambient temperature. Summer and winter seasons were considered, as well as low/high tide, and maximum and minimum current velocities.

9.7.135 Mixing zone plumes in CORMIX are modelled over different stages; the stages relevant for this outfall are an initial period of mixing as effluent rises vertically and is deflected laterally by momentum and ambient currents (the rising stage) and the later period of mixing when the plume reaches the water surface and spreads laterally (the surface spreading stage). Dilution occurs during the rising stage due to turbulent mixing and entrainment of ambient water, while dilution during the surface spreading stage is more dominated by diffusion of the plume into the large ambient water volume. Further details of the modelling assumptions regarding currents and the operation of the proposed diffuser head are provided in the modelling report in Annex G.

9.7.136 For discharges at low tide, high tide and maximum current velocities vigorous lateral mixing means that the EQS value is met immediately on discharge. The temperature EQS is met within the vertical rising stage during minimum current conditions (i.e. less than 0.5 m from the outfall and vertically within 3.4 m in summer and 6.5 m in winter). This would be seen as three extremely narrow areas of elevated concentration extending away from the outfall. Overall, the near-field mixing zone for temperature is extremely small.

9.7.137 Sea temperature changes are discussed in full detail within Chapter 14: Marine Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2); this includes potential changes to the marine environment surrounding the outfall and associated effects on receptors.

9.7.138 With regards to marine plankton, given the highly limited predicted extent of the thermal plume and the apparent degree of mixing, it is unlikely that the planktonic community would be exposed to a temperature increase that would affect their metabolic rate or productivity, even within the immediate vicinity of the treated water outfall. Any effect is therefore unlikely to impact the wider abundance and diversity of plankton communities and is considered to have a negligible impact, especially at the water body level.

9.7.139 With regard to intertidal habitats and communities, the intertidal area within the vicinity of the discharge outfall is known to support a low abundance and diversity of macrofauna with few species of macroalgae present. All intertidal habitats and associated communities within the footprint of the thermal plume are considered to be highly resistant and resilient to local temperature increases (see Chapter 14: Marine Ecology and Nature Conservation, ES Volume I, Document Ref.6.2). There is predicted to be limited interaction between the small thermal plume and intertidal habitats and so the magnitude of impact is predicted to be negligible and highly localised, especially at the water body level.

9.7.140 Subtidal organisms are naturally less adapted to wide fluctuations or increases in temperature than those in intertidal communities, and as a result are possibly more susceptible to the effects of thermal stress. However, the thermal plume has been shown to be very localised, and thermal effluent generated by the Proposed Development will be naturally buoyant (due to lower salinity and the lower density of warmer water) and therefore the footprint of the thermal plume on the seabed will likely be further reduced. Given sensitivity of habitats and species known to be present (dominated by

Fabulina fabula and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'), discharge of thermal effluents during operations of the Proposed Development is not predicted to have any discernible impact on the subtidal habitats and the abundance, distribution and diversity of associated species beyond the immediate vicinity of the outfall. The magnitude of impact is therefore predicted to be negligible and highly localised, especially at the water body level.

9.7.141 The exposure of fish and shellfish (namely demersal life stages and species such as sandeels) to the thermal plume is unlikely to result in changes to communities in terms of abundance and diversity. The thermal plume is spatially very limited and is not predicted to affect the reproductive success of fish species of conservation and / or commercial importance nor would it represent a barrier to migratory species (which can also avoid areas of unfavourable conditions), and so a negligible impact on fish is expected.

9.7.142 Direct effects to marine mammals from the discharge of thermal effluent, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be insignificant. Refer to Chapter 14: Marine Ecology and Nature Conservation (ES Volume I, Document Ref.6.2) for further details. As such, no impact on designated sites is predicted.

9.7.143 Finally, in terms of INNS, during baseline surveys, wakame (*Undaria pinnatifida*) was reported as the only INNS currently known to be present and growing within the Study Area. This intertidal macroalgae is a species of kelp which originates from Japan. Due to its rapid growth rate, it is known to outcompete native species within rocky reef habitats (GB NNSS, nd.).

9.7.144 The growth of wakame is stimulated by reduced rather than increased temperatures with persistent colder conditions below 15°C promoting recruitment and growth. Thus, cooling water system operations are not predicted to exacerbate growth of this species within the vicinity of the Proposed Development, especially given the very localised impact around the outfall and the large area of the waterbody (c 88 km^2).

9.7.145 It is possible that some INNS which are present in the surrounding waters, that are adapted to warmer water, could become established in the vicinity of the treated water outfall during operation. The baseline for non-native species will continue to evolve during the construction phase and therefore it is not possible to accurately predict the species that could become established.

9.7.146 Overall, the risk that thermal discharge from the Proposed Development could facilitate introduction and spread of INNS during operation is considered to be low. The effect on native habitats and species from the establishment of non-natives linked to the thermal plume is therefore predicted to not be significant.

9.7.147 Given the above assessment, no deterioration or prevention of future improvement of the Tees Coastal WFD water body is predicted in relation to discharge of water from the cooling water system.

Chemical Impacts from Process Wastewater Discharge

9.7.148 There is potential for physico-chemical water quality impacts on the Tees Bay coastal water body from discharges of cooling water and treated process water from the proposed new Tees Bay outfall as follows:

- Cooling Tower Blowdown Water: a supply of untreated raw water abstracted upstream of the tidal limit on the River Tees by Northumbrian Water Limited (NWL) will be supplied to the site via NWL's pipeline network. This supply will be used as cooling water in the power station, after which a portion of the used cooling water is discharged as blowdown. The blowdown will be discharged as effluent to Tees Bay.
- Filter Reject Water: prior to use in the cooling system, the untreated raw water from the River Tees will be filtered on site. An allowance of 10% water loss at this stage has been allowed for, with the rejected water directed to the Tees Bay outfall.
- Process Water: CO_2 compression and dehydration produces a small amount of water which will be diluted and neutralised prior to discharge.
- Condensed Water: A small amount of additional effluent will be generated on site as steam condensate ("Condensed Water") and will also be discharged to Tees Bay.
- HRSG Blowdown: a small quantity of ammonia containing blowdown water from the HRSG will be discharged directly to Tees Bay.
- Return Flows: Some wastewater produced on site within the Carbon Capture and Storage plant (Direct Contact Cooler (DCC) Blowdown) will contain significant concentrations of ammonia and will be routed to Bran Sands WwTW for treatment. Bran Sands WwTW discharges to Dabholm Gut; in order to preserve nutrient neutrality within the Gut (and the River Tees downstream) water will be returned to the NZT site from Bran Sands WwTW at an agreed rate ("Return Flows") for discharge to Tees Bay via the new outfall.
- Surface Water Runoff: surface water runoff from the NZT site will be collected and discharged to Tees Bay via on-site attenuation storage facilities. Where there is the potential for hydrocarbon contamination, surface water from the redeveloped site will be routed through oil interceptors.

9.7.149 The origin of the Cooling Tower Blowdown Water is untreated raw water from the River Tees and contains contaminants typical of a large lowland river draining a diverse catchment with extensive farming and industrial use including DIN. Abstracting and discharging this water could be considered maintaining the status quo, as without the abstraction these contaminants would remain in the flow and likely find their way to the estuary and then the sea. However, these contaminants can be concentrated by up to five times by the on-site processes and this should be considered.

9.7.150 The Condensed Water flows are significantly smaller than the Cooling Tower Blowdown Water flows but this water may contain concentrations of ammonia up to 5 mg/l.

9.7.151 Some additional effluent will be generated within the DCC (blowdown) that may contain high levels of ammonia and this will be treated at NWL's existing Bran Sands WwTW before being discharged to the Tees Estuary via the Dabholm Gut (with a return flow of final treated effluent from Bran Sands WwTW returned to the PCC site to an equivalent nitrogen load, for discharge to the Tees Coastal waterbody via the new outfall). The Return Flows from Bran Sands WwTW will also comprise treated wastewater and will have pollutant profiles typical of a large WwTW final treated effluent, including elevated nitrate concentrations. This may include dissolved organic nitrogen or particulate nitrogen but the return of this effluent from Bran Sands and discharge to Tees Bay will merely divert this effluent from the estuary (as at present) to the bay.

9.7.152 To investigate potential water quality impacts to Tees Coastal WFD waterbody, near-field and far-field effluent discharge modelling has been undertaken and is described in full in Annex G (water quality modelling assessment). For the near-field modelling, scenarios considered include summer and winter seasons, high/low tide, and maximum and minimum current velocities. The beneficial effects of surface water cooling the water from the cooling system or diluting process effluent is also considered. Far-field modelling was undertaken for DIN only and expressed as the percentage change in average ambient concentrations (across the monitored period for DIN between November and February) and duration of EQS exceedance. For both the modelled impact is illustrated for different depths in the water column. The benefit of dilution from the inclusion of surface water runoff is also modelled.

Application of WFD Standards

9.7.153 The EQS for DIN need to be normalised for a specific salinity. AECOM has considered background Environment Agency salinity data for the Tees Transitional and the Tees Coastal water bodies, and both are considered 'coastal' in this respect, and thus the same standards apply. Based on our analysis the EQS maxima (i.e. 99th percentile for the winter monitoring period) are as follows:

- High status = less than 0.168 mg/l
- Good status = 0.168-0.252 mg/l
- Moderate status = 0.252-0.378 mg/l
- Poor status = 0.378-0.567 mg/l
- Bad status = above 0.567 mg/l

9.7.154 Based on this analysis, the current DIN status for the Tees Transitional water body would be Poor (average ambient value from Environment Agency monitoring as reported in the water quality modelling report presented in Annex G is 0.5 mg/l). There is no routine background monitoring of DIN by the Environment Agency for the Tees Coastal water body and thus no status class to report.

Near-field Water Quality Modelling

9.7.155 Only effluent parameters with concentrations above EQS standards and ambient conditions were modelled (namely chromium VI, copper, zinc, un-ionised ammonia and DIN), as the others would not risk exceeding the EQS in Tees Bay. Near-field modelling was shown to be sufficient for determining mixing zones for all effluent parameters tested with the exception of DIN, for which far-field modelling was required.

9.7.156 With reference to the modelling report in Annex G, the results of the near-field modelling of chemicals present in effluent above the EQS and ambient concentrations show that EQS values for all substances are met within the plume rising stage for low tide, high tide and maximum current conditions. EQS values for all substances except chromium (VI) are met immediately after discharge during the high tide and maximum current conditions and are met extremely close to the outfall for chromium (VI). EQS values for copper and unionised ammonia are met within the vertical rising stage during minimum current conditions and EQS values for chromium (VI) and zinc are met during the lateral spreading stage. This would be seen as three extremely narrow areas of elevated concentration extending away from the outfall. The near field mixing zone for unionised ammonia and metals are all extremely small. When surface water runoff is mixed with the discharge effluent there is increased dilution and the mixing zone decreases.

9.7.157 The near-field water quality modelling indicates that none of the modelled chemical parameters would create sufficiently sized mixing zones that would cause deterioration or prevention of future improvement in any WFD classification elements for the waterbody, especially at the water body level.

Far-field Water Quality Modelling

9.7.158 The far-field water quality monitoring results for DIN are as follows (see also Figure 9-5):

- The average impact of the effluent discharge over the tidal cycle is to increase DIN concentrations in a small part of the Tees Bay by up to 10% around the outfall and by 1-5% in the wider area. There are no areas of significant size which show exceedances of the EQS as an average condition over the tidal cycle.
- For the maximum increase over the tidal cycle the EQS around the outfall in Tees Bay is predicted to be exceeded, however, the duration of EQS exceedance at any given location around the outfall is short due to the rotating and reversing current directions over the tidal cycle. The duration is typically limited to 0.25 to 2 hours per day and effects an area approximately 2.7 km^2 within the bottom 10% of the water column (in the context of an 88 km^2 water body this is just 3% and 0% at the surface) but not at the surface. When surface water runoff is included, the added dilution significantly reduces the spatial area affected (within the bottom 10% of the water column).
- The duration over which concentrations of DIN are increased by more than 1% have been calculated and show that DIN concentrations within the Tees Estuary are increased over approximately half of the tidal cycle,

on the flood tide only. These results also show that areas away from the immediate coastline of Tees Bay experience an increase in DIN concentration of more than 1% for less than 10 hours per day, with areas north of Tees Mouth showing this increase for less than 2 hours per day.

9.7.159 Some increase in average DIN concentrations is expected throughout the water column over a wider area. However, the extent of EQS breaches is spatially limited in terms of extent and duration, noting that this does not occur at the surface. It is also worth noting that there is little ambient DIN data for the Tees Coastal waterbody and the Environment Agency currently do not monitor DIN, thus there is no status class against which compliance can be judged. The nearest DIN data to the proposed outfalls are from Teesmouth, within the Tees Transitional WFD waterbody. This data has been used as a proxy for ambient conditions in Tees Bay in the model but is a worst case scenario as it could reasonably be expected that DIN concentrations are higher in the estuary than at Tees Bay given the many industrial inputs to the former. This higher ambient concentration would lead to modelled mixing zones being larger in the model than is actually the case.

9.7.160 Unlike the intertidal mudflats of the estuary (e.g. Seal Sands) surveys undertaken for the Proposed Development indicate that the intertidal sandflats of the open bay have low macro-algal diversity and abundance. Wakame (*Undaria pinnatifida*) was reported as the only INNS currently known to be present and growing within the Study Area. This is most likely due to a combination of increased exposure to wave action and storms, as some degree of shelter is required to help mats form, and the much greater mixing that is available in the bay compared to the estuary. Algae mats are generally much more likely to form in estuarine environments where nutrients are already high, with less mixing and with multiple source inputs of nitrogen. As stated, there is little data on existing DIN for the bay as the Environment Agency do not monitor this parameter in the bay; however, the low macro-algal abundance despite existing nitrogen levels in the bay indicates that the Proposed Development will not change the low risk of algal accumulation in the intertidal zone of Coatham Sands.

Impact on Protected Areas

9.7.161 In light of no status class for DIN, ensuring that the Proposed Development is compliant with the conservation objectives of Protected Areas is perhaps given added weight. Marine water clarity can be affected by pollution (such as by nutrients, including DIN, causing plankton blooms in the water column) spatial differences in water turbidity can have both negative effects (obscuring prey from the predator) and positive effects (making it less likely the prey detect the predator and increasing food for prey drawing more of them to the surface). Holbech *et. al*. (2018) found that water clarity had no effect on prey capture success by common terns, while Econ (2014) suggests turbid waters may be an essential prerequisite for foraging little terns.

9.7.162 Given the major role of physical and biological (competition) factors in influencing predation behaviour and success, the variability in some of these factors, and the 9,000 ha size of the designated part of Tees Bay compared to the population of terns (approximately 480 pairs based on the Defra departmental brief at the time the SPA was extended into the marine environment), it is considered unlikely that an increase in dissolved inorganic nitrogen to the Tees Bay as a result of the Proposed Development would materially affect its ability to provide adequate sustenance to maintain the tern populations.

Surface Water Runoff

9.7.163 The Proposed Development includes an outfall retention pond upstream of the outfall to Tees Bay. The retention pond would provide a minimum of eight hours residence time to allow equalisation and for operators to take action should water quality deteriorate. Water sampling facilities are to be provided for manual sampling of water prior to discharge. The frequency of testing and parameters to be tested will be agreed with the permitting authority. In situ continuous monitoring of flow, temperature, total organic carbon (TOC), conductivity and pH measurement shall also be undertaken. The Proposed Development will have an Environmental Management System (EMS) defining how to deal with any chemical spillages that may occur.

Summary

9.7.164 Given the modelling assessment summarised above and presented in Annex G, the potential for adverse effects to marine water quality is considered to be minor and localised, and not significant at the water body scale. Furthermore, no detectable effects to marine species or habitats are predicted, nor to biodiversity or the conservation objectives for any marine species or designated site. The discharged effluent from the Proposed Development will also require a Water Activity Permit (i.e. a consent from the Environment Agency to discharge), at which point it is expected that final effluent quality parameters will be known so that final water quality modelling can be undertake. There also remains the possibility that further on-site treatment could be provided if it is required by the Environment Agency before cooling water and process water is discharged to Tees Bay. The draft DCO has also been amended to include a requirement for an Effluent Nutrient Nitrogen safeguarding scheme to be prepared before any part of the authorised development other than the permitted preliminary works may commence.

Foul Water Discharge

9.7.165 Sewage and sanitary waste from the Proposed Development will be sent off-site via pipeline connecting to the local Northumbrian Water treatment plant (WwTW) at Marske-on-Sea, which discharges to Tees Bay in line with the conditions of an Environmental Permit. Given the small volumes required to be treated (i.e. foul water would only be from the administration and control building, workshop and warehouse building and gatehouse) it has been assumed that Northumbrian Water will treat foul water prior to discharge to Tees Bay in accordance with requirements to not cause deterioration or prevent improvement under the WFD. Further consultation with Northumbrian Water will be undertaken as the Proposed Development is progressed. Given that the discharge from wastewater treatment works is tightly regulated, no deterioration or prevention of future improvement in any WFD element for the Tees Bay water body is predicted. Furthermore, hydrodynamic modelling has indicated that effluent discharged from the

Marske-on-Sea WwTW would predominantly propagate to the east over neap and spring tides, and so would not interact with the Teesmouth and Cleveland Coast Ramsar/SPA habitat site (located to the north-west of the WwTW). There are therefore no requirements to demonstrate nutrient neutrality for this discharge.

Morphological Impacts

9.7.166 If the existing outfall to Tees Coastal waterbody cannot be used unchanged, then a new water discharge pipeline and outfall head will need to be installed, as described above. The new outfall would consist of a pipeline and diffuser head weighed down with rock armour.

9.7.167 An obstruction on the seabed, such as a new diffuser head, has the potential to induce localised scouring of the seabed. This is likely to occur quite rapidly leading to the development of a 'scour pit,' which will then be subject to ongoing, smaller-scale erosion/accretion in response to the natural tidal and wave processes. However, the risk will depend on the nature of the shallow bed substrate and whether this consists of sand (which will settle quickly), consolidated clay (which is resistant to erosion), or unconsolidated fine sediments that are easy to erode. Appropriate scour protection would be installed to minimise this impact around the diffuser head, which would be very localised and is not anticipated to have any adverse impact on WFD objectives for the water body. Indeed, the maximum size of the outfall head and associated scour protection would be 100 m^2, which is small at the scale of the WFD waterbody which is 88 km^2 in area.

Atmospheric Deposition Impacts

9.7.168 Deposition of air pollutants released from point source aerial emissions can be deposited into the marine environment either by wet or dry deposition processes. Deposition of air pollutants, particularly nitrogen and sulphur compounds can cause direct disturbance to marine habitats and species through acidification.

9.7.169 The air quality assessment (see Chapter 8: Air Quality, ES Volume I, Document Ref.6.2) has identified a potential air quality impact on coastal habitats including sand dune and saltmarsh habitat for which the Teesmouth and Cleveland Coast Ramsar and SSSI and the Teesmouth NNR are designated and which support the interest features of the SPA. A formal assessment of effects to these habitats and designated sites has been made in Chapter 12: Terrestrial Ecology and Nature Conservation (ES, Volume I). This assessment concluded a significant (major adverse) effect to sand dune and saltmarsh habitats. Consequently, there is considered potential for the deposition of air pollutants to effect other intertidal habitats (e.g. mudflats) and species, as well as fish species which may depend on these for specific functions (e.g. nursery grounds).

9.7.170 Further assessment into the impact of atmospheric deposition on the marine environment, shows that nitrogen deposition from the Proposed Development will be at its peak in the area of Coatham Sands. This encompasses the intertidal mudflats and sandflats in the marine environment within this area. Despite this, the hydrodynamic conditions and the open nature of the coastline mean that this area is subject to frequent tidal washing. This will facilitate the rapid dispersion of nitrogen deposits and therefore the potential for effects to intertidal habitats is considered to be negligible.

9.7.171 An assessment of atmospheric deposition on the single remaining open water pond within Coatham Dunes (see Annex E) was undertaken, which falls within the Tees Coastal WFD catchment. Pond 14 is within the Teesmouth and Cleveland Coast SSSI and the Teesmouth and Cleveland Coast SPA designations. The Coatham Sands waterbodies and dune slacks provide habitat for bird populations, particularly redshank (*Tringa totanus*), who move inland to open water at high tide. Site survey has indicated that Pond 14 is the only water body remaining in the Coatham Sands dunes complex that has not succeeded to a fully vegetated wetland state, and therefore has particular importance as the sole area of open water habitat within the dunes.

9.7.172 The assessment indicates that the contribution of the Proposed Development to atmospheric oxides of nitrogen (NOx) concentrations and ammonia (NH3) concentrations will exceed 1% of the critical level at Teesmouth and Cleveland Coast SPA. However, at no point will total NOx or ammonia concentrations exceed the critical level at the SPA, even with the Proposed Development. The highest Predicted Environmental Concentration (i.e. the baseline, plus the Proposed Development and any other relevant projects expected over the same timetable) reported in Appendix 8B: Operations (ES, Volume III) for NOx is <70% of the critical level at the Teesmouth and Cleveland Coast SPA, while that for ammonia is equivalent to 23% of the critical level.

9.7.173 Since the critical levels will not be exceeded, the only effect that may arise is through the role of NOx and NH_3 in nitrogen deposition rather than through direct effects of the pollutants in the atmosphere.

9.7.174 The nitrogen deposition isopleths for the stack emissions from the Power and Capture plant reported in Appendix 8B: Operational Phase (ES Volume III, Document Ref.6.4) show that there will be an additional nitrogen deposition of approximately 0.36 kg N/ha/yr at the Teesmouth and Cleveland Coast SPA due to the Proposed Development alone, which occurs at the edge of Coatham Dunes. This would represent an additional deposition equivalent to 3.6% of the critical nitrogen load for the broad habitat contained therein (as identified on UK Air Pollution Information System (APIS) – calcareous fixed dunes with a minimum critical load of 10 kgN/ha/yr; a similar critical load applies to the reeds that are present within the open pool, although the open water itself has no critical load on APIS). A 3.6% change in nitrogen deposition is a 'small' dose (typically defined as a dose of between 1% and 5% of the critical load). The predicted nitrogen dose to the SSSI from the Proposed Development is very modest when compared against historic doses from the former steelworks and there can be reasonable certainty that it would not undermine conservation objectives for the SPA (see further discussion in Chapter 12: Terrestrial Ecology and Nature Conservation (ES, Volume I, Document Ref. 6.2)). Moreover, the birds that use these dunes and pools within the SPA / Ramsar (redshank) are noted on APIS as not being sensitive to atmospheric nitrogen deposition.

9.7.175 Furthermore, water quality monitoring of Pond 14 between October 2020 and January 2021 indicates a maximum total nitrogen concentration value of 1.6 mg/l (6 January 2021). This is variable over relatively short time scales with total nitrogen having been below the laboratory limits of detection on three of eight sampling visits (i.e. <0.5 mg/l on 22 October 2020). Based on the maximum recorded total nitrogen baseline value of 1.6 mg/l in Pond 14, deposition of 0.36 kg/N/ha/yr as a worst-case scenario would cause an increase in total nitrogen concentration to 1.78 mg/l after one year, for a hypothetical scenario with no other gains or losses of nitrogen. This is considered to be within the likely range of concentrations that would be observed in the pond over a year and would not be of detriment to the pond ecosystem.

9.7.176 Given the low level of enrichment of Pond 14, and the fact that the bird populations which utilise the pond are not sensitive to atmospheric deposition, then a negligible impact is considered appropriate for this waterbody.

9.7.177 The extent of impact of atmospheric nitrogen deposition at the Tees Coastal WFD waterbody scale has also been considered through a simple mass balance analysis, to determine whether there would be any potential for deterioration or prevention of future improvement. The analysis was based on the total nitrogen isopleth mapping from the air quality modelling outputs. This assumed a precautionary closed box system, with the maximum average total nitrogen deposition of 0.45 kg N/ha/yr (sourced from emissions of both NO_2 and NH_3) applied across the entire waterbody (>88 km^2) with an assumed precautionary average water depth of 8m.

9.7.178 Based on these assumptions the analysis indicated that the impact on nitrogen concentrations within the WFD waterbody would be insignificant with an increase of 0.009% total nitrogen per year. In reality, total nitrogen would be dispersed outside of the WFD water body and the highest nitrogen deposition rate would only apply to a very small area off Coatham Sands. As a simple analysis the results cannot be interpreted in absolute terms, but the predicted worst case increase is so small that there is confidence that atmospheric deposition of nitrogen is an insignificant issue, and no further water quality modelling of this issue is considered necessary. This was agreed with the Environment Agency at a meeting in April 2022.

9.7.179 Given the above analyses, there is no impact from atmospheric deposition predicted at the WFD catchment scale, nor on the status of the designated sites in which it is located.

Tees Transitional Waterbody (Tees Estuary)

9.7.180 The water discharge corridor for the Proposed Development includes a pipeline between the PCC Site and Brans Sands WwTW. This includes space for another parallel pipeline to convey final treated effluent from Bran Sands WwTW back towards the site for onward discharge to Tees Bay. This option has been included at the request of the Environment Agency as a potential replacement for the existing discharge from Bran Sands WwTW to Dabholm Gut, and which may incorporate waste from other sites in the area in the future. It also supports ensuring that the Proposed Development remains nutrient nitrogen neutrality in respect to the Tees Estuary.

9.7.181 In the original WFD assessment submitted with the DCO application potential operational phase water quality impacts on the Tees Transitional water body were scoped out. This was on the basis that it was believed that there would not be any influence of the discharge of cooling and process water from the new outfall into the bay back on the estuary. However, the revised water quality modelling as presented in Annex G now shows that under certain conditions an increase in DIN may occur in limited areas at depth within the dredged channel at the mouth of the estuary.

9.7.182 The far-field water quality monitoring results for DIN shows that there are small areas within the Tees Estuary at Tees Mouth, specifically in the dredged channel of the Tees, where average DIN concentrations increase (see Figure 9-5). However, this is limited mainly to less than a 1% increase over average ambient concentrations, and to less than 2.5% increase over average ambient concentrations at any location. Also, this effect is concentrated in the lower half of the water column of the dredged channel of the Tees Estuary and not at the location of the Seal Sands mudflats, where average DIN concentrations show a less than 1% increase above background. Furthermore, nutrient inputs appeared to Seal Sands appear to be blocked by the natural boundary surrounding that area.

9.7.183 As described earlier under the assessment for the Tees Coastal water body, the EQS for that water body and the Tees Transitional water body is the same. The extent of any area that may exceed the EQS is shown on Figure 9-3 and in the modelling report in Annex G. There is no exceedance of the EQS for DIN in the estuary and therefore no deterioration in the DIN parameter. This is based on an assessment of change against ambient water quality data, which our analysis shows would put DIN in the poor status class rather than the moderate class reported online.

9.7.184 The Project recognises the sensitivity of the Seal Sands area and its importance for designated features of the Teesmouth and Cleveland Coast SPA/Ramsar site, as well as the need to maintain nutrient neutrality. It is understood that the Seal Sands mudflats are currently exhibiting the effects of nutrient enrichment and are important for the designated features of the Teesmouth and Cleveland Coast SPA/Ramsar, the conservation objectives of which are an important consideration of WFD compliance. The annual load of nitrogen to Seal Sands has therefore been estimated in a Nutrient Nitrogen Briefing Paper (Document Reference 9.36) submitted to PINS at Deadline 9. This assessment concluded that on balance, the removal of nitrogen from the Tees Transitional water body by the new abstraction of water for the cooling system would be greater than that which might spill back into the estuary mouth and affect Seal Sands (i.e. the net effect would be a reduction in nitrogen supply via a water source to Seal Sands). Consequently, it is considered that there would be no adverse effect on the integrity of the Teesmouth and Cleveland Coast SPA/Ramsar site due to nutrient nitrogen discharges to the Tees Estuary.

9.7.185 In addition, to maintain nutrient neutrality in the estuary and the Teesmouth and Cleveland Coast SPA/Ramsar, the Proposed Development proposes to redirect to Tees Bay final treated effluent containing an equivalent load of nitrogen away from Dabholm Gut (i.e. a return flow of final treated effluent from Bran Sands WwTW that would otherwise be discharged to the Dabholm Gut equivalent to the amount of nitrogen in process water sent to Bran Sands by the Proposed Development would be discharged to the bay). This will be subject to obtaining an Environmental Permit from the Environment Agency.

9.7.186 Finally, there will be use of existing pipe bridges over tributaries of the waterbody, but all operational surface water runoff and process water discharges are directed to the Tees Coastal water body. As such, the Proposed Development would be compliant with all WFD objectives for this water body.

Tees Estuary (S Bank) Water body (The Fleet)

9.7.187 No operational impacts are predicted to this water body given that it does not have any direct hydrological connection to the Proposed Development. There will be pipe bridges over the watercourse, but all operational surface water runoff and process water discharges are directed to the Tees Coastal water body. As such, the Proposed Development would be compliant with all WFD objectives for this water body.

Tees Mercia Mudstone & Redcar Mudstone groundwater body & Tees Sherwood Sandstone WFD groundwater body

9.7.188 All surface water runoff and treated process water from areas of hardstanding on the Proposed Development site will be discharged to Tees Bay including the use of attenuation ponds. There are no planned discharges to groundwater during operation. There is some potential for leaks, spillages and contamination from storage of chemicals and use of fuels that could affect groundwater. However, any fuel and chemical storage areas would be bunded as outlined in 'Operation Phase Mitigation' above to prevent spread of spillages and to allow rapid clean up and removal for off-site disposal. Given that the majority of spillages would be directed to the surface water drainage system (including treatment and isolation potential), and that storage areas would be adequately bunded, negligible impacts on these WFD groundwater bodies are predicted during operation of the Proposed Development. The Proposed Development would therefore be compliant with all WFD objectives for these water bodies.

Decommissioning

9.7.189 At the end of its design life decommissioning of the Proposed Development will see the removal of all above ground equipment down to ground level.

9.7.190 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. At this stage it is assumed that decommissioning impacts are expected to be limited and will be the same/similar to the construction impacts, as discussed above.

Mitigation Measures / Reasons for not Achieving Good Status Assessment

9.7.191 As discussed earlier, the Tees Transitional waterbody is already at target status, and although the Tees Coastal waterbody is not at target status, the parameters for not achieving that will not be affected by the Proposed

Development. Similarly, the Tees Sherwood Sandstone WFD groundwater body is also already at Good Ecological Potential. Thus, there is no requirement for a separate assessment against the WFD objective to do not prevent improvement. However, although no mitigation measures have been provided by the Environment Agency for the Tees Transitional, Tees Coastal and Tees Mercia Mudstone and Redcar Mudstone groundwater body, we have briefly considered the Proposed Development against the known pressures and reasons for not achieving Good Status/Potential that can be viewed on the Environment Agency's Catchment Data Explorer Website (see Table 9C-30 to Table 9C-32).

9.7.192 The Environment Agency has provided mitigation measures for the Tees Estuary (S Bank). An assessment has been made in Table 9C-30 regarding whether the Proposed Development has the potential to prevent implementation of these mitigation measures. It is concluded that the Proposed Development will not prevent implementation of any of these mitigation measures.

Table 9C- 30: Tees Coastal water body – assessment against reasons for not achieving Good Status and reasons for Deterioration

Classification element affected	Pressure Type	Activity	Appraisal
Mitigation Measures Assessment	Physical Modification	Local and Central Government / Sector under Investigation	It is proposed to use a replacement new pipeline and outfall head. The pipeline would be installed beneath the water body using trenchless techniques, and so the only physical modification to the bed would be the outfall head, which would have a very small footprint when considered in the context of the WFD water body. As a worst case scenario the footprint with rock armouring may be 0.025 ha. The overall water body is 8,838 ha in size. As such, it is not considered that the Proposed Development would prevent implementation of improvements in terms of physical modifications.

Table 9C-31: Tees Estuary water body – assessment against reasons for not achieving Good Status and reasons for Deterioration

Classification element affected	Pressure Type	Activity	Appraisal
Tributyltin Compounds	Diffuse source	Contaminated water body bed sediments	There is no potential for mobilisation of bed sediments which may contain tributyltin compounds.

Classification element affected	Pressure Type	Activity	Appraisal
Angiosperms	Physical modification	Coastal Squeeze	No new structures are proposed and so there should be no impact on the angiosperm WFD classification from physical modification associated with the Proposed Development.
Polybrominated diphenyl ethers (PBDE)	Unknown	Unknown	PBDEs are flame retardants found in a wide array of products and can commonly pollute watercourses. Measures to protect watercourses from pollution during construction are outlined in the CEMP and WMP. No operational runoff is discharged to Tees Estuary. As such, there is not anticipated to be any impact on PBDEs as a result of the Proposed Development in this water body.
Dissolved Inorganic Nitrogen	Diffuse Source	Agriculture – Poor nutrient management	Not applicable – relates to other parts of the catchment
	Point Source	Water Industry – Sewage discharge (continuous)	Foul water from the Proposed Development will be treated at Marske-by-the-Sea WwTW and from there to Tees Bay under the conditions of Northumbrian Water's environmental permit. Northumbrian Water is responsible for ensuring no deterioration or prevention of improvement in the receiving waterbody from their treatment works. Consultation will continue with Northumbrian Water as the scheme develops to ensure there is sufficient capacity to take foul water from the Proposed Development.
	Point Source	Industry – Trade / Industry discharge	Cooling water will consist of water abstracted from the Tees upstream of the tidal limit, but through the system will be concentrated up to five times. Process water discharged from the new outfall may also contain DIN. The discharge will also include final treated effluent that would otherwise have been discharged to the Dabholm Gut but which will be discharged to bay to ensure nutrient neutrality in the estuary (i.e. a return flow equivalent in nitrogen loading to that process water sent to Brand Sands WwTW for treatment). However, water quality modelling presented in Annex G shows that although some small increase in DIN may occur at the mouth of the estuary, in the dredged channel, there is no exceedance of the

Classification element affected	Pressure Type	Activity	Appraisal
			EQS and therefore no deterioration in the DIN parameter.
Macroalgae	Diffuse Source	Agriculture – Poor nutrient management	Not applicable – relates to other parts of the catchment
	Point Source	Navigation – Ports and harbours (structures) and recreation	There will be no construction impacts relating to navigation and not have any impact on the macroalgae classification.
	Physical modification	Coastal squeeze	No new permanent structures are proposed, and so there should be no impact on the macroalgae WFD classification from physical modification associated with the Proposed Development.
	Point Source	Industry – trade / industry discharge	The Seal Sands area is important for the designated features of the Teesmouth and Cleveland Coast SPA/Ramsar site and is known to be impacted by excessive growth of algal mats. However, the amount of additional nitrogen that may 'spill' back into the estuary from the emissions of colling and process water from the proposed new outfall will be compensated for by removal of nitrogen in water abstracted for cooling the Proposed Development. There also appears to be natural morphological barriers separating the Seal Sands area and the area of the estuary that may be affected by slightly elevated DIN levels compared to ambient conditions.
	Point Source	Sewage discharge (continuous)	Foul water from the Proposed Development will be treated at Marske-by-the-Sea WwTW and discharged to Tees Bay under the conditions of Northumbrian Water's environmental permit. Northumbrian Water is responsible for ensuring no deterioration or prevention of improvement in the receiving water body from their treatment works. Consultation will continue with Northumbrian Water as the scheme develops to ensure there is sufficient capacity to take foul water from the Proposed Development.
Invertebrates	Point Source	Sewage discharge (continuous)	Foul water from the Proposed Development will be treated at Marske-by-the-Sea WwTW and discharged to Tees

Classification element affected	Pressure Type	Activity	Appraisal
			Bay under the conditions of Northumbrian Water's environmental permit. Northumbrian Water is responsible for ensuring no deterioration or prevention of improvement in the receiving waterbody from their treatment works. Consultation will continue with Northumbrian Water as the scheme develops to ensure there is sufficient capacity to take foul water from the Proposed Development.
	Point Source	Industry – trade / industry discharge	As per the response regarding macroalgae.

Table 9C-32: Tees Mercia Mudstone and Redcar Mudstone Groundwater Body – Assessment against Reasons for not achieving Good Status and Reasons for Deterioration

Classification element affected	Pressure Type	Activity	Appraisal
Chemical Dependent Surface Water Body Status	Point Source	Mining and Quarrying – Abandoned Mine	Pollution impacts to groundwater during construction would be controlled through measures outlined in the Final CEMP, WMP, frac out plan and risk assessment and Remediation Strategy. Any piling operations required would be subject to foundation works risk assessment and any potential to cause pollution to the aquifer would be covered by measures to be detailed in piling method statements. There are no planned discharges to groundwater during operation. There is potential for leaks, spillages and contamination from storage of chemicals and use of fuels that may affect groundwater. However, any fuel and chemical storage areas would be bunded to prevent spread of spillages and to allow rapid clean up and removal for off-site disposal. Given the above, there is not considered to be any prevention of future improvement of the Chemical Dependent Surface Water Body Status for this groundwater body.

Table 9C-33: Tees Estuary (S Bank) – Mitigation Measures Assessment

Mitigation Measure Option	Mitigation Measure screening and status	Appraisal
Restore or increase floodplain (lateral) connectivity	Required but not yet implemented	No new structures (e.g. culverts) are proposed over the watercourse. There would be no adverse impacts

Mitigation Measure Option	Mitigation Measure screening and status	Appraisal
		on future implementation of this mitigation measure
Install fish passes	Required but not yet implemented	Not applicable
Enhance existing structures to improve ecology	Required but not yet implemented	No works to existing structures are planned with the exception of certain pipe bridges that will need strengthening to accommodate new pipes. There would be no adverse impacts on future implementation of this mitigation measure.
Remove obsolete structure(s)	Required but not yet implemented	No works to existing structures are planned with the exception of certain pipe bridges that will need strengthening to accommodate new pipes. There would be no adverse impacts on future implementation of this mitigation measure.
Implement changes to locks etc.	Required but not yet implemented	Not applicable
Implement appropriate vegetation control technique	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works to vegetation proposed.
Implement appropriate timing (vegetation control)	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works to vegetation proposed.
Implement invasive species techniques	Required but not yet implemented	The Final CEMP will include measures to ensure that invasive species are not spread during construction. The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works to vegetation proposed.
Retain habitats	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works to vegetation proposed. Any potential construction impacts that may affect habitats (e.g. runoff of sediment or chemical spillages) will be dealt with by best practice measures outlined in the Final CEMP.
Ensure maintenance minimises habitat impact	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works to the watercourse proposed following strengthening of pipe bridge structures.
Remove or soften hard bank engineering	Required but not yet implemented	There are no works proposed to the banks of this watercourse. This will

Mitigation Measure Option	Mitigation Measure screening and status	Appraisal
		not prevent future softening of watercourse banks.
Ensure maintenance prevents sediment transfer	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, and mitigation measures described in the Final CEMP will be implemented to prevent further sediment entering the watercourse during construction.
Water level management	In place and functioning effectively	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works that might impact water levels proposed. All surface water runoff and process water will be discharged to Tees Coastal water body rather than this watercourse.
Preserve or restore habitats	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no works that might impact habitats proposed to this watercourse. Any potential construction impacts that may affect habitats (e.g. runoff of sediment or chemical spillages) will be dealt with by best practice measures outlined in the Final CEMP.
Educate landowners	Required but not yet implemented	Not applicable – applies elsewhere in the catchment.
Restore or Increase In-channel morphological diversity	Required but not yet implemented	The Proposed Development does not prevent this mitigation measure from being implemented in future, with no direct works to the channel bed or banks proposed that might influence morphology.
Re-opening of culverts	Required but not yet implemented	No works to existing structures are planned with the exception of certain pipe bridges that will need strengthening to accommodate new pipes. There would be no adverse impacts on future implementation of this mitigation measure.
Alter culvert channel bed	Required but not yet implemented	No culverts are required as a result of the Proposed Development or works to any existing culverted crossings, and so no adverse impact on this mitigation measure.

Enhancements

9.7.193 The Environment Agency have noted that the Tees (estuary) Transitional water body is currently failing to meet statutory environmental objectives including and in respect to the WFD element of DIN. Excess DIN is also a factor in the failure of protected sites to achieve objectives, and as such Natural England have declared the Teesmouth and Cleveland Coast Ramsar/SPA a site that requires new developments to demonstrate nutrient neutrality. The main source of DIN to this waterbody is believed to be WwTW and industrial emitters, although a significant load will also be derived from diffuse agricultural runoff.

9.7.194 The Proposed Development will send some process effluent to Brans Sands WwTW for treatment, but a volume of final treated effluent with an equivalent load of nitrogen will be redirected back to the new PCC outfall for discharge to the Tees Bay and thus will not enter Dabholm Gut. This will require an Environmental Permit from the Environment Agency.

9.7.195 The Environment Agency have also highlighted notable local enhancement projects in and around the Tees Estuary during consultation, in particular the following:

- Tees Estuary Edges Enhancement Study (2018) (University of Hull): this study aimed to identify a framework of habitat enhancement opportunities to improve biodiversity provision and habitat connectivity within the Tees. There is considered potential for functional provision to be improved for species associated with the existing and proposed SPA designation (e.g. increased foraging potential for waders using intertidal mudflat habitat and breeding birds such as tern species through improvements to essential fish habitats and associated populations). The study focused on areas along the Tees estuary (from barrage to mouth) where estuary edges improvement techniques could be applied. Identified techniques included re-profiling foreshore levels, vegetated floating pontoons, fish habitat creation and extending intertidal areas (Boyes, Cutts and Thomson, 2018).
- The Tees Tideland project is currently assessing the potential for implementing measures to restore habitats in the Holme Fleet / Belasis Beck catchment that would formerly naturally have formed part of the Tees Estuary intertidal area, and to restore ecological connectivity with the Tees Estuary.

9.7.196 With regard to the Proposed Development, there are DCO boundary limitations that will prohibit meaningful enhancement of watercourses crossed by the pipelines. While the Proposed Development does make use of existing infrastructure (e.g. pipe bridges) within the catchment, it does not introduce any additional physical constraints to enhancing the WFD catchments. However, the potential for further contribution by the Applicant to delivering enhancements can be taken forward with the Environment Agency as the Proposed Development progresses outside of the DCO application process. These potential opportunities have not been used as part of the WFD assessment process presented here, whereby no deterioration or prevention of future improvement has been identified for any water body.

9.8 Conclusions

9.8.1 The WFD assessment indicates that, based on the current understanding of the Proposed Development and the intermediate water quality modelling (see Annex G), that the Proposed Development will not lead to deterioration of any water body at the water body scale. This applies to the objectives for the

Tees Coastal waterbody, the Tees Transitional waterbody, the Tees Estuary (S Bank) waterbody, Tees Mercia Mudstone & Redcar Mudstone groundwater body & Tees Sherwood Sandstone WFD groundwater body, provided that the outlined mitigation measures are implemented. Furthermore, as all relevant WFD water bodies are either at their target status or since the reasons for not being at target status will not be influenced by the Proposed Development, no separate assessment of the objective to do not prevent improvement is required. However, all known reasons for not achieving good status or potential have been appraised to demonstrate how the Proposed Development is compliant.

9.8.2 The intermediate water quality modelling assessment presented in Annex G shows that there will be an increase in DIN when compared to ambient levels within the Tees Bay. A smaller area within the wider plume will exceed the EQS for DIN, although the duration of the exceedance is short lived and occurs in the lower half of the water column rather than at the surface. The spatial distribution is also significantly reduced when surface water is discharged with the cooling and process water.

9.8.3 There is no routine monitoring of DIN in Tees Bay and thus no status class against which a deterioration can be stated. The assessment uses data from the Tees Estuary as a proxy, and it would be expected that DIN levels are higher in the estuary due to proximity to significant known local sources. Overall, the potential for adverse effects to marine water quality by this increase in DIN is considered to be minor and localised, and not significant at the water body scale. Furthermore, no detectable effects to marine species or habitats are predicted, nor to biodiversity or the conservation objectives for any marine species or designated site. The discharged effluent from the Proposed Development will also require a Water Activity Permit (i.e. a consent from the Environment Agency to discharge), at which point it is expected that final effluent quality parameters will be known so that final water quality modelling can be undertake. There also remains the possibility that further on-site treatment could be provided if it is required by the Environment Agency before cooling water and process water is discharged to Tees Bay under the permit. The draft DCO has also been amended to include a requirement for Nutrient Nitrogen safeguarding scheme to be prepared before any part of the authorised development other than the permitted preliminary works may commence.

9.8.4 The revised water quality modelling as presented in Annex G now shows that under certain conditions an increase in DIN may occur in limited areas at the mouth of the estuary. However, this is limited mainly to less than a 1% increase over average ambient concentrations, and to less than 2.5% increase over average ambient concentrations at any location. Also, this effect is concentrated in the lower half of the water column of the dredged channel of the Tees Estuary and not at the location of the Seal Sands mudflats, for which there appears to be natural morphological barriers preventing easy spread. Overall, there is no exceedance of the EQS for DIN in the estuary and therefore no deterioration in the DIN parameter. Furthermore, the abstraction of water from the River Tees will remove nitrogen and it is estimated that the benefit of this will be greater than the ‘spill back’ of nitrogen potentially to Seal Sands via discharges from the new outfall. Finally, to ensure nutrient neutrality in the estuary and with regards to the Teesmouth and Cleveland Coast SPA / Ramsar site, a return flow of final treated effluent from Bran Sands WwTW will be sent back to the PCC for discharge to the bay that has an equivalent nitrogen load to the process water sent to the works for treatment.

9.8.5 During construction, mitigation measures include best practice to be adopted during construction to manage all pollution risks, and which will be implemented by the Contractor using a WMP prepared as part of a Final CEMP. They also include measures to treat surface water runoff, process water, and to manage the risk of future spillages or pollution incidents occurring on the Site.

9.8.6 A number of permissions will be required from the Environment Agency (unless these are disapplied by the DCO and replaced with alternative agreements in consultation with the relevant regulator) and these will provide an additional check on the proposed works. Prior to construction this will include consents related to discharges of any ‘unclean’ runoff during construction, for any activity within 8 m of the bank of a main river or culvert on a main river, works affecting the flow within ordinary watercourses (from the LLFA), and a deemed marine licence under the DCO for regulated activities below the Mean High Water Spring Tide level. Appropriate licences and permits will also be obtained from the Environment Agency and Marine Management Organisation with regards to the operational discharges to Tees Coastal water body and construction of the new outfall pipeline and outfall head, as well as the CO_2 export corridor. It is proposed that a Final Water Quality Modelling Assessment will be carried out at this stage.

9.8.7 Consultation with Northumbrian Water will continue to confirm capacity to supply the Proposed Development with water, and to accept foul water from the Proposed Development at Marske-by-the-Sea WwTW.

9.8.8 Finally, the Environment Agency have highlighted notable local enhancement projects in and around the Tees Estuary during consultation and that could be supported by the Applicant. Whilst there are DCO boundary limitations that will prohibit meaningful enhancement of watercourses crossed by the pipelines, the Applicant recognises the importance of these local projects and has confirmed to the Environment Agency a willingness to explore opportunities outside of the DCO application process.

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Annex A - WFD Water Body Assessments - Cycle 2 (2019)

Table A1 Surface Water Body Classification Details – Tees Coastal

RMBP Parameter	Northumbria Middle Cycle 2 2019 Classification
RBMP	Northumbria RMBP
Waterbody Name and ID	Tees Coastal - GB650301500005
Water Body Type	Coastal Water
Hydromorphological Designation	Heavily Modified
Length	-
Catchment area	8838.147 ha
Overall Ecological Potential	**Moderate**
Chemical Status	**Fail**
Downstream Waterbody	-
Supporting elements (Surface Water)	**Moderate**
Mitigation Measures Assessment	Moderate or less
Biological Quality Elements	**High**
Angiosperms	-
Fish	-
Invertebrates	High
Macroalgae	-
Phytoplankton	-
Physico-Chemical Parameters	**High**
Dissolved Inorganic Nitrogen	-
Dissolved oxygen	High
Hydromorphological Supporting Elements	**-**
Specific Pollutants	Moderate
Arsenic	High
Copper	High
Iron	High
Zinc	High
Priority Substances	**Good**
Fluoranthene	Good
Lead and Its Compounds	Good
Nickel and Its Compounds	Good
Other Pollutants	**Does not require assessment**
Priority Hazardous Substances	**Fail**
Polybrominated diphenyl ethers (PBDEs)	Fail
Perfluoroctane sulphonate (PFOS)	Good
Benzo(a)pyrene	Good
Cadmium and Its Compounds	Good
Dioxins and dioxin-like compounds	Good
Heptachlor and cis-Heptachlor epoxide	Good
Hexabromocyclododecane (HBCDD)	Good
Hexachlorobenzene	Good

RMBP Parameter	Northumbria Middle Cycle 2 2019 Classification
Hexachlorobutadiene	Good
Mercury and Its Compounds	Fail

Table A2 Surface Water Body Classification Details – Tees

RMBP Parameter	Cycle 2 2019 Classification
RBMP	Northumbria RMBP
Waterbody Name and ID	TEES - GB510302509900
Water Body Type	Transitional Water
Hydromorphological Designation	Heavily Modified
Length	-
Catchment area	1144.046 ha
Overall Ecological Potential	Moderate
Chemical Status	Fail
Downstream Waterbody	-
Supporting elements (Surface Water)	Moderate
Mitigation Measures Assessment	Moderate or Less
Biological Quality Elements	Moderate
Angiosperms	Moderate
Fish	Good
Invertebrates	Good
Macroalgae	Moderate
Phytoplankton	Good
Physico-Chemical Parameters	Moderate
Dissolved Inorganic Nitrogen	Moderate
Dissolved Oxygen	High
Hydromorphological Supporting Elements	Supports Good
Hydrological regime	Supports Good
Specific Pollutants	High
Chlorothalonil	High
Pendimenthalin	High
Chromium (IV)	High
Triclosan	High
2,4-dichlorophenol	High
2,4-dichlorophenoxyacetic acid	High
Arensic	High
Copper	High

RMBP Parameter	Cycle 2 2019 Classification
Diazinon	High
Dimethoate	High
Iron	High
Linuron	High
Mecoprop	High
Phenol	High
Toluene	High
Un-ionised ammonia	High
Zinc	High
Priority Substances	Good
1,2-dichloroethane	Good
Atrazine	Good
Benzene	Good
Alachlor	Good
Chlorpyrifos	Good
Cypermethrin (Priority hazardous)	Fail
Octylphenol	Good
Dichlorvos (Priority)	Good
Aclonifen	Good
Bifenox	Good
Chlorfenvinphos	Good
Cybutryne (Irgarol®)	Good
Terbutryn	Good
Dichloromethane	Good
Diuron	Good
Fluoranthene	Good
Isoproturon	Good
Lead and Its Compounds	Good
Napthalene	Good
Nickel and Its Compounds	Good
Pentachlorophenol	Good
Simazine	Good
Trichlorobenzenes	Good
Trichloromethane	Good
Other Pollutants	Good
Aldrin, Dieldrin. Endrin & Isodrin	Good

RMBP Parameter	Cycle 2 2019 Classification
Carbon Tetrachloride	Good
DDT Total	Good
para - para DDT	Good
Tetrachloroethylene	Good
Trichloroethylene	Good
Priority Hazardous Substances	Fail
Anthracene	Good
Polybrominated diphenyl ethers (PBDE)	Fail
Perfluorooctane sulphonate (PFOS)	Good
Cadmium and Its Compounds	Good
Dioxins and dioxin-like compounds	Good
Benzo(b)fluoranthene	Good
Benzo(g-h-i)perylene	Fail
Benzo(k)fluoranthene	Good
Heptachlor and cis-Heptachlor epoxide	Good
Hexabromocyclododecane (HBCDD)	Good
Quinoxyfen	Good
Di(2-ethylhexyl) phthalate (Priority hazardous)	Good
Endosulfan	Good
Hexachlorobenzene	Good
Hexachlorobutadiene	Good
Mercury and Its Compounds	Fail
Nonylphenol	Good
Pentachlorobenzene	Good
Tributyltin Compounds	Fail
Trifluralin (Priority hazardous)	Good

Table A3 Surface Water Body Classification Details – Tees Estuary (S Bank)

RMBP Parameter	WFD Cycle 2 2019 Classification
RBMP	Northumbria RMBP
Waterbody Name and ID	Tees Estuary (S Bank) - GB103025072320
Water Body Type	River
Hydromorphological Designation	Heavily Modified
Length	8.721 km
Catchment area	3245.943 ha
Overall Ecological Potential	Moderate

RMBP Parameter	WFD Cycle 2 2019 Classification
Chemical Status	Fail
Downstream Waterbody	Tees (GB510302509900)
Supporting elements (Surface Water)	Moderate
Mitigation Measures Assessment	Moderate or Less
Biological Quality Elements	Bad
Invertebrates	Bad
Physico-Chemical Parameters	-
Hydromorphological SupportingElements	Supports Good
Hydrological regime	Supports Good
Specific Pollutants	-
Priority Substances	Good
Cypermethrin (Priority hazardous)	Good
Fluoranthene	Good
Other Pollutants	Does not require assessment
Priority Hazardous Substances	Fail
Polybrominated diphenyl ethers (PBDE)	Fail
Perfluorooctane sulphonate (PFOS)	Good
Dioxins and dioxin-like compounds	Good
Heptachlor and cis-Heptachlor epoxide	Good
Hexabromocyclododecane (HBCDD)	Good
Hexachlorobenzene	Good
Hexachlorobutadiene	Good
Mercury and Its Compounds	Fail

Table A4 Tees Estuary (S Bank) – Mitigation Measures

Mitigation Measure Option	Mitigation Measure screening & status
Restore or increase floodplain (lateral) connectivity	Required but not yet implemented
Install fish passes	Required but not yet implemented
Enhance existing structures to improve ecology	Required but not yet implemented
Enhance existing structures to improve ecology	Required but not yet implemented
Remove obsolete structure(s)	Required but not yet implemented
Implement changes to locks etc.	Required but not yet implemented
Implement appropriate vegetation control technique	Required but not yet implemented
Implement appropriate timing (vegetation control)	Required but not yet implemented
Implement invasive species techniques	Required but not yet implemented
Retain habitats	Required but not yet implemented
Ensure maintenance minimises habitat impact	Required but not yet implemented
Remove or soften hard bank engineering	Required but not yet implemented
Ensure maintenance prevents sediment transfer	Required but not yet implemented
Water level management	In place and functioning effectively
Preserve or restore habitats	Required but not yet implemented
Educate landowners	Required but not yet implemented
Restore or Increase In-channel morphological diversity	Required but not yet implemented
Re-opening of culverts	Required but not yet implemented
Alter culvert channel bed	Required but not yet implemented

Table A5 Ground Water Body Classification Details – Tees Sherwood Sandstone

RMBP Parameter	WFD Cycle 2 2019 Classification
RBMP	Northumbria RMBP
Waterbody Name and ID	Tees Sherwood Sandstone - GB40301G702000
Water Body Type	Groundwater Body
Groundwater Area	29301.122 ha
Surface Area	293.011 km2
Overall Water Body Status	Good
Quantitative Status	Good
Quanitative Saline Intrusion	Good
Quantitative Water Balance	Good
Quantitative GWDTEs Test	Good
Quantitative Dependent Surface Water Body Status	Good
Chemical Status	Good
Chemical Drinking Water Protected Area	Good
General Chemical Test	Good
Chemical GWDTEs Test	Good
Chemical Dependent Surface Water Body Status	Good
Chemical Saline Intrusion	Good

Table A6 Ground Water Body Classification Details – Tees Mercia Mudstone & Redcar Mudstone

RMBP Parameter	Cycle 2 2019 Classification
RBMP	Northumbria RMBP
Waterbody Name and ID	Tees Mercia Mudstone & Redcar - GB40302G701300
Water Body Type	Groundwater Body
Groundwater Area	49457.045 ha
Overall Water Body Status	Poor
Quantitative Status	Good
Quanitative Saline Intrusion	Good
Quantitative Water Balance	Good
Quantitative GWDTEs Test	Good
Quantitative Dependent Surface Water Body Status	Good
Chemical Status	Poor
Chemical Drinking Water Protected Area	Good
General Chemical Test	Good
Chemical GWDTEs Test	Good
Chemical Dependent Surface Water Body Status	Poor
Chemical Saline Intrusion	Good

Annex B Further WFD Water body Description

Tees Estuary

B.1.1 The present-day Tees Estuary has a largely anthropogenic character due to land reclamation, canalisation and channel deepening that began in the mid-1800s. Originally the estuary was surrounded by expansive wetlands and the tidal ingress extended for approximately 44 km upstream from the mouth. Historical maps indicate a channel width of up to 300 m between Stockton and Middlesbrough prior to 1900, which has reduced to a modern-day width varying between 100 and 200 m. This relatively narrow estuarine channel has marginal intertidal areas, especially where the mouth widens, spanning around 300 ha. This includes an approximately 140 ha area known as Seal Sands, on the north bank, which is separated from other intertidal areas by Seaton Channel (Royal Haskoning, 2016a). In the mid-1990s the Tees Barrage was built. This comprises a river barrage together with a road bridge and a footbridge. Navigation for boats is maintained by a barge lock, whilst there is also a fish pass. Water is held upstream of the barrage at the level of a typical high tide and the water used to supply a white-water course. The barrage has reduced the tidal stretch of the Tees to approximately 14 km from the mouth and reduced tidal volume upstream of South Gare by around 7% (ABPmer, 2002).

B.1.2 The Tees Estuary is not designated as a Bathing Water or Shellfishery. Northumbrian Water's Brans Sands WwTW discharges to the estuary close to Teesmouth.

B.1.3 The mouth of the Tees Estuary has a breakwater to either side, the North Gare and South Gare breakwaters. The South Gare breakwater is the larger and longer structure (approximately 2 km in length compared to around 850 m for the North Gare breakwater). The South Gare breakwater runs parallel to the main approach channel of the Tees and is built over areas of deposited slag. Within the mouth of the Tees, to the south, is Bran Sands Bay, while Coatham Sands is to the east of the breakwater. North Gare Sands is to the south of the North Gare breakwater, with Seaton Sands to the north.

B.1.4 PD Teesport report that the Tees Approach Channel has a charted depth of 15.4 m, which progressively reduces to 4.5 m east of Billingham Beck, which is 8 nautical miles upstream from the entrance to the estuary (Royal Haskoning, 2016c).

B.1.5 The tide curve at Teesmouth is near sinusoidal in shape with a mean spring range of 4.6 m and a mean neap tide range of 2.3 m (UKHO, 2006). Other tidal statistics are given in Table B1.

Table B1: Tidal Statistics for the Tees Estuary (ABPmer, 2002)

Tide Statistic	Level (m Chart Datum)
Lowest recorded water level	-0.38
Lowest astronomical tide	0.00
Mean low water spring tide	+0.90
Mean low water neap tide	+2.00
Mean sea level	+3.20
Mean high water neap tide	+4.30
Mean high water spring tide	+5.50
Highest astronomical tide	+6.10
Highest recorded water level	+6.86

B.1.6 The data in Table B1 indicates that there is variability between the astronomical tide range and the maximum and minimum recorded water levels, thereby suggesting that meteorological factors (e.g. wind, surge and waves) have an important influence on water levels in the estuary.

B.1.7 The source of the Tees is at Cross Fell in the Pennines, some 160 km from the mouth of the Tees. Freshwater input to the estuary is measured at a gauging station at Low Moor (NGR NZ 364 105). According to the National River Flow Archive (CEH, n.d.) for the period 1969-2018, the Tees at this point has a mean flow of 20.528 m^3/s, with a 10% exceedance (Q10) of 46.5 m^3/s, and a 95 exceedance (Q95) of 3.07 m^3/s.

B.1.8 The Tees Barrage controls freshwater flow into the Tees Estuary and allows partial mixing with saline water. However, the combination of reduced tidal volume, partial mixing and longitudinal salinity gradient drive a density driven gravitational circulation. Ebb flows are strongest at the surface, while flood tide flows are more evenly spread through depth. As such, the tidally average currents tend to be seawards in the surface waters and landwards closer to the estuary bed (Royal Haskoning, 2016a). This effect leads to a net sediment supply into the estuary from offshore areas.

B.1.9 Waves in the Tees Estuary result from a combination of locally generated wind waves, and offshore swell. The majority of offshore swell is from a northerly direction. The most common wind direction observed at South Gare is from the southwest (210-217ºN), although the largest wind events (i.e. of over 40 m/s) tend to be from the north (HR Wallingford, 2006).

B.1.10 Extreme wave heights for defined return periods, as previously reported for the waverider buoy north of the Tees North Buoy, are presented in Table B2. The North and South Gare breakwaters limit swell wave energy into the Tees Estuary, where any remaining energy is combined with local wind-driven waves (Royal Haskoning, 2016a).

Table B2: Extreme Wave Heights North of Tees North Buoy as Reported by HR Wallingford (2006)

Return Period in Years	Significant Wave Height (Hs (m))
0.1	3.87
1	6.03
10	8.63
50	10.69

B.1.11 Suspended sediment concentrations are generally low in Tees Bay and in the Tees Estuary when compared to some UK estuaries, with values typically below 50 mg/l based on historical (pre-Tees Barrage) measurements held by the Environment Agency. Highest concentrations tend to coincide with spring tides, and inputs tend to be derived from marine influences downstream, freshwater inputs from further up the catchment and industrial inputs. The marine input is washed in with the flood tide, and often causes resuspension of fine bed sediments.

B.1.12 The DCO Application relating to York Potash Harbour Facilities in 2016 (Royal Haskoning, 2016a) demonstrates that historical bed sampling in the vicinity of the Proposed Development has bed sediments comprising 65-70% silt, with some clay (around 20%) and the reminder sand and gravel. Coarser sands tend to settle in the lower estuary, with finer material transported further up the estuary by the tides. It is estimated that the total fine material input to the estuary is 280,000 m^3 to 330,000 m^3 per year (Royal Haskoning, 2016d).

Tees Bay

B.1.13 Tees Bay includes Bathing Waters designated under the Bathing Waters Directive, with ‘Redcar Coatham’ being located immediately north of the PCC Site, and ‘Seaton Carew North Gare’ being situated immediately north of the Study Area. There are no designated shellfisheries within Tees Bay.

B.1.14 Tees Bay has a tidal regime driven by the North Sea tidal wave, which originates in the north and travels south. The tide is semi-diurnal, repeating every 12.5-13 hours, with a macro-tidal range of 4.6 m for a mean spring tide and meso-tidal range of 2.3 m for a mean neap tide. Tidal velocities are generally low, reaching up to 0.25 m/s to 0.3 m/s. The flood tide direction in the Bay is southeast and the ebb direction northwest (EDF Energy, n.d.).

B.1.15 The sediment regime in the area includes surface seabed sediments, suspended sediments and a variety of sources and sinks. Silts and muds are readily transported as suspended sediment load and can remain in suspension for extended periods through the tidal cycle, while coarser sands and gravels may only be mobilised at times of peak hydrodynamic forcing carried as bedload. Suspended sediment concentrations between 1500 and 4000 mg/l have been measured at exposed locations during peak wave events (EDF Energy, n.d.).

B.1.16 Coatham Sands are protected at the western end by nearshore slag banks exposed at low water and known as the German Charlies. The Redcar seafront then extends as a defended headland for around 1.5 km. The headland results from the outcropping rocks of Coatham Rocks and Redcar Rocks (Royal Haskoning, 2014).

B.1.17 Within this area is the cable landfall of the Teesside Offshore Wind Farm, which is a 27 turbine 62 MW capacity offshore wind farm situated 1.5 km north of Coatham Sands, and which has been operational since 2013. There is also the discharge point from the former Steelworks site within Tees Bay off Coatham Sands.

Navigation

B.1.18 The Tees Estuary and adjacent Tees Bay is subject to significant commercial vessel traffic. The Navigational Risk Assessment for the York Potash Harbour development (Royal Haskoning, 2016c) provided a summary of vessel movements within the Tees Estuary for 2013-2014, which are shown in Table B3. Updated figures will be requested from PD Teesport and will be included in the full impact assessment once received. The general pattern from 2013 is of an average of 878 vessel movements per month, peaking in May (1009) and with fewest in December (714).

Table B3: Vessel Movements for the Tees Estuary 2013 (Royal Haskoning, 2016c)

Month	No of movements
January	824
February	808
March	981
April	922
May	1009
June	871
July	899
August	867
September	869
October	890
November	886
December	714

B.1.19 Further to the above, commercial fishing vessels are launched from Redcar and Marske-by-the-Sea and give rise to further traffic in the Tees Bay area. In particular, fishing effort in the area is focused on potting for crab and lobster, supplemented by trawling for cod, haddock, sole, whiting, plaice and turbot (EDF Energy, n.d.).

B.1.20 The nearest HM Coastguard moorings (Maritime and Coastguard Agency, n.d.) are to the north of the Study Area at Hartlepool Marina. There is an RNLI Lifeboat station at Redcar Seafront.

Annex C - Surface Water Quality Data

Table C1 Summary of Tees Estuary Water Quality Data Based on Monitoring at Multiple Sites Between 2009 - 2019 (Environment Agency, n.d.c)

Parameter	WFD Threshold for Transitional Waters (for Good)	Tees at the Gares, NGR NZ 55200 28400	Dabholm Gut Confluence, NGR NZ 54822 24858	Teesport, NGR NZ 54400 23700	Redcar Jetty, NGR NZ 54500 25700	Smiths Dock, NGR NZ 52800 22100
Temperature of Water (ºC)	-	10.28	12.01	11.9	10.2	10.6
Ammoniacal Nitrogen as N (mg/l)	21	0.270	-	-	0.545	-
Nitrate as N (mg/l)	-	0.43	-	-	0.88	1.19
Nitrite as N (mg/l)	-	0.011	-	-	0.0205	0.0155
Orthophosphate, reactive as P	-	0.045	-	-	0.0961	0.1185
Oxygen, Dissolved, % Saturation	-	101.95	98.07	94.25	97.41	93.39
Arsenic, Dissolved	25	1.15	-	1.100	-	1
Chromium, Dissolved		-	5.22	0.5	-	0.5
Copper, Dissolved	3.76*	0.630	1.39	-	0.91	0.89
Lead, Dissolved	1.3	0.128	0.574	0.294	0.244	0.59
Nickel, Dissolved	8.6	0.891	3.483	-	1.598	0.168
Zinc, Dissolved	6.8**	2.167	8.90	4.30	3.24	3.79
Tributyltin	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002
Lindane		-	-	-	0.0004	-
para para DDT	0.01	-	-	-	0.0012	-
Chloroform		-	1.060	0.116	-	-
Hexachlorobenzene	0.05	-	-	-	0.0004	-
Hexaclorobutadiene	0.6	-	-	-	0.0004	-

*where DOC is less than or equal to 1 mg **dissolved plus Ambient Background Concentration (µg/l)

Table C2: Summary of Water Quality Data for Waterbodies within the Study Area based on Monitoring between 2009-2019 (Environment Agency, n.d.c)

Monitoring Station	Duration of Sampling	Type of Water Sampled	Parameters	General Quality Comments
COASTAL / ESTUARINE:				
Wilton Complex Main Effluent Composite NGR: NZ 56100 24100	1 year (2019)	Effluent	Sanitary pollutants (e.g. Biochemical Oxygen Demand (BOD)), metals and organics (e.g. chloroform).	This effluent shows high levels of numerous pollutants. BOD is very high and indicative of sanitary wastewater containing high concentration of organic material; Chloroform exceeds the EQS stated in the Dangerous Substance Directive; and copper and zinc exceed WFD EQS.
Brans Sands NGR: NZ557002660 0	2000-2019	Estuarin e water	Physico-chemical parameters (e.g. pH, temp, dissolved oxygen); Nutrients and sanitary products (e.g. nitrate, ammoniacal nitrogen, orthophosphate).	Slightly alkaline and well oxygenated. Concentration of nitrates was relatively low, although orthophosphate elevated. Copper and zinc were not measured at this site. Escherichia coli and Intestinal enterococci have been measured once (2014) and were below limits of detection.
Dabholm Gut 100 m upstream from the Tees confluence NGR: NZ555002450 0	2000-2019	Estuarin e water	Physico-chemical parameters (e.g. pH); Trace metals (copper and zinc).	Circum-neutral pH with average concentrations zinc exceeding the WFD Standards for estuarine water. It should be noted that only six samples were taken at this site.
Greatham Creek 100 m from outfall (adjacent to Able UK) NGR: NZ524902649 0	2009-2012	Estuarin e Water	Physico-chemical parameters (e.g. pH, temp, dissolved oxygen); Nutrients and sanitary products (e.g. nitrate, ammoniacal nitrogen, orthophosphate)*; Trace metals.	Slightly alkaline and well oxygenated. Concentration of nitrates and phosphate were low. Numerous metals were measured at this site, all falling below EQS (as outlined in Table 9-11).
FRESHWATER:				
Billingham Beck 50 m upstream of River Tees confluence NGR: NZ474702050 7	2000-2019	River	Physico-chemical parameters (e.g. pH, temp, dissolved oxygen); Nutrients and sanitary products (e.g. nitrate, ammoniacal nitrogen, orthophosphate); Intermittent metals	Circum-neutral and well oxygenated. Concentration of nitrates and phosphate are slightly elevated. Dissolved copper concentrations are above the WFD Standard of 1 µg/l even in the 10^{th} percentile value. However, the standard applies to bioavailable copper, and there is insufficient data to determine bioavailability.

Monitoring Station	Duration of Sampling	Type of Water Sampled	Parameters	General Quality Comments
			monitoring until 2014 following which monitoring was regular.	The mean concentration of zinc is just below the WFD Standard of 10.9 µg/l (plus ambient)
Billingham Beck at Billingham Bottoms NGR: NZ4549522393	2000-2019	River	Physico-chemical parameters (e.g. pH, temp, dissolved oxygen); Nutrients and sanitary products (e.g. nitrate, ammoniacal nitrogen, orthophosphate); Trace metals (copper and zinc).	Circum-neutral and well oxygenated. Concentration of nitrates and phosphate are considerably lower than the downstream sampling site close to the Tees confluence. Dissolved copper concentrations are high and may rise above the WFD Standard of 1 µg/l bioavailable (insufficient data to determine bioavailability).

Table C3: Summary of Water Quality Data for Wilton Complex Main Effluent Composite based on Monitoring Data from 2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
BOD	mg/l	35.8	14.96	68.2	37
Chromium	ug/l	14.8	5.7	25.6	38
Chloroform	ug/l	25.2	13	39.4	38
Copper	ug/l	12.37	7.3	16.02	38
Zinc	ug/l	65.8	43.3	106.2	38

Table C4: Summary of Water Quality Data for Brans Sands (Surface) Based on Monitoring Between 2009-2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
pH	pH Units	8.10	8.01	8.23	6
Temperature of Water	°C	10.77	6.81	16.04	6
Ammoniacal Nitrogen as N	mg/l	0.48	0.15	0.75	5
Nitrogen, Total Oxidised as N	mg/l	0.75	0.20	1.27	5
Nitrate as N	mg/l	0.70	0.18	1.20	5
Nitrite as N	mg/l	0.05	0.01	0.09	5
Orthophosphate, reactive as P	mg/l	0.07	0.03	0.10	5

Oxygen, Dissolved, % Saturation	%	114.20	114.20	114.20	1

Table C5: Summary of Water Quality Data for Dabholm Gut 100m U/S Tees (Surface) Based on Monitoring Between 2009-2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
pH	pH Units	7.96	7.80	8.17	6
Copper, Dissolved	µg/l	1.83	0.37	3.38	6
Zinc, Dissolved	ug/l	21.75	4.51	34.40	6

Table C6: Summary of Water Quality Data for Greatham Creek-100m from out – Surface Based on Monitoring Between 2009-2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
pH	pH Units	8.00	7.98	8.13	17
Temperature of Water	°C	11.32	6.05	14.95	17
Ammoniacal Nitrogen as N	mg/l	0.21	0.16	0.29	5
Arsenic, Dissolved	ug/l	1.19	1.0	1.41	11
Copper, Dissolved	µg/l	0.69	0.36	0.94	9
Zinc, Dissolved	ug/l	3.14	2.21	5.09	12
Cadmium, Dissolved	ug/l	<0.04	<0.04	<0.04	<0.04
Nickel, Dissolved	ug/l	0.83	0.47	1.26	12
Nitrogen, Total Oxidised as N	mg/l	0.39	0.20	0.69	5
Nitrate as N	mg/l	0.37	0.18	0.67	5
Nitrite as N	mg/l	0.02	0.01	0.02	5
Orthophosphate, reactive as P	mg/l	0.05	0.04	0.07	5
Oxygen, Dissolved as O2	mg/l	8.40	7.55	9.47	12
Oxygen, Dissolved, % Saturation	%	92.47	86.74	97.17	12

Table C7: Summary of Water Quality Data for Billingham beck 50m U/S of River Tees Confluence Based on Monitoring Between 2009-2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
pH	pH Units	7.46	7.01	7.94	164
Temperature of Water	°C	13.07	6.20	20.82	117
Ammoniacal Nitrogen as N	mg/l	19.78	4.98	35.54	117

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
Carbon, Organic, Dissolved as C- {DOC}	mg/l	12.07	8.25	16.31	60
Copper, Dissolved	µg/l	3.51	2.46	4.56	73
Zinc, Dissolved	ug/l	9.31	3.78	15.54	73
Nitrogen, Total Oxidised as N	mg/l	28.49	6.69	49.62	117
Nitrate as N	mg/l	28.39	6.60	49.48	117
Nitrite as N	mg/l	0.11	0.06	0.18	117
Orthophosphate, reactive as P	mg/l	1.60	0.21	2.93	117
Oxygen, Dissolved, % Saturation	%	79.69	61.25	96.45	116
Oxygen, Dissolved as O2	mg/l	8.58	5.77	11.25	116

Table C8: Summary of Water Quality data for Billingham Beck at Billingham Bottoms based on monitoring between 2009-2019

Determinand	Unit	Mean	10th percentile	90th percentile	No. of samples
pH	pH Units	7.93	7.62	8.20	77
Temperature of Water	°C	9.55	3.96	14.64	77
Ammoniacal Nitrogen as N	mg/l	0.11	0.03	0.23	76
Copper, Dissolved	µg/l	2.84	1.68	4.12	58
Nitrogen, Total Oxidised as N	mg/l	4.92	2.69	8.55	102
Nitrate as N	mg/l	4.88	2.63	8.51	102
Nitrite as N	mg/l	0.04	0.01	0.06	105
Orthophosphate, reactive as P	mg/l	0.21	0.13	0.34	38
Oxygen, Dissolved, % Saturation	%	84.37	71.00	95.60	77
Oxygen, Dissolved as O2	mg/l	9.75	7.14	12.10	77

Annex D - Sediment Quality

D.1.1 Numerous investigations of sediment quality have recently been undertaken to support various recent dredging proposals and developments around the Tees Estuary, with samples compared to CEFAS[3] Action Levels for the disposal of dredged material. These give an indication of sediment quality in the Tees Estuary and Teesmouth areas. In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence marine licensing decisions and is suitable for sea disposal. However, dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for sea disposal.

D.1.2 Samples were collected in 2017 and 2018 to support dredging at Seaton Port (Able UK, 2018), adjacent to the Seaton Port Dry Dock facility on the north bank of the River Tees, centred approximately on NGR NZ 52416 26658. Sampling consisted of four surface samples in the vicinity of the dry dock in 2017 and a further five in 2018. A summary of results is shown against CEFAS Action Levels in Table D1. It is clear that several metals are present in concentrations over Action Level 1, which triggered additional sampling, but none were found to exceed Action Level 2.

Table D1: Assessment of Sediment Samples Against CEFAS Action Levels for Samples Collected in 2017/18 from Seaton Port (Adapted From Able UK (2018))

Parameter	Action Level 1	Action Level 2	Maximum 2017 Result	Maximum 2018 Results	Comment
Arsenic	20	100	36.28	26.2	Above Level 1; Significantly below Level 2.
Mercury	0.3	3	0.72	0.35	Above Level 1; Significantly below Level 2.
Cadmium	0.4	5	0.47	Below AL1	2017 result above Level 1; Significantly below Level 2.
Chromium	40	400	105.84	92.8	Above Level 1; Significantly below Level 2.
Copper	40	400	66.4	40	Above/equal to Level 1; Significantly below Level 2.
Nickel	20	200	42.88	40.2	Above Level 1; Significantly below Level 2.
Lead	50	500	151.32	108	Above Level 1; Significantly below Level 2.
Zinc	130	800	244.5	199	Above Level 1; Significantly below Level 2.

Note: all value as mg/kg Dry weight (ppm)

D.1.3 The DCO Application relating to York Potash Harbour Facilities in 2016 (Royal Haskoning, 2016a) also included sediment sampling in the main Tees Estuary downstream of Dabholm Gut. The sampling was undertaken in 2014 and full results are available in Royal Haskoning (2016b).

[3] Centre for Environment, Fisheries and Aquaculture Science

D.1.4 Surface sediment samples were collected as well as sediment from a range of depths down to 4.87 m below the surface. In summary, the sediments contained relatively high levels of contamination, including elevated metals and polycyclic aromatic hydrocarbon (PAH) concentrations. Metals and PAHs exceeded CEFAS Action Level 1 at the majority of sampling stations and depths. In some cases, CEFAS Action Level 2 was also exceeded, notably for chromium, copper and mercury. As such these sediments were not considered suitable for disposal at sea. The concentration of metals in dredged samples from the Tees Approach Channel were generally less than those sampled closer to the east bank, with no exceedances of CEFAS Action Level 1 in the samples from the approach channel. On the whole, there were fewer exceedances of Polychlorinated biphenyls (PCBs) against the CEFAS Action Levels than metals and PAHs, although there were instances of exceedances against both Action Level 1 and 2. Concentrations of contaminants are greater at depth than in surface samples, reflecting the historical impact of heavy industry in this area around the waterbody, which in the past received a large amount of waste discharge.

D.1.5 Two earlier impact assessments of sediment quality were undertaken to support the EIA of the Northern Gateway Container Terminal (NGCT) and QE II berth redevelopment project.

D.1.6 The QE II berth sediment assessment consisted of two samples immediately west of Tees Dock, taken in 2008. Two vibrocores were used for sampling sediment to a depth of 4 m below ordnance datum. Results indicated that all metals exceeded CEFAS Action Level 1 levels of contamination. Concentrations of dibutyl tin and organotins were present below Action Level 1. Concentrations of cadmium, chromium, copper, lead, mercury and zinc also exceeded CEFAS Action Level 2 (Royal Haskoning, 2016a) and were not considered suitable for disposal at sea.

D.1.7 The NGCT sediment samples were collected in 2006 from several locations throughout the Tees Estuary, including the main channel between Tees Dock and Dabholm Gut, Seal Sands, Bran Sands and the Tees Approach Channel. In summary, there was some level of contamination recorded in the samples, particularly with regard to heavy metals. However, levels were not deemed high enough to prevent material being disposed of at sea (Royal Haskoning, 2016a).

D.1.8 These past sampling campaigns indicate significant historical contamination in the Tees Estuary, which is more concentrated at the margins of the channel and at depth than in surface sediments. In some locations, concentrations of contaminants exceeded CEFAS Action Level 2 and so disposal at sea is not considered suitable in these cases.

Annex E - Pond 14 Water Quality Monitoring Technical Note

Annex F - Water Resources Tables

Table F1: Water Activity Permits within 250m from the Proposed Development Boundary

Label on Fig 9.1	Licence	NGR and approx. distance from nearest Site boundary / direction	Issued Date	Discharge Type	Receiving Water
D1	Qr.25/04/1588	NZ4753022100	2nd August 1999	Trade Discharge - Process Water	Tees
D2	254/1941	NZ5400023150	6th March 2007	Trade Discharges - Site Drainage	River Tees Estuary
D2	254/1923	NZ5033023272	11th November 2008	Sewage Discharges - Final/Treated Effluent - Not Water Company	Trib Of Holme Fleet
D4	254/A/0583	NZ5081023310	4th January 1980	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tees, Tributary Of
D5	254/A/0583	NZ5081023310	4th January 1980	Sewage and Trade Combined - Unspecified	Tees, Tributary Of
D6	254/A/0582	NZ5080023300	21st November 1979	Sewage Discharges - Final/Treated Effluent - Not Water Company	Greatham Creek, Tributary Of
D7	254/A/0583/5262	NZ5080023295	21st November 1979	Septic tank	Greatham Creek; Tributary Of
D8	254/D/0250/5512	NZ5060023495	27th November 1970	Engineering	Greatham Creek; Tributary Of
D9	QC.25/04/1432	NZ5193024405	11th September 1995	Sewage Effluent Discharge-Treated Effluent	Land
D10	25/04/1739	NZ5267024785	26th July 2012	Sewage Discharges - Final/Treated Effluent - Not Water Company	Land
D11	254/1141	NZ5396024160	4th September 1992	Trade Discharges - Site Drainage	Tees Estuary
D12	254/1365	NZ5390024100	19th August 1987	Chemical	Tees
D13	AO0237	NZ5390023695	23rd December 1994	Trade Effluent Discharge-Treated Effluent	Tees Estuary

Label on Fig 9.1	Licence	NGR and approx. distance from nearest Site boundary / direction	Issued Date	Discharge Type	Receiving Water
D14	AL6956	NZ5425024350	16th June 1994	Trade Effluent Discharge-Treated Effluent	Tees
D15	254/0653	NZ5413024190	2nd September 1988	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tees
D16	25/04/1654	NZ5474023470	30th October 2001	Trade Discharge - Process Water	Tees Dock - Saline Estuary
D17	254/1271	NZ5470023500	19th November 1993	Miscellaneous Discharges - Mine / Groundwater As Raised	Tees Estuary
D18	254/1271	NZ5470023500	19th November 1993	Miscellaneous Discharges - Mine / Groundwater As Raised	Tees Estuary
D19	254/B/0153	NZ5470023200	23rd March 1972	Unspecified	Tees
D20	254/1942	NZ5635019810	16th April 2007	Trade Discharges - Site Drainage	Tributary Of Kettle Beck
D21	254/1942	NZ5635019810	16th April 2007	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tributary Of Kettle Beck
D22	25/04/1776	NZ5717720096	23rd March 2010	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Unnamed Trib Of Dabholme Beck
D23	25/04/1777	NZ5717020090	18th February 2004	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Unnamed Trib Of Dabholme Beck
D24	254/1813	NZ5714020140	21st February 2005	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Dabholme Beck,Trib Of
D25	256/E/0259	NZ5647019710	25th March 1960	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Kettle Beck
D26	254/E/0130	NZ5713019990	26th October 1956	Unspecified	Dabholme Beck,

Label on Fig 9.1	Licence	NGR and approx. distance from nearest Site boundary / direction	Issued Date	Discharge Type	Receiving Water
D27	254/1935	NZ5536122142	15th February 2019	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Kinkerdale Beck
D28	254/1814	NZ5533022170	3rd March 2005	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Kinkerdale Beck
D29	254/1423	NZ5600023000	26th July 2012	Trade Discharges - Cooling Water	Land
D30	QC 254/1423	NZ5600023000	19th October 1995	Cooling Water	Land
D31	QC.254/1423	NZ5600022995	19th October 1995	Trade Effluent Discharge-Cooling Water (Direct)	Soakaway
D32	AR0241	NZ5650022600	7th September 1995	Trade Effluent Discharge-Cooling Water (Direct)	Not Supplied
D33	254/1528	NZ5614024055	31st July 2014	Trade Discharge - Process Water	The Dabholm Gut
D34	254/1528	NZ5614024055	31st July 2014	Sewage (Private)/SSO	The Dabholm Gut
D35	254/1920	NZ5614024090	25th November 2010	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	Dabholm Gut
D36	254/1920	NZ5614024090	25th November 2010	Sewage Discharges - Pumping Station - Water Company	Dabholm Gut
D37	254/1920	NZ5614024090	25th November 2010	Sewage Discharges - Final/Treated Effluent - Water Company	Dabholm Gut
D38	254/1920	NZ5614024090	25th November 2010	Sewage Discharges - Unspecified - Water Company	Dabholm Gut
D39	25/04/1630	NZ5612024090	21st August 2002	Sewage Discharges - Unspecified - Water Company	The Dabholm Gut
D40	25/04/1630	NZ5612024090	21st August 2002	Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company	The Dabholm Gut

Label on Fig 9.1	Licence	NGR and approx. distance from nearest Site boundary / direction	Issued Date	Discharge Type	Receiving Water
D41	Qc.25/04/1579	NZ5507024310	26th July 2012	Sewage Discharges - Final/Treated Effluent - Not Water Company	Land In The Tees Catchment
D42	QC.25/04/1578	NZ5518024210	28th April 1999	Sewage Discharges - Final/Treated Effluent - Not Water Company	Land (River Tees)
D43	25/04/1646	NZ5655023780	1st November 2000	Sewage Discharges - Pumping Station - Water Company	Dabholm Gut
D44	254/EPA/028	NZ5470026400	3rd June 1987	Chemical	Tees Estuary
D45	AJ0094	NZ5694027130	18th June 1993	Trade Effluent Discharge-Cooling Water (Direct)	North Sea

Table F2: Abstractions in the Study Area

Fig 9.1 Reference	Licence Holder Name	Abstraction Licence Number	Use	Source Description	National Grid Reference
A1	Sabic UK Petrochemicals	1/25/04/134	Water Supply	Groundwater	NZ51232470
A2	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ51282500
A3	KP Snacks Ltd	1/25/04/142	Industrial, Commercial and Public Services	Groundwater	NZ475241
A4	Sabic UK Petrochemicals	1/25/04/134	Water Supply	Groundwater	NZ50702295
A5	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ50832340
A6	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ51032338
A7	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ51182410
A8	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ51202437
A9	Sabic UK Petrochemicals	1/25/04/134	Environmental	Groundwater	NZ51232470
A10	Middlesbrough Council	1/25/04/183/R01	Industrial, Commercial and Public Services	Groundwater	NZ4951320865
A11	Sabic UK Petrochemicals	1/25/04/134	Industrial, Commercial and Public Services	Groundwater	NZ50702295
A12	North Tees Ltd	1/25/04/164	Environmental	Groundwater	NZ52312319
A13	Sahaviriya Steel Industries UK Ltd	1/25/04/135	Industrial, Commercial and Public Services	Tidal Waters	NZ547259

Fig 9.1 Reference	Licence Holder Name	Abstraction Licence Number	Use	Source Description	National Grid Reference
A14	British Energy Generation ltd	1/25/04/120	Production of Energy	Tidal Waters	NZ529268
A15	Able UK Ltd	NE/025/0001/018	Industrial, Commercial and Public Services	Tidal Waters	NZ5218826949
A16	SUEZ Recycling and Recovery Tees Valley Ltd	1/25/04/161	Industrial, Commercial and Public Services	Tidal Waters	NZ48082192
A17	Cleveland Potash Ltd	NE/025/0001/011	Industrial, Commercial and Public Services	Tidal Waters	NZ5466023558
A18	RSPB	NE/025/0001/008	Environmental	Surface Water	NZ4973222992

Table F3: Pollution Incidents to Controlled Waters within 250 m of the Site

Fig 9.1 Ref	Notification ID and Date	Category	National Grid Reference	Pollutant	Probable Receiving Waters
P1	969033 10/03/2012	3 (Minor)	NZ 49573 21710	Atmospheric pollutants and effects - smoke	Tees Estuary
P2	1187178 25/12/2013	3 (Minor)	NZ 49573 21710	Contaminated Water – firefighting runoff	Tees Estuary
P3	1256199 15//07/2014	2 (Significant)	NZ 56608 23878	Crude sewage	Dabholm Gut
P4	1405228 22/01/2016	2 (Significant)	NZ 57917 23982	Oils – Diesel (including agricultural)	Tributary of the Fleet

Annex G – Intermediate Water Quality Monitoring Report

Net Zero Teesside - Water Quality Assessment

Intermediate Design Stage - Alternative Discharge Option

Net Zero Teesside

Project number: 60675797

October 2022

Quality information

Prepared by	Checked by	Verified by	Approved by
Sarah Waite Water Quality Scientist	Frans van Eeden Senior Coastal Modeller	Paul Norton Technical Director	Richard Lowe Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
Rev 1.0	05/10/2022	Option A Modelling			

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Prepared for:

bp

Prepared by:

Sarah Waite
Water Quality Scientist

AECOM Limited
Royal Court, Basil Close
Chesterfield
Derbyshire S41 7SL
United Kingdom

T: [redacted]

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1. Introduction

1.1 Background

The Power Capture and Compression (PCC) site of the Net Zero Teesside (NZT) Proposed Development is located on part of the former Redcar Steel Works. It is proposed to redevelop the site and construct a gas fired power station with carbon capture, as well as a high pressure compressor station. A CO_2 Gathering Network will also be constructed in the Teesside area which will facilitate decarbonisation of industry in the area.

During operation of the PCC site, it is proposed to discharge surface water run-off and slightly contaminated wastewater from on-site processes including condensed water from the Heat Recovery Steam Generator (HRSG) to Tees Bay via an outfall. Contaminated effluent will be pumped to Northumbrian Water Ltd.'s (NWL's) Bran Sands Waste Water Treatment Works (WwTW). The 'base case' assumption for the Proposed Development has been that the treated effluent from Bran Sands WwTW will be discharged through the existing NWL consented discharge to the Dabholm Gut which in turn discharges into the Tees Estuary.

In their Relevant Representations, the Environment Agency and Natural England have asked for an assessment of the potential impacts of the proposed discharges on water quality in the Tees Estuary and Tees Bay with specific focus on localised temperature impacts and wider impacts on nitrogen concentrations within Tees Bay and the Tees Estuary. The results of this assessment will aid in the assessment of the impact of the Proposed Development on nutrient levels and how this may impact the Teesside and Cleveland Coast Special Protection Area/Ramsar site, including parts of Tees Bay and the Tees Estuary.

The impacts of the discharge of surface water and slightly contaminated wastewater to Tees Bay were assessed in the Base Case Water Quality Assessment (Appendix A to the Nutrient Nitrogen Briefing Paper 9, DCO Document Ref. 5.36).

Natural England have expressed their concerns about the discharge of treated NZT effluent from Bran Sands WwTW to the Tees Estuary (via Dabholm Gut) due to the increased loading of nitrogen entering the waterbody. Following consultation with NWL, the Applicants have looked at an alternative discharge option involving returning treated effluent from NWL to the PCC site by pipeline. This effluent will contain an equivalent nitrogen loading to the effluent sent from NZT to Bran Sands WwTW for treatment. This document sets out an updated assessment to assess this alternative option.

Two alternative proposals were under consideration for the location of the Tees Bay outfall during the Initial Design Stage Assessment. The first option was to re-use the existing former steelworks outfall. The second was to construct a new outfall at a location south-east of the existing outfall, with the precise location and outfall pipeline/diffuser design still to be determined. As there are technical and commercial challenges to reusing the existing outfall this report only assesses the use of a newly constructed outfall to Tees Bay from the PCC site. If the challenges to re-using the existing outfall can be managed, the discharge from the existing outfall would also need to be modelled.

This assessment sets out details of the near and far field water quality modelling carried out on the basis of the information now available. This includes consideration of chemical constituents using data which were not available to inform the Initial Design Stage Assessment. The assessment aims to represent worst case thermal and nitrogen impacts on Tees Bay and the Tees Estuary given current design philosophies and water management methods proposed for the PCC site. However, the Proposed Development is currently in the Front End Engineering Design (FEED) stage and as such proposals have yet to be finalised, and proposed discharge rates and effluent quality may change in the future as the design progresses further and arrangements for water use are finalised (e.g. on or off site water treatment provision, water re-use on site, design of future outfalls). This Intermediate Design Stage Assessment therefore seeks to provide a worst-case scenario assessment of water quality impacts based on the currently available information. It is envisaged that the modelling will be revisited post consent when a Final Design Stage Assessment is carried out. The purpose of this assessment is to establish the worst-case possible impacts on Tees Bay and the Tees Estuary using the discharge of returned effluent from Bran Sands via the alternative outfall option.

This assessment builds on the work carried out for the Initial Design Stage Assessment, including work to characterise the receiving environment and construct a 3D hydrodynamic model of the tidal River Tees and Tees Bay. Details of this work are provided in Appendix A and the same 3D model is used to provide input data to the near field modelling discussed below as well as to carry out the far field modelling. The scope of each design stage assessment is summarised in Table 1-1.

Table 1-1: Design Stage Water Quality Assessment Scopes

Design Stage	Scope
Initial Assessment	Assesses thermal impacts of heated discharges on Tees Bay only Assesses mixing zone extents at the location of an existing discharge point and a potential future discharge point (outfall locations generally known but not precise) One single discharge rate from the site of 1.37 m^3/s (combination of all wastewater streams and surface water runoff) Assumes entire discharge is heated to 30°C (theoretical maximum based on general power station operations, separate heated and cold water stream components of final discharge not known) Focussed on developing 3D hydrodynamic model of Tees Bay, the River Tees and Tees Estuary to allow mixing and dispersion modelling Includes near and far field mixing zone modelling for thermal impacts Shows smaller mixing zones in the region of the existing discharge point and larger mixing zones in the region of the potential future discharge point
This Assessment	Presents sources and flows of wastewater streams for the current design philosophy for the site Calculates resulting chemistry and temperature of the combined wastewater discharge to Tees Bay Redefines thermal impacts on Tees Bay from Initial Assessment modelling given known future heated water flows Following comments from the Environment Agency and Natural England, models DIN mixing and dispersion in Tees Bay Provides initial calculations for impacts in terms of microcontaminant loads (dissolved metals, hydrocarbons and pesticides) with some assumptions to account for data availability Uses the 3D hydrodynamic model developed for the Initial Design Stage report to inform near field mixing zone modelling and carry out far field mixing zone modelling for the future discharge location which is more precisely defined
Final Assessment (to be undertaken post consent)	Confirm the final sources and flows of wastewater streams given finalised site design Recalculate the resulting chemistry and temperature of the combined wastewater discharge to Tees Bay using known chemistry and temperature data. Use the 3D hydrodynamic model developed for the Initial Design Stage report to check the extent of the thermal and chemical mixing zones for the final selected discharge location Update the model representation of the outfall to reflect the final design of the outfall, including multiport diffuser if required

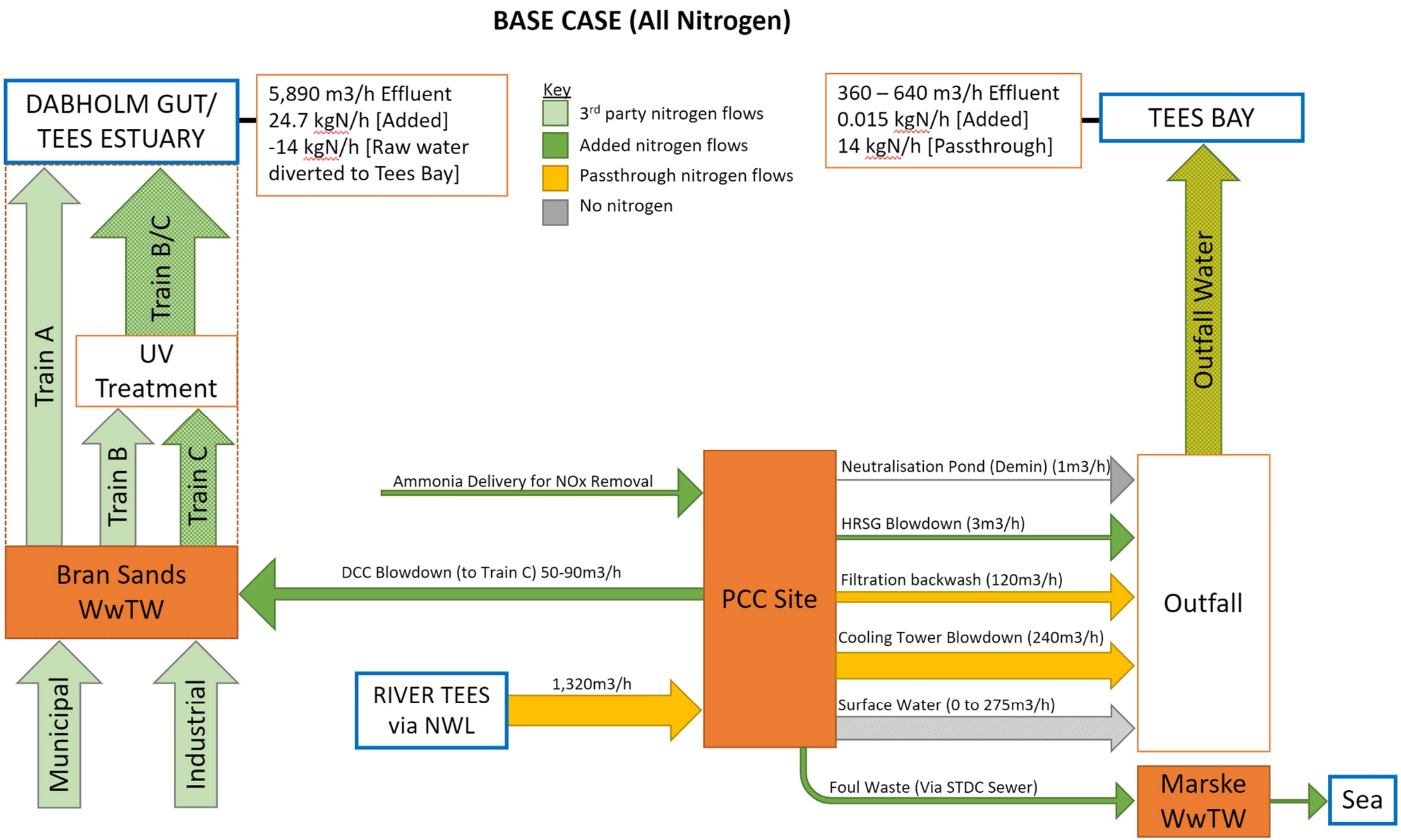
Design Stage	Scope
	Ensure that the impacts of the final design on Tees Bay water quality are acceptable and support application for discharge licencing

1.2 Development Proposals

At this stage the Proposed Development design remains under development, with FEED works ongoing. Based on the available information, for the alternative design option the effluent from the PCC site will consist of:

- **Cooling Tower Blowdown Water**: a supply of untreated raw water abstracted upstream of the tidal limit on the River Tees by Northumbrian Water Limited (NWL) will be supplied to the site via NWL's network. This supply will be used as cooling water in the power station, after which a portion of the used cooling water is discharged as blowdown. The blowdown will be discharged as effluent to Tees Bay.
- **Filter Reject Water**: prior to use in the cooling system, the untreated raw water from the River Tees will be filtered on site. An allowance of 10% water loss at this stage has been allowed for, with the rejected water directed to the Tees Bay outfall.
- **Process Water**: CO_2 compression and dehydration produces a small amount of water which will be diluted and neutralised prior to discharge.
- **Condensed Water**: A small amount of additional effluent will be generated on site as steam condensate ("Condensed Water") and will also be discharged to Tees Bay.
- **Return Flows**: Some wastewater produced on site within the Carbon Capture and Storage plant (Direct Contact Cooler (DCC) Blowdown) will contain significant concentrations of ammonia and will be routed to Bran Sands WwTW for treatment. Bran Sands WwTW discharges to Dabholm Gut; in order to preserve nutrient neutrality within the Gut (and the River Tees downstream) water will be returned to the NZT site from Bran Sands WwTW at an agreed rate ("Return Flows") for discharge to Tees Bay.
- **Surface Water Runoff**: surface water runoff from the NZT site will be collected and discharged to Tees Bay via on-site attenuation storage facilities. Where there is the potential for hydrocarbon contamination, surface water from the redeveloped site will be routed through oil interceptors.

The flow chart in Figure 1-1 summarises the different flows at the proposed NZT site in the base case and alternative design options. Water quality impacts in Tees Bay may occur from the Cooling Tower Blowdown Water and Condensed Water. Further, the origin of the Cooling Tower Blowdown Water is untreated water from the River Tees and contains contaminants typical of a large lowland river draining a diverse catchment with extensive farming and industrial use including DIN. These contaminants can be concentrated by up to five times by re-use within the cooling system. The Condensed Water flows are significantly smaller than the Cooling Tower Blowdown Water flows but this water may contain concentrations of ammonia up to 5 mg/l. The Return Flows from Bran Sands WwTW will also comprise treated wastewater and will have pollutant profiles typical of a large WwTW final treated effluent, including elevated nitrate concentrations. This may include dissolved organic nitrogen or particulate nitrogen but the return of this effluent from Bran Sands and discharge to Tees Bay will merely divert this effluent from the estuary (as at present) to the bay. Section 2 of this report sets out the flows and pollutant loads of the different streams and the final combined effluent discharged to Tees Bay.


BASE CASE (All Nitrogen)
DABHOLM GUT/ TEES ESTUARY
5,890 m3/h Effluent
24.7 kgN/h [Added]
-14 kgN/h [Raw water diverted to Tees Bay]
Key
3rd party nitrogen flows
Added nitrogen flows
Passthrough nitrogen flows
No nitrogen
360 – 640 m3/h Effluent
0.015 kgN/h [Added]
14 kgN/h [Passthrough]
TEES BAY
Train A
Train B/C
UV Treatment
Train B
Train C
Outfall Water
Ammonia Delivery for NOx Removal
Neutralisation Pond (Demin) (1m3/h)
HRSG Blowdown (3m3/h)
Filtration backwash (120m3/h)
Cooling Tower Blowdown (240m3/h)
Surface Water (0 to 275m3/h)
Bran Sands WwTW
DCC Blowdown (to Train C) 50-90m3/h
PCC Site
Outfall
RIVER TEES via NWL
1,320m3/h
Municipal
Industrial
Foul Waste (Via STDC Sewer)
Marske WwTW
Sea

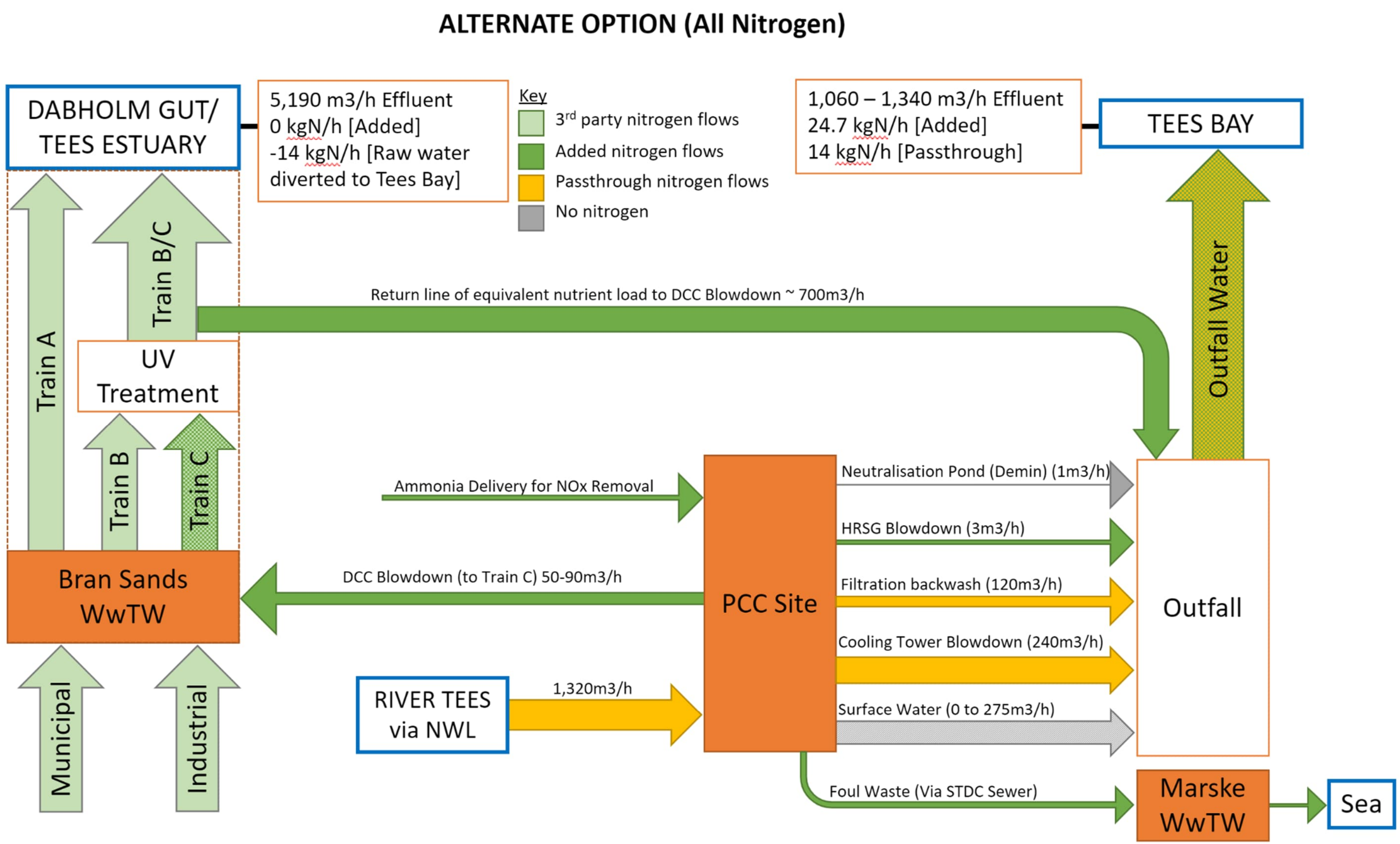


Figure 1-1: Proposed Wastewater Streams from NZT Site in Base Case and Alternate Option

The main purpose of the modelling in this report is to assess the water quality impacts of discharging to Tees Bay. However, Natural England have also requested consideration of nutrient neutrality in the Tees Estuary which forms part of the Teesside and Cleveland Coast Special Protection Area and Ramsar Site. Abstracting and discharging the Blowdown Water will slightly reduce the mass of nitrogen reaching the tidal Tees Estuary as the water (and dissolved nitrogen compounds) abstracted from the non-tidal Tees upstream will be diverted to Tees Bay and bypass the Estuary. This effective reduction in DIN in the Tees Estuary needs to be balanced by DIN that disperses back into the Estuary from the discharges of DIN to the Tees Bay. For further details of the Nutrient Nitrogen Assessment, please see the Nutrient Nitrogen Briefing Paper (Document Ref. 9.36) and the Habitat Regulations Assessment (Document Ref. 5.13).

This report assesses the impacts of discharges to Tees Bay based on discharges from the NZT site only. The site location is shown in Figure 1-2. The Environment Agency have confirmed that currently the NZT Proposed Development will be the only existing or potential permitted discharge to the Bay which has the potential to contribute nitrogen to this waterbody and therefore modelling of cumulative impacts with other discharges into Tees Bay or the Tees Estuary is not required.

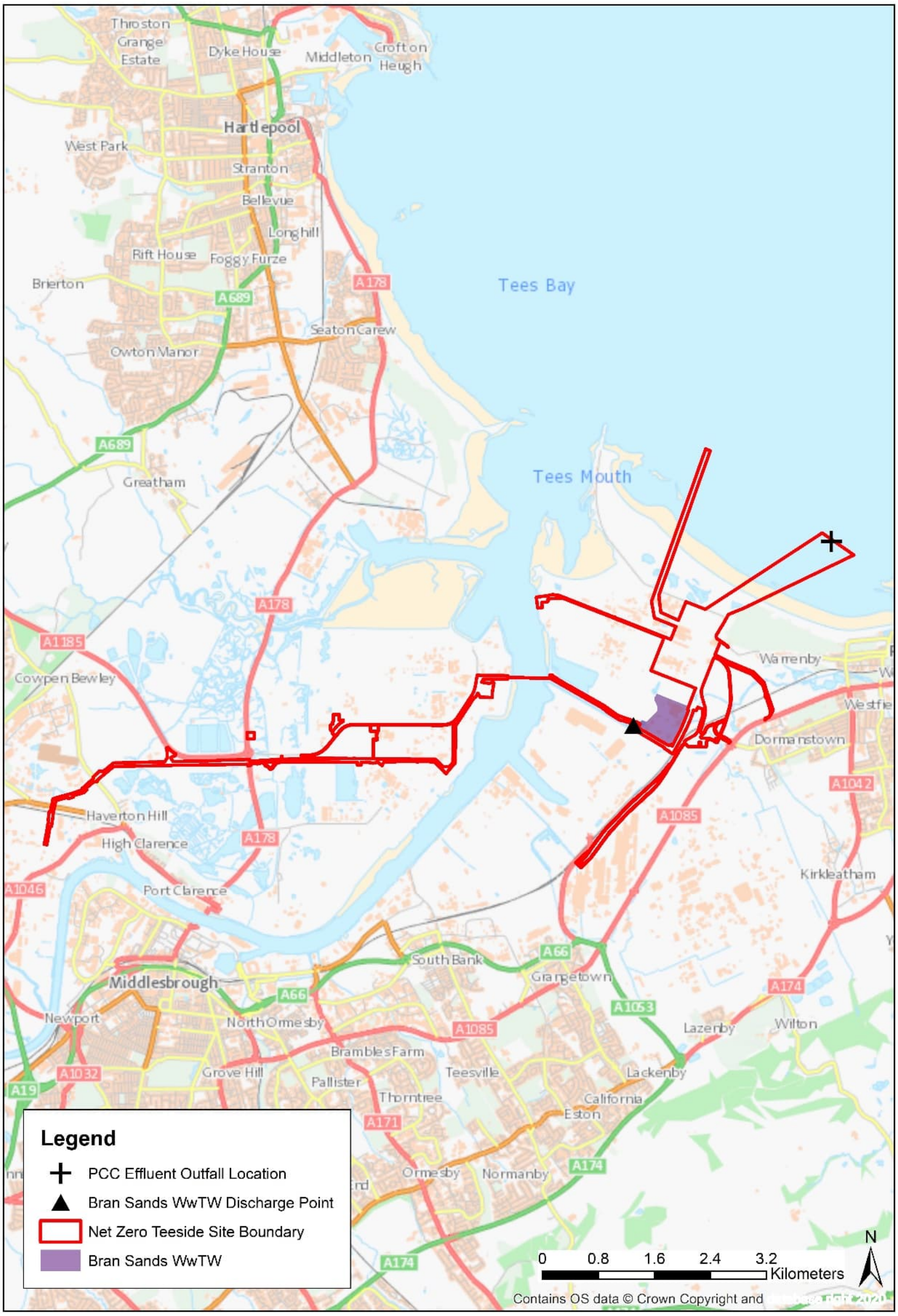


Figure 1-2: NZT Development Boundary and Potential Effluent Discharge Locations

2. Discharged Effluent Quality

2.1 Environmental Quality Standards

Table 2-1 sets out Environmental Quality Standards (EQS) relevant to the Tees Bay coastal water under current UK legislation. These standards have been used to develop the list of pollutants which need to be assessed to determine the water quality impacts of the proposed discharge.

Table 2-1: Environmental Quality Standards for Tees Bay

Parameter	Environmental Quality Standard
Temperature	Less than 3°C increase in temperature outside the immediate mixing zone
Dissolved Oxygen	Mean = 5.74 mg/l (calculated from salinity)
Un-ionised Ammonia	Mean = 21 µg/l
Arsenic	Mean = 25 µg/l
Chlorine	95%ile = 10 µg/l
Cyanide	Mean = 1 µg/l, 95%ile = 5 µg/l
Hydrocarbons	
Benzyl butyl phthalate	Mean = 0.75 µg/l 95%ile = 10 µg/l
2,4-dichorophenol	Mean = 0.42 µg/l, 95%ile = 6 µg/l
3,4-dichloroaniline	Mean = 0.2 µg/l, 95%ile = 5.4 µg/l
Phenol	Mean = 7.7 µg/l, 95%ile = 46 µg/l
Toluene	Mean = 0.074 µg/l, 95%ile = 0.370 µg/l
Triclosan	Mean = 0.1 µg/l, 95%ile = 0.28 µg/l
Metals	
Chromium (VI)	Mean = 0.6 µg/l, 95%ile = 32 µg/l
Copper	Mean = 3.76 µg/l dissolved
Iron	Mean = 1 mg/l
Zinc	Mean = 6.8 µg/l dissolved plus ambient (1.1 µg/l) = 7.9 µg/l
Pesticides	
Cypermethrin	Mean = 0.1 ng/l, 95%ile = 0.4 ng/l
Diazinon	Mean = 0.01 µg/l, 95%ile = 0.26 µg/l
2,4-dichlorophenoxyacetic acid (2,4-D)	Mean = 0.3 µg/l, 95%ile = 1.3 µg/l
Dimethoate	Mean = 0.48 µg/l, 95%ile = 4 µg/l
Glyphosate	Mean = 196 µg/l, 95%ile = 398 µg/l
Linuron	Mean = 0.5 µg/l, 95%ile = 0.9 µg/l
Mecoprop	Mean = 18 µg/l, 95%ile = 187 µg/l
Permethrin	Mean = 0.2 ng/l, 95%ile = 1 ng/l

In addition to these standards, nitrogen concentrations in coastal waters are limited with reference to Dissolved Inorganic Nitrogen (DIN). The applicable EQS values for DIN are selected for each coastal waterbodies based on its recorded salinity and suspended particulate matter concentration[1]. In this case, Environment Agency data show an average of 8 mg/l suspended solids and normal salinity of 30 ppt at Tees Mouth (see Section 3.6) and salinity of 32-35 ppt in Tees Bay. These values are consistent with clear water and coastal (i.e. not transitional) waters.

[1] For further information see https://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf

Table 2-2 sets out the WFD class boundaries for DIN concentrations for clear coastal waters. The boundaries are provided as µmol/l, which are citied in the WFD legislation, and as the equivalent concentration in mg/l based on guidance provided by the UK Technical Advisory Group[2] in their method statement document in which these standards are derived.

Table 2-2: WFD Class Boundary EQS Values for DIN

Unit Expression	WFD Class Boundary			
	High	Good	Moderate	Poor
Dissolved Inorganic Nitrogen (µmol/l)	12	18	27	40.5
Dissolved Inorganic Nitrogen (mg/l)	0.168	0.252	0.378	0.567

Nitrogen data available for this analysis are presented using varying units between different forms and sources of nitrogen. For consistency, the DIN standards expressed as mg/l N will be used in this report, with the appropriate conversions applied to the raw data where required.

The dissolved oxygen EQS in Table 2-1 is calculated for High Status from salinity for coastal waters with salinity less than 35 ppt. Dissolved oxygen discharges will not be modelled as a pollutant because concentrations in receiving waters will be controlled by temperature and nutrient (DIN) impacts.

2.2 Effluent Pollutant Concentrations

2.2.1 Filtration Reject Water and Cooling Tower Blowdown Water Quality

The source of the Cooling Tower Blowdown Water is untreated River Tees water from one of three abstraction points – Low Worsall, Blackwell and Broken Scar. River water quality monitoring data have been provided by Northumbrian Water for Broken Scar and a summary dataset of key substances has been provided for Low Worsall and Blackwell. Additional water quality data have been sourced from the Environment Agency monitoring at Low Worsall. Review of the data show significant differences in water quality at Low Worsall while water quality at Blackwell is similar to that at Broken Scar – average pollutant concentrations at each abstraction are shown in Table 2-3.

Table 2-3: Mean Pollutant Concentrations at River Tees Abstraction Points (2016-2022)[2]

Parameter	Broken Scar	Blackwell	Low Worsall
Temperature (°C)[3]	11.2	10.8	10.9
Dissolved Inorganic Nitrogen (mg/l)	0.81	0.83	2.49
Un-ionised Ammonia (µg/l)	0.12	0.51	1.34
Arsenic (µg/l)	No data	No data	0.54
Chlorine (µg/l)	No data	No data	No data
Cyanide (µg/l)	No data	No data	Not detected
Hydrocarbons			
Benzyl butyl phthalate (µg/l)	No data	No data	No data
2,4-dichorophenol (µg/l)	No data	No data	Not detected
3,4-dichloroaniline (µg/l)	No data	No data	No data
Phenol (µg/l)	No data	No data	No data
Toluene (µg/l)	No data	No data	Not detected

[2] [redacted] page 40, accessed 23 August 2022
[3] Data provided by Northumbrian Water for Low Worsall abstraction

Parameter	Broken Scar	Blackwell	Low Worsall
Triclosan (µg/l)	No data	No data	Not detected
Metals			
Chromium (VI) (µg/l)	Mean = 0.48, 95%ile = 1.40	No data	Mean = 0.73, 95%ile = 1.85
Copper (µg/l)	No data	1.0	1.6
Iron (mg/l)	0.6	0.5	0.6
Zinc (µg/l)	No data	No data	17.6
Pesticides			
Cypermethrin (ng/l)	Not detected	No data	Mean = 0.03, 95%ile = 0.1
Diazinon (µg/l)	Mean = 0.003, 95%ile = 0.005	No data	Mean = 0.001, 95%ile = 0.002
2,4-D (µg/l)	Mean = 0.002, 95%ile = 0.006	No data	Mean = 0.035, 95%ile = 0.070
Dimethoate (µg/l)	No data	No data	Not detected
Glyphosate (µg/l)	Mean = 0.012, 95%ile = 0.042	No data	Mean = 0.094, 95%ile = 0.260
Linuron (µg/l)	No data	No data	Not detected
Mecoprop (µg/l)	Mean = 0.002 95%ile = 0.007	No data	Mean = 0.062, 95%ile = 0.269
Permethrin (µg/l)	No data	No data	Not detected

Discussions with NWL have confirmed that although the Low Worsall abstraction point is currently out of use it is expected to return to use as local water requirements increase, including in response to development of the PCC site. It is therefore assumed that the PCC site will receive the majority of its raw water supply from Low Worsall. Based on the current site design information (see Figure 1-1), the raw water from the River Tees will be filtered, with approximately 10% directed straight to the Tees Bay as Filter Reject Water. The remaining 90% will be used in the cooling towers where potential contaminant will be concentrated by up to five times as the raw water is condensed and recycled as Cooling Tower Blowdown Water.

The pollutant loads in the Filter Reject Water and Cooling Tower Blowdown Water have been calculated in this report based on the assumption that all raw water will be sourced from Low Worsall, with no supply from Broken Scar or Blackwell. This gives a worst-case scenario for effluent DIN concentrations. The Low Worsall data show that the raw water will not contain significant quantities of cyanide, 2,4-dichlorophenol, toluene, triclosan, dimethoate, linuron or permethrin. There are no data for chlorine, benzyl butyl phthalate, 3,4-dichloroaniline or phenol. The impact of mixing and concentration on final effluent quality is discussed in Section 2.2.6.

The abstraction of water and dissolved pollutants, including dissolved nitrogen, from the non-tidal River Tees, and subsequent discharge to Tees Bay, will effectively reduce the overall annual pollutant mass reaching the Tees Estuary. There will be no overall change in total annual pollutant mass reaching Tees Bay through the Filter Reject Water or Cooling Tower Blowdown Water creation process because the ultimate source of pollutants in these effluent streams is the River Tees – use of this water changes the pathway of pollutants reaching Tees Bay but does not represent a new source of pollutants.

2.2.2 Direct Contact Cooler Water and Return Flows

The carbon capture and storage facility proposed at the NZT site will generate Direct Contact Cooler Water which will contain high concentrations of ammonia. This water will be sent to Bran Sands WwTW. In order to maintain nutrient neutrality in the Dabholm Gut and Estuary, it is proposed to return an appropriate volume of treated effluent from Bran Sands to the NZT site. The volume of Return Flow treated effluent required to offset the additional supply of dissolved nitrogen to Dabholm Gut is calculated below.

STEP 1: DIRECT CONTACT COOLER WATER N MASS	
Flow rate to Bran Sands WwTW	50-90 m^3/hr *(assume 90 m^3/hr as worst case scenario)*
Ammonia load to Bran Sands WwTW	10-30 kg/hr *(assume 30 kg/hr as worst case scenario)*
N load as ammonia to Bran Sands WwTW	$\frac{30}{1.1259} = \mathbf{24.67\ kg/hr}$
STEP 2: DIRECT CONTACT COOLER WATER TREATMENT AT BRAN SANDS WWTW	
At Bran Sands, an average of 97% of ammonia is converted to nitrate with 3% remaining as ammonia	
Treated Water N load as nitrate	$24.67 \times 97\% = 23.90\ kg\ N/hr$
Treated Water N load as ammonia	$24.67 \times 3\% = 0.74\ kg\ N/hr$
STEP 3: TREATED WATER IS MIXED WITH BRAN SANDS TREATED EFFLUENT	
Average existing Bran Sands Effluent discharge rate	5774 m^3/hr
Current (2015 onwards) Dissolved Inorganic Nitrogen concentration breakdown in Bran Sands treated effluent (based on Environment Agency regulatory monitoring data)	Average N as ammonia = 5.53 mg/l Average N as nitrate = 24.58 mg/l Average N as nitrite = 0.99 mg/l Total Current N load = 31.10 mg N/l
Current Dissolved Inorganic Nitrogen load breakdown in Bran Sands treated effluent	Average N load as ammonia = 31.95 kg/hr Average N load as nitrate = 141.1 kg/hr Average N load as nitrite = 5.69 kg/hr
Dissolved Inorganic Nitrogen Load Breakdown in Bran Sands Treated Effluent, including additional load from NZT	Average N as ammonia = 32.69 kg/hr Average N as nitrate = 165.06 kg/hr Average N as nitrite = 0.99 kg/hr
Predicted Dissolved Inorganic Nitrogen concentration breakdown, including additional flows from NZT Total flow rate = 5774+ 90 = 5864 m^3/hr	Average N as ammonia = 5.57 mg/l Average N as nitrate = 28.15 mg/l Average N as nitrite = 0.97 mg/l Total N, including NZT contribution = 34.69 mg N/l
STEP 4: NUTRIENT NEUTRALITY CALCULATION	
Required nitrogen mass to be returned to NZT	24.67 kg N/hr
N concentration in return flow	34.69 mg N/l (3.469 x10^{-5} kg N/l)
Return flow rate required	$\frac{24.67}{3.469 \times 10^{-5}} = 7.11 \times 10^5 l/hr = \mathbf{711 m^3/hr}$

The above calculation shows that a return flow rate of 711 m^3/hr from Bran Sands will be required to preserve nutrient neutrality in the Dabholm Gut and River Tees estuary. A return flow rate of 750 m^3/s will be assumed at this stage in the design to allow for future refinement of the NZT site operations.

The current concentrations of pollutants in Bran Sands effluent is set out in Table 2-4. Un-ionised Ammonia concentrations have been calculated from observed ammonia concentrations from 2015 onwards using the formula in Equation 2-1.

Equation 2-1: Approximation for Calculating Un-ionised Ammonia Fraction from Total Ammonia[4]

$$Unionised\ Ammonia\ (mg/l) = \frac{Total\ Ammonia\ (mg/l) \times \frac{17}{14}}{1 + 10^{\left[0.09018 + \frac{2729.92}{273.15 + Temp\ (°C)} - pH\right]}}$$

[4] https://floridadep.gov/sites/default/files/5-Unionized-Ammonia-SOP_1.pdf, accessed 10 May 2022

Table 2-4: Mean Pollutant Concentrations in Bran Sands Effluent

Parameter	Current
Temperature (°C)	16.3
Dissolved Inorganic Nitrogen (µg/l)	2,478 (including contribution from NZT)
Un-ionised Ammonia (µg/l)	28
Arsenic (µg/l)	4.51
Chlorine (µg/l)	Not detected
Cyanide (µg/l)	No data
Hydrocarbons	
Benzyl butyl phthalate (µg/l)	No data
2,4-dichorophenol (µg/l)	No data
3,4-dichloroaniline (µg/l)	No data
Phenol (µg/l)	No data
Toluene (µg/l)	Mean = 0.003, 95%ile = 0.015
Triclosan (µg/l)	No data
Metals	
Chromium (VI) (µg/l)	Mean = 7.81, 95%ile = 21.5
Copper (µg/l)	12.9
Iron (mg/l)	0.34
Zinc (µg/l)	54.0
Pesticides	
Cypermethrin (µg/l)	No data
Diazinon (µg/l)	No data
2,4-D (µg/l)	No data
Dimethoate (µg/l)	No data
Glyphosate (µg/l)	No data
Linuron (µg/l)	No data
Mecoprop (µg/l)	No data
Permethrin (µg/l)	No data

2.2.3 Condensed Water Quality

The Cooling Tower Blowdown Water and Return Flows will make up the majority of the effluent produced by the PCC site. However, as noted previously a small additional flow of Condensed Water from the HRSG is also expected to be discharged into Tees Bay. This water is expected to contain only one contaminant which is subject to an EQS, ammonia, at concentrations of 5 mg/l, which is limited through the DIN EQS. The Condensed Water may also contain dissolved carbon dioxide at concentrations sufficient to reduce the pH to a value of 6, however neither pH nor carbon dioxide concentrations are limited in coastal waters. The impact of mixing and re-use of Condensed Water on the final discharged effluent quality is discussed in Section 2.2.5.

2.2.4 Process Water and Surface Water Runoff

Process water from CO_2 compression and dehydration is a very small contribution to effluent discharges from the PCC site. This water is not expected to contain pollutants limited through EQS standards for coastal waters.

Surface water runoff is also not expected to be a significant source of contaminants or nitrogen to the discharged effluent. The surface water management proposals for the PCC site are still at an early stage, however they include installation of oil interceptors where there is a risk of surface water contamination, plus testing of any surface water prior to discharge, in accordance with Environmental Permitting requirements. Sustainable drainage systems will be installed following redevelopment which will include surface water attenuation features which will allow settlement of solids and breakdown of contaminants. Therefore, it is assumed at this stage of the study that the addition of surface water runoff to the discharged effluent will serve to dilute contaminants rather than increase concentrations (see Section 2.2.5).

2.2.5 Final Mixed Effluent Discharge Scenarios

As discussed in Section 1.2, the final effluent discharged to Tees Bay will comprise a mixture of concentrated Cooling Tower Blowdown Water, Filter Reject Water, Return Flows, Process Water and Condensed Water, with or without surface water addition. The pollutant flows, effluent loads and temperatures in scenarios which include or exclude the addition of surface water are set out in Table 2-5. Worst case scenario conditions are assumed where required, e.g. it is assumed that all Filter Reject Water and Cooling Tower Blowdown Water are sourced from Low Worsall as this is the worst case for DIN. When considering the impact of surface water runoff, the runoff volume has been estimated by allowing for 9 mm rainfall depth[5] (the rainfall depth expected during a rainfall event lasting 1 hour and occurring, on average, once per year, i.e. a moderately sized storm) over an area of 150,000 m^2 of hard standing surface, based on the area of the PCC site.

Effluent quality has been calculated using the quality data summarised in Tables 2-3 and 2-4 for Filter Water, Cooling Tower Blowdown Water and Return Flows. Note that data are not available for pesticide concentrations and concentrations of most hydrocarbons in the Return Flows. An allowance has been made for some contribution of Return Flows to pollutant loads for these substances by assuming that concentrations in the final treated effluent from Bran Sands WwTW is similar to those in the non-tidal River Tees at Low Worsall. Condensed Water is assumed to contain only ammonia as a pollutant, while surface water runoff and Process Water are not expected to significantly contribute to the concentrations of pollutants.

For each scenario, each chemical substance present in the effluent at concentrations greater than the EQS in Table 2-1 is highlighted in yellow. The combined effluent is not expected to contain concentrations of any restricted hydrocarbon above the EQS and does not contain chlorine, cyanide, 2,4-dichorophenol or triclosan. The effluent may contain traces of arsenic and iron originating from the non-Tidal River Tees and Bran Sands WwTW, however average concentrations are not expected to exceed the EQS and there will be no net change in the pollutant load reaching Tees Bay because these pollutants currently reach the Bay via the River Tees or Bran Sands discharge currently. Mixed effluent concentrations of DIN, unionised ammonia chromium (VI), copper and zinc are expected to exceed the EQS. There are no data available for benzyl butyl phthalate, 3,4-dichloroaniline or phenol.

The temperature of the discharged effluent will depend on the final development design because the current site designs include balancing ponds where Cooling Tower Blowdown Water, Condensed Water and surface water run-off will be mixed prior to discharge, giving opportunity for cooling. Significant additional cooling will occur through addition of the Filter Reject Water and Return Flows, which are not heated and make up the majority if the discharged effluent in the absence of surface water runoff. The current site design is expected to result in a worst-case summer scenario discharged effluent temperature of approximately 19°C, reducing to 15°C when the effects of runoff are included.

The current design for the site includes pumping of the combined effluent streams to the Tees Bay outfall. This means that the rate of discharge will be limited by the pump capacity. The current site

[5] Rainfall depth information taken from Flood Estimation Handbook 2013 model, accessed at [redacted] on 10 May 2022

design shown in Figure 1-1 shows a final pumped discharge rate of 341 m^3/hr, or 0.094 m^3/s, however this does not account for Return Flows or surface water runoff addition. The Return Flows are continuous and will increase discharge rates by 750 m^3/hr to 0.30 m^3/s. The further addition of surface water runoff will require an increase in pumping rate – a rate of 0.4 m^3/s (30% increase) has been allowed for in the modelling to represent this.

The discharge has been modelled to represent two options:

- Continuous discharge – the flow rate is taken as 0.3 m^3/s or 0.4 m^3/s with surface runoff and is discharged at all stages of the tidal cycle.
- Intermittent discharge – effluent is discharged only during high tide conditions when the current direction carries effluent away from the River Tees estuary. This is in order to provide additional protection to sensitive environmental receptors within the Tees Bay and Tees Estuary the 3D hydrodynamic model described in Section 3 has been used to identify pumping times. The model shows that effluent can be pumped for 50% of the tidal cycle, therefore pumping rates of 0.6 m^3/s and 0.8 m^3/s are assumed.

Table 2-5: Flows and Pollutant Loads for Modelled Discharge Scenarios

Parameter	Without Surface Water Runoff	Surface Water Runoff Included	EQS
Temperature (°C)	19	15	3°C above ambient
Dissolved Inorganic Nitrogen (mg/l)[1]	26.34	12.21	0.567
Un-ionised Ammonia (µg/l)	36	16	21
Arsenic (µg/l)	3.68	1.73	25
Chlorine (µg/l)	None	None	95%ile = 10 µg/l
Cyanide (µg/l)	None	None	Mean = 1 µg/l, 95%ile = 5 µg/l
Hydrocarbons			
Benzyl butyl phthalate (µg/l)	No Data	No Data	Mean = 0.75 µg/l 95%ile = 10 µg/l
2,4-dichorophenol (µg/l)	None	None	Mean = 0.42 µg/l, 95%ile = 6 µg/l
3,4-dichloroaniline (µg/l)	No Data	No Data	Mean = 0.2 µg/l, 95%ile = 5.4 µg/l
Phenol (µg/l)	No Data	No Data	Mean = 7.7 µg/l, 95%ile = 46 µg/l
Toluene (µg/l)	0.002	0.001	Mean = 0.074 µg/l, 95%ile = 0.370 µg/l
Triclosan (µg/l)	None	None	Mean = 0.1 µg/l, 95%ile = 0.28 µg/l
Metals			
Chromium (VI) (µg/l)	6.13	2.86	Mean = 0.6 µg/l, 95%ile = 32 µg/l
Copper (µg/l)[2]	10.6	4.98	Mean = 3.76 µg/l dissolved
Iron (mg/l)[2]	0.94	0.50	Mean = 1 mg/l
Zinc (µg/l)	57.2	28.1	Mean = 6.8 µg/l dissolved plus ambient (1.1 µg/l) = 7.9 µg/l
Pesticides			
Cypermethrin (ng/l)	0.14	0.07	Mean = 0.1 ng/l, 95%ile = 0.4 ng/l
Diazinon (µg/l)	0.005	0.002	Mean = 0.01 µg/l, 95%ile = 0.26 µg/l
2,4-D (µg/l)	0.19	0.08	Mean = 0.3 µg/l, 95%ile = 1.3 µg/l
Dimethoate (µg/l)	None	None	Mean = 0.48 µg/l, 95%ile = 4 µg/l
Glyphosate (µg/l)	0.43	0.21	Mean = 196 µg/l, 95%ile = 398 µg/l
Linuron (µg/l)	None	None	Mean = 0.5 µg/l, 95%ile = 0.9 µg/l
Mecoprop (µg/l)	0.28	0.14	Mean = 18 µg/l, 95%ile = 187 µg/l
Permethrin (µg/l)	None	None	Mean = 0.2 ng/l, 95%ile = 1 ng/l

[1] Represents worst case scenario operating conditions when condensate collected on site is being discharged to Tees Bay. Discharge of condensate occurs for 1 hour per month.

3. Receiving Environment

3.1 Model of the River Tees Estuary

Information on the physical environment of Tees Bay have been obtained for the study area from an existing, calibrated hydrodynamic model configured using the Delft3D (Deltares) software. This model was developed using the latest available data (ABPmer, 2019) and is provided in Appendix A. The model domain covers the River Tees Estuary and extends 10 km offshore and 30 km along the Hartlepool, Redcar and Cleveland coastline, as shown in Figure 3-1.

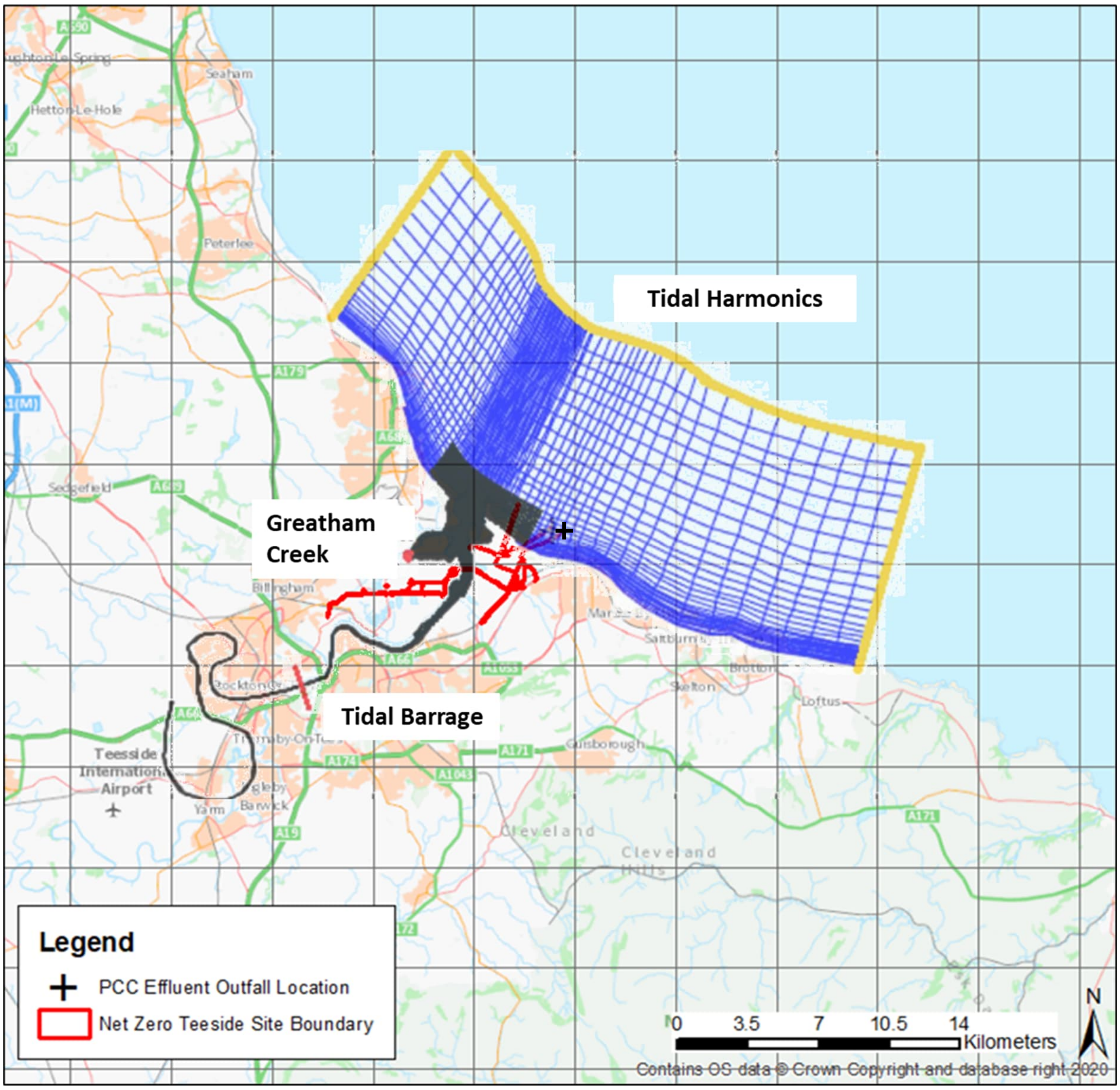


Figure 3-1: Delft3D hydrodynamic model extent

The model uses a curvilinear computational grid, which allows a grid composed of various sizes to be used throughout the model domain. A finer grid has been used for a section of the estuary west of the former steelworks (black shaded area in Figure 3-1) and a coarser grid for the offshore region (blue grid lines in Figure 3-1). The model uses a vertical layering with eight layers using a sigma value setup such that the layers compress or stretch with changes in the vertical water depth while retaining a given percentage of the total water depth in each layer. The vertical layering structure is as follows:

Table 3-1: Vertical Layering Details for the River Tees and Tees Bay Hydrodynamic Model

Layer	Layer Percentage	Percentage of Water Column Depth
1	5%	95%-100%
2	5%	90-95%
3	7%	82-90%
4	10%	72-82%
5	15%	58-72%
6	23%	35-58%
7	25%	10-35%
8	10%	Bed to 10%

Input flows to the model have been applied at three locations: tidal boundaries surrounding the offshore section of the model, Greatham Creek inflow and River Tees inflow represented at the location of Tees Barrage. These flows have been applied as follows:

- Three offshore boundaries have been used in the model (yellow lines in Figure 3-1) which are driven by tidal harmonics.
- The Tees Barrage has been represented as a “thin dam” structure (an infinitely thin barrier which prevents flow passing between two model cells without affecting the total volume of the channel) to prevent saline water extending upstream in the River Tees. A non-continuous freshwater discharge has been added at this location which was calculated from flow data available from the National River Flow Archive (NRFA). Peak discharge rates used in the model vary seasonally between 3 m^3/s (summer) and 74 m^3/s (winter).
- A continuous inflow of 1.8 m^3/s has been added to the model to represent the flow from Greatham Creek. This has been based on previous values used in prior modelling work.

The Delft3D hydrodynamic model was run for three simulation periods: calibration (20/04/2005 – 01/05/2005), verification (13/01/2001 – 27/10/2001) and 2019 seasonal runs (23/06/2019 – 08/07/2019). The period chosen for the 2019 seasonal run was selected to ensure that the mean spring and mean neap tidal conditions are captured in the model simulation period. The results from this simulation have been used in this study to simulate the tidal water variations and flows at the two outfall locations.

3.2 Outfall Location

Effluent from the PCC site is modelled as being discharged via a newly constructed outfall. The current proposed location of the new outfall is at OS NGR 458983N 526734E. This location has been selected to allow construction of the new outfall within the deepest water present within the proposed DCO boundary (Figure 1-2).

3.2 Bathymetry

The bathymetry data for the model has been compiled from a number of sources: PD Teesport Redcar Bulk Terminal Survey Data (29/01/2020), PD Teesport Survey Data (2019), LiDAR Contours, CMap, Admiralty Charts and survey data contained in previous models (2003). Where datasets overlapped, they were prioritised in the above order which has been dictated based on the quality of data. The bed profile extending from the shore towards the proposed outfall location is shown in Figure 3-2, where zero chainage is at the high tide shoreline (mean high water). The proposed outfall location is at approximately 1130 m chainage and at -9.4 mAOD.

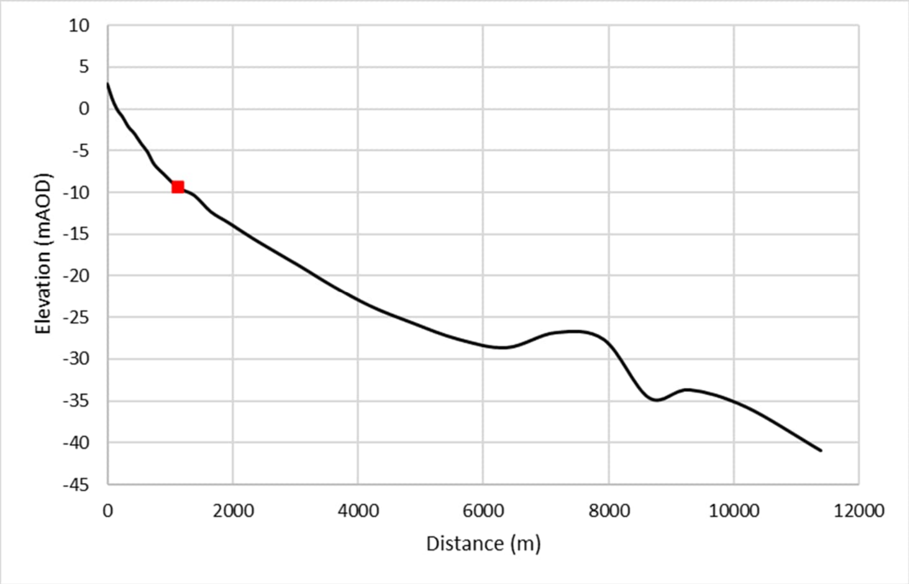


Figure 3-2: Bed Profile Extending Offshore at W3 Outfall Location

3.3 Tide Levels and Currents

Water level and current data have been extracted from the Delft3D model for the 2019 seasonal runs at the location of the proposed new outfall and are shown in Figures 3-3 to 3-5.

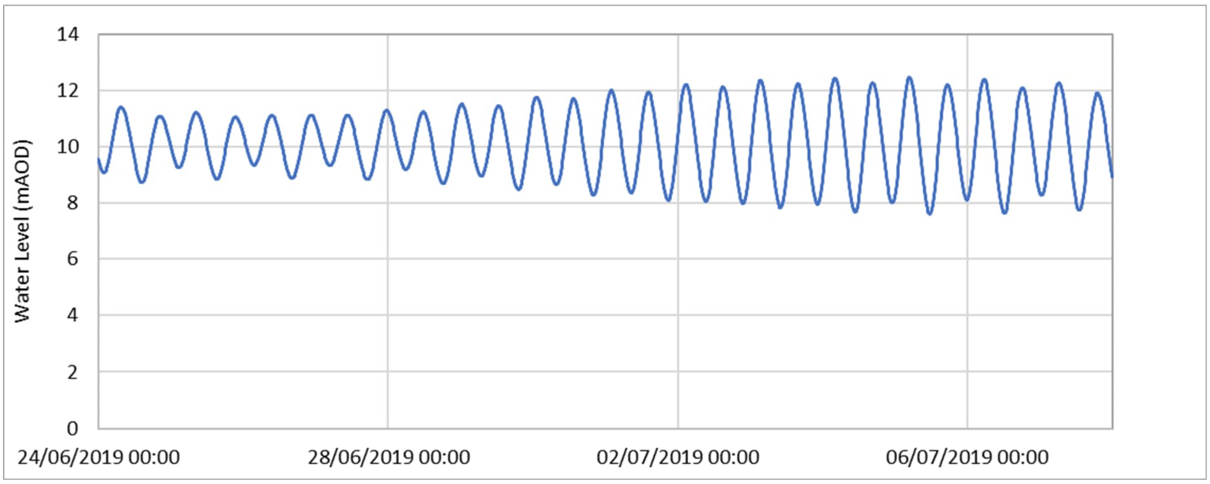


Figure 3-3: Water Levels at Proposed New Outfall Location

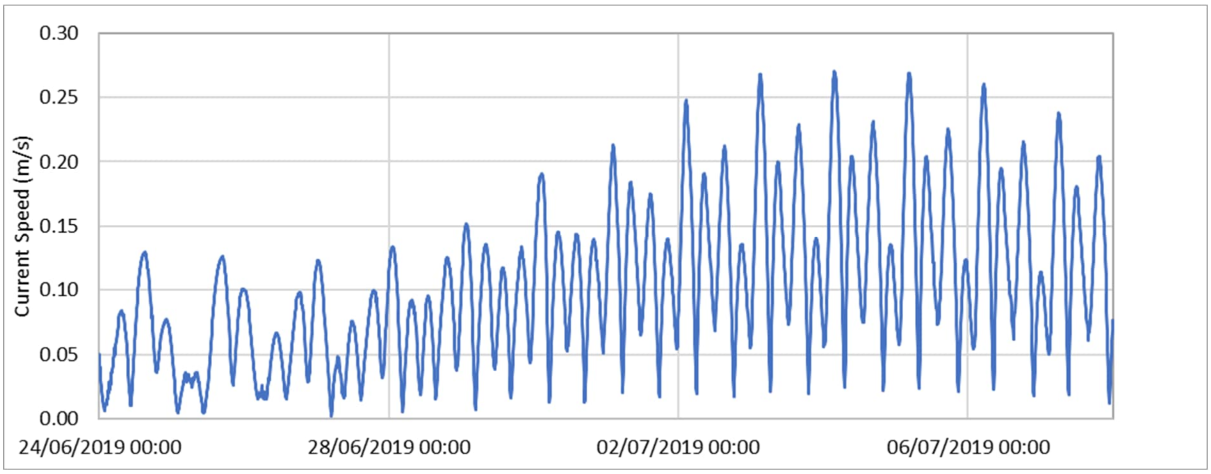


Figure 3-4: Depth Averaged Current Speeds at the Proposed New Outfall Location

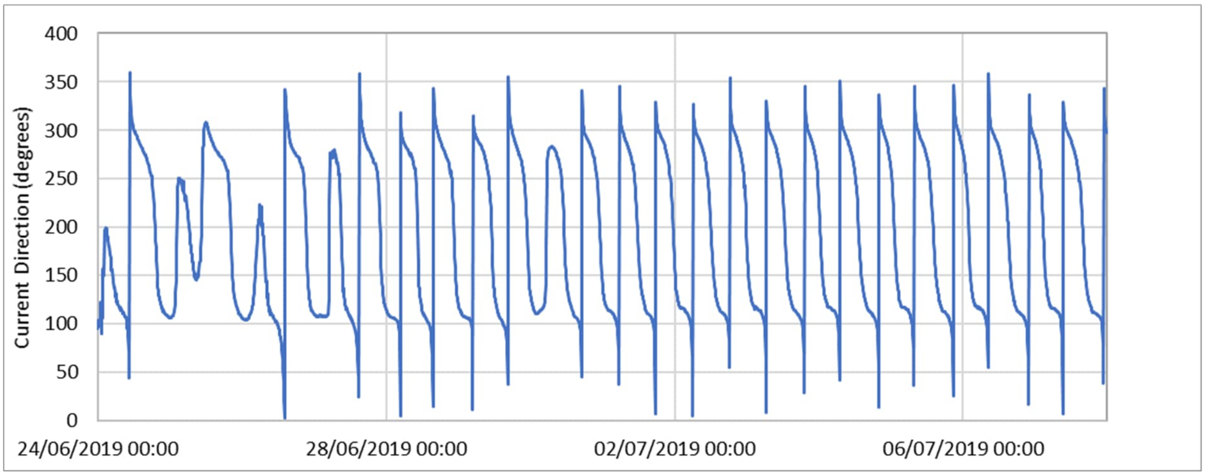


Figure 3-5: Current Directions at the Proposed New Outfall Location

Based on the above data, the values for water level, current speed and current direction, as listed in Table 3-2, have been used in the CORMIX modelling of the proposed new outfall. Note that the minimum current condition corresponds to the 99th percentile condition rather than the absolute modelled minimum current. This condition was used in place of a minimum current condition due to CORMIX results becoming unreliable during extreme low current conditions.

Table 3-2: Water Level and Current Conditions at Proposed New Outfall Location

Tidal Stage	Water Level (mAOD)	Current Speed (m/s)	Current Direction (°)
Minimum Tide Level	-2.23 (7.6 mAOD)	0.163	278
Maximum Tide Level	2.61 (12.5 mAOD)	0.264	116
Maximum Current Condition	2.54 (12.4 mAOD)	0.271	117
Minimum Current Condition	-0.41 (9.4 mAOD)	0.010	73

3.4 Wind Conditions

Wind speed data has been obtained from the Durham Tees Valley Airport anemometer. Data is available for the years 2015 to 2019 at hourly intervals. This data was analysed as part of the Delft3D thermal discharge modelling exercise to calculate a monthly average wind speed and direction. From this, the highest (5.32 m/s) and lowest (4.08 m/s) average speeds were taken as the winter and summer condition in the Delft3D model. A value of 4.08 m/s has been applied in the CORMIX modelling as a worst case low wind speed scenario, however the Initial Design Stage modelling in Appendix A shows that the near field mixing zone is not sensitive to wind speeds over the observed range at Durham Tees Valley Airport.

3.5 Temperature and Salinity

Temperature and salinity are included in the Environment Agency ambient water monitoring data at the sample points shown in Figure 3-6. The salinity in Tees Bay (Sampling Point A in Figure 3-6) is shown to be relatively constant and varies between 31 and 34 ppt. A value of 32 ppt will be used in the near field modelling.

The temperature in Tees Bay is shown to vary between 5°C in winter and 16°C in summer. Given the significant variation in seawater temperatures, separate CORMIX model runs will be carried out to assess the seasonal variation in mixing zone extent.

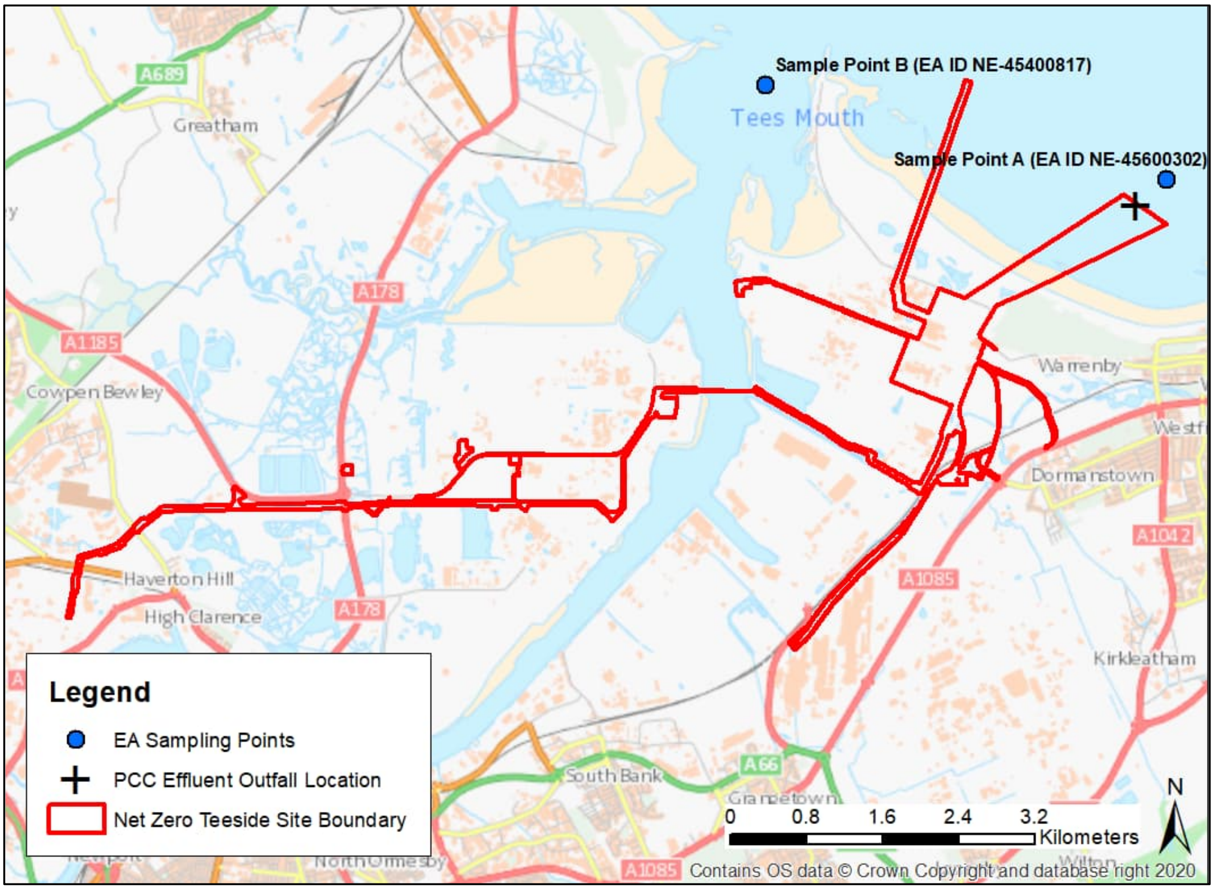


Figure 3-6: Environment Agency Ambient Water Quality Monitoring Locations

3.6 Ambient Water Quality

The Environment Agency data for two water quality sampling points, as shown in Figure 3-6, have been analysed to obtain suitable ambient water quality values for near field mixing zone modelling. Sample Point A is located within Tees Bay and records data from July 2019 to November 2021, however this sample point mainly records concentrations of metals, hydrocarbons and particulates, with physical parameters such as temperature and salinity. Parameters such as DIN are monitored at Sample Point B which has a longer record, from 2007 onwards, and is considered to be the best available data for water quality in Tees Bay. The location of Sample Point B does mean that water quality at this location may be more influenced by flows from the River Tees and use of the Sample Point B data will therefore allow for the effects of discharges into the River Tees to be taken into account in the modelling. Sample point B gives an average suspended solids concentration of 8.5 mg/l.

Table 3-2 sets out ambient water quality values used in the near field CORMIX modelling and the sample point(s) used to provide the data. DIN concentrations are calculated in accordance with the WFD standards – winter (1 November to 28 February) DIN concentrations at Sample Point B have been plotted against the corresponding salinity at Sample Point A. A linear line of best fit is plotted through the data and the equation of this line is solved for DIN at a salinity of 32 ppt. This gives an ambient winter DIN concentration at this salinity value of 0.50 mg/l, which is between the moderate and poor class thresholds of 0.378 mg/l and 0.567 mg/l in Table 2-2. The current classification of Tees Bay would be poor with respect to DIN and exceeding the threshold of 0.567 mg/l would result in a class deterioration to bad water quality.

Calculated average ambient chromium (VI) concentrations are above the mean EQS value, however of 14 samples taken at Sample Point B between 2008 and 2022, only 5 contained measurable chromium VI and a further 14 contained concentrations below a limit of detection of 30 µg/l. The minimum recorded chromium (VI) concentration recorded at Sample Point B was 1.58 µg/l which still exceeds the EQS value for mean chromium (VI) concentrations. Given these high ambient concentrations, the effluent from the NZT site will not be diluted to below the EQS. The extent of any mixing zone for chromium (VI) will therefore be taken as the distance over which there is no longer a measurable increase in ambient concentrations. For the purposes of this analysis, this is taken as 0.1 µg/l above ambient concentrations, or 2.6 µg/l.

Ambient concentrations of all other substances are all below the EQS and effluent concentrations under at least one discharge scenario.

Table 3-3: Ambient Pollutant Concentrations in Tees Bay

Substance	Ambient Concentration	EQS	Sample Point
DIN[1]	0.500 mg N/l	0.567 mgN/l	A & B
Un-ionised Ammonia	3.9 µg/l	21 µg/l	A & B
Chromium (VI)	Mean =2.5 µg/l[2] 95%ile = 3.32 µg/l	Mean = 0.6 µg/l 95%ile = 32 µg/l	B
Copper	0.81 µg/l[3]	3.76 µg/l	B
Zinc	2.83 µg/l[3]	7.90	B

[1]EQS value based on average suspended solids concentration of 8.5 mg/l recorded at Sample Point B and average salinity of 32 PSU at Sample Point A. This is the WFD class boundary for Poor water quality.
[2]Values for total chromium (VI) quoted as per UK water quality standards. Of 14 samples taken between 2008 and 2022, 5 contained measurable chromium VI however a further 14 contained concentrations below a limit of detection of 30 µg/l.
[3]Values for dissolved copper and zinc quoted as per UK water quality standards

4. Near Field Mixing Zone Modelling

4.1 CORMIX Input Data

The Cornell Mixing Model software (CORMIX), developed and maintained by MixZon Inc., has been used to define the extent of the near field mixing zone at the proposed new outfall. CORMIX requires details of the effluent, the ambient conditions and the outfall geometry and the following sections outline how these aspects have been represented in the model. Following analysis of the effluent and ambient water quality in Section 2 and 3.6 above, the near field mixing zone has been modelled for temperature, unionised ammonia, copper, chromium (VI) and zinc.

The CORMIX modelling shows that the EQS concentration for DIN is not exceeded within the near field for any modelled scenario. In addition, the CORMIX model has difficulty producing reliable results at the limit of the near field for very low current conditions. The mixing zones for DIN will therefore be modelled using the far field model only (see Section 6) and the CORMIX model will not be used to inform the far field modelling to allow for consistency of approach for all current conditions.

4.2.1 Outfall Representation

The design of the new outfall for the PCC will be finalised at a later point in the design process, however an initial design has been carried out[6] to inform costings for options assessments. The initial design consists of a multiport diffuser with a total length of 10 m and a main pipe diameter of 500 mm. The diffuser has three pairs of 500 mm diameter parallel ports orientated at 45° to the horizontal and will be orientated approximately east-west to be at close to 90° to the prevailing current direction given the fully reversing current directions shown in Section 3.3. The initial diffuser design is shown in Figure 4-1.

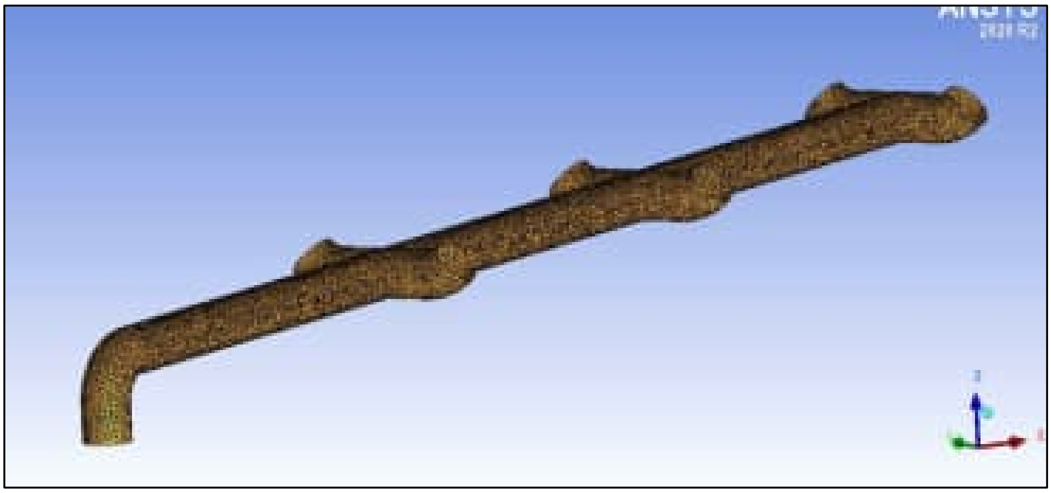


Figure 4-1: Initial Diffuser Design Illustration

4.2.1 Ambient Geometry

The following parameters must be specified in CORMIX to characterise the ambient geometry at a coastal water outfall: average depth; depth at the discharge and seabed roughness (n, Manning's number or roughness coefficient). The parameters for each modelled scenario have been calculated based on information extracted from the Delft3D model and discussed in Sections 3.4 and 3.5 and are set out in Table 4-1.

[6] PCC Outfall Study (Net Zero Teesside (NZT) / Northern Endurance Partnership (NEP) Carbon Capture & Storage Project) carried out by Wood on behalf of bp Exploration Operating Company Ltd, 19 August 2022

4.2.2 Ambient Density

The ambient water density is calculated within CORMIX based on temperature and salinity. The calculated densities used for each scenario have been summarised in Table 4-1.

Table 4-1: Ambient Water Density used in CORMIX

Scenario	Temperature (°C)	Salinity (ppt)	Density (kg/m3)
Winter	5	32	1025.3
Summer	16	32	1023.4

A winter heat loss coefficient of 42 W/m^2,°C has been used in the modelling while the summer heat loss coefficient is 44 W/m^2,°C. These values have been selected based on ambient water temperatures and wind speeds of 5.32 m/s in winter and 4.08 m/s in summer.

4.3 Presentation of Results

The CORMIX results are presented in terms of the distance from the outfall over which the temperature in the mixing zone falls to less than 3°C above ambient temperatures and when contaminant concentrations are diluted to below the EQS. Mixing zone plumes in CORMIX are modelled over different stages; the stages relevant for this outfall are an initial period of mixing as effluent rises vertically and is deflected laterally by momentum and ambient currents (the rising stage) and the later period of mixing when the plume reaches the water surface and spreads laterally (the surface spreading stage). Dilution occurs during the rising stage due to turbulent mixing and entrainment of ambient water, while dilution during the surface spreading stage is more dominated by diffusion of the plume into the large ambient water volume.

Current velocities at the proposed outfall location are relatively low, however they vary by a factor of more than 20. In addition, the ports on the diffuser in Figure 4-1 are relatively close in terms of spacing and relatively large in terms of diameter and flow rate. This means that the software models the mixing zone plumes in different ways depending on the current conditions specified:

- For minimum current conditions (0.01 m/s), the model combines the mixing zone from each pair of ports and resolve the dimensions of the resulting three individual plumes (Figure 4-2). However, the model cannot solve the equations for the surface spreading stage unless a slightly higher current speed of 0.013 m/s is specified.

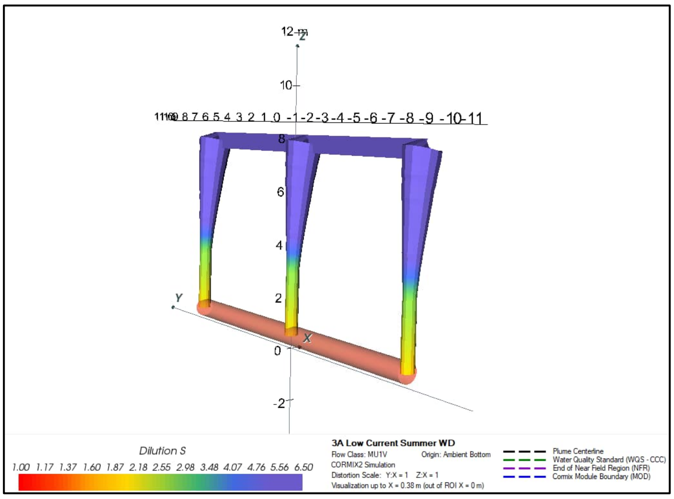


Figure 4-2: CORMIX Vertical Mixing Stage Visualisation Output for Minimum Current Conditions

- The current speed during the low tide condition (0.163 m/s) is low enough for CORMIX to resolve individual mixing plumes for each pair of outfalls, although the plumes are significantly deflected by the current (Figure 4-3). The model produces results for both the initial rising stage of each plume and for the surface spreading stage. The plumes combine and become vertically fully mixed close to the point where the mixing zone reaches the water surface.

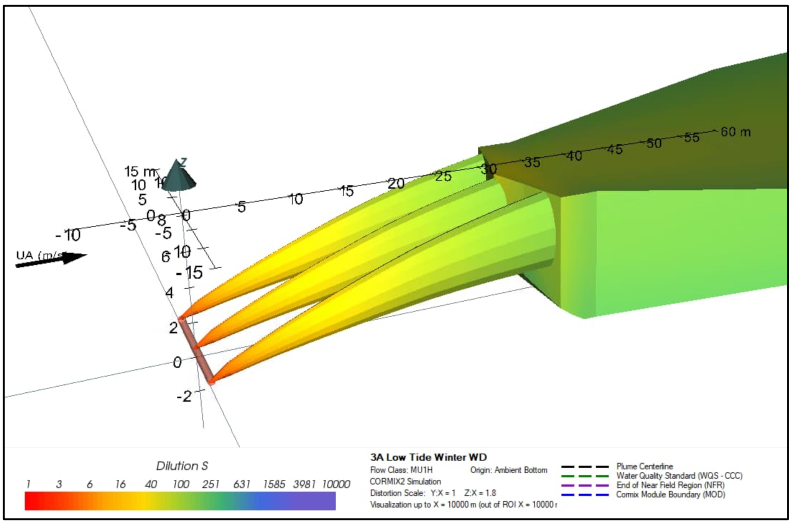


Figure 4-3: CORMIX Visualisation Output for Low Tide Conditions

- At higher current speeds (high tide and maximum current, with current speeds of 0.264 m/s and 0.271 m/s respectively) the plumes undergo rapid lateral mixing at the point of discharge. CORMIX represents this by combining the plumes into a single mixing zone for both the vertical and lateral spreading stage (Figure 4-4). Given the short length of the diffuser (10 m) and the relatively large port diameter (0.5 m), this approximation is considered to be acceptable.

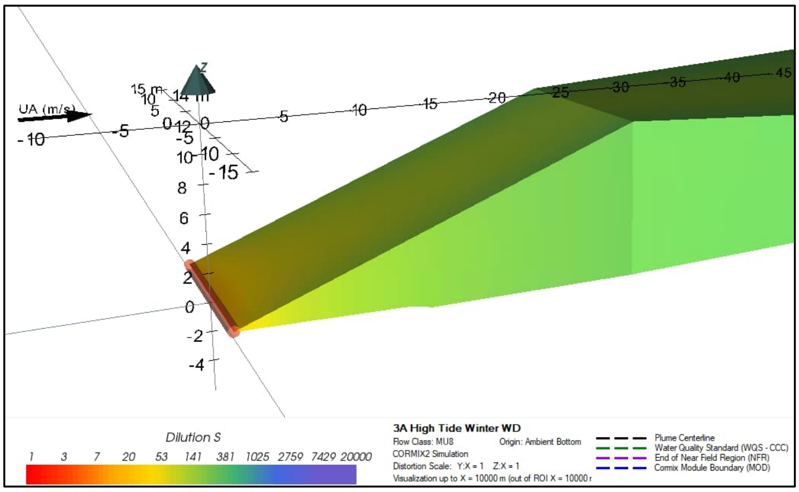


Figure 4-4: CORMIX Visualisation Output for High Tide and High Current Conditions

The CORMIX modelling results are presented below in terms of the vertical height of the top of the mixing plume above the outfall, the lateral distance travelled by the plume and the cross section width of the mixing zone plume at the point when the EQS is reached. If the EQS is met in the surface spreading stage then the cross section width is measured at the water surface.

4.4 Near Field Modelling Results

Sections 4.4.1 and 4.4.2 below describe the size of the near field mixing zones for temperature and contaminant concentrations for summer and winter conditions, with and without the addition of surface water runoff in the final discharged effluent. The addition of surface water results in an effluent temperature which is similar to summer seawater temperatures, therefore thermal impacts are only assessed for winter conditions for this model scenario. Further, concentrations of unionised ammonia in the effluent are diluted to below the EQS by the addition of runoff (see Table 2-5) so the mixing zone for this substance is not assessed for the surface water runoff scenario.

4.4.1 PCC Effluent Only

Table 4-2 below sets out the results of the near field modelling with consideration of effluent streams from the PCC and returned treated effluent from Bran Sands, excluding surface water runoff. The exit velocity at each port under the current diffuser design is 0.26 m/s. Entries highlighted in green show where the EQS is met in the surface spreading stage; for all other entries the EQS is met during the plume rising stage.

Table 4-2: CORMIX Near Field Modelling Results (Excluding Surface Runoff) – distances from discharge to where parameters drop below the EQS (m)

Season	Tide Condition	Mixing Zone Measurement	Chromium (VI)	Copper	Zinc	Unionised Ammonia	Temperature (+3°C)
Winter	Low Tide	Height above outfall	4.7	1.3	2.6	1.0	1.6
		Distance from outfall	26.1	3.0	10.4	1.6	4.7
		Plume Cross Section Width	1.9	0.5	1.0	0.6	0.9
	High Tide	Height above outfall	0.8	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall	1.5				
		Plume Cross Section Width	15				
	Maximum Current	Height above outfall	0.8	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall	1.5				
		Plume Cross Section Width	15				
	Minimum Current	Height above outfall	8.5	5.2	8.5	4.2	6.5
		Distance from outfall	124	0.2	19	0.2	0.4
		Plume Cross Section Width	1.8	0.4	0.5	0.3	0.5
Summer	Low Tide	Height above outfall	4.7	1.3	2.6	1.0	0.8
		Distance from outfall	26.4	3.0	10.4	1.6	0.6
		Plume Cross Section Width	1.9	0.5	1.0	0.4	0.3
	High Tide	Height above outfall	0.8	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall	1.5				
		Plume Cross Section Width	15				
	Maximum Current	Height above outfall	0.8	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall	1.5				
		Plume Cross Section Width	15				
	Minimum Current	Height above outfall	8.5	5.2	8.5	4.2	3.4
		Distance from outfall	125	0.2	19	0.1	0.1
		Plume Cross Section Width	1.8	0.4	0.8	0.3	0.3

The results in Table 4-3 show that EQS values for all substances are met within the plume rising stage for low tide, high tide and maximum current conditions. EQS values for all substances except chromium (VI) are met immediately after discharge during the high tide and maximum current conditions and are met extremely close to the outfall for chromium (VI). EQS values for copper, unionised ammonia and temperature are met within the vertical rising stage during minimum current conditions and EQS values for chromium (VI) and zinc are met during the lateral spreading stage. This would be seen as three extremely narrow areas of elevated concentration extending away from the outfall (Figure 4-5). The near field mixing zone for temperature, unionised ammonia and metals are all extremely small and would have no significant environmental impact.

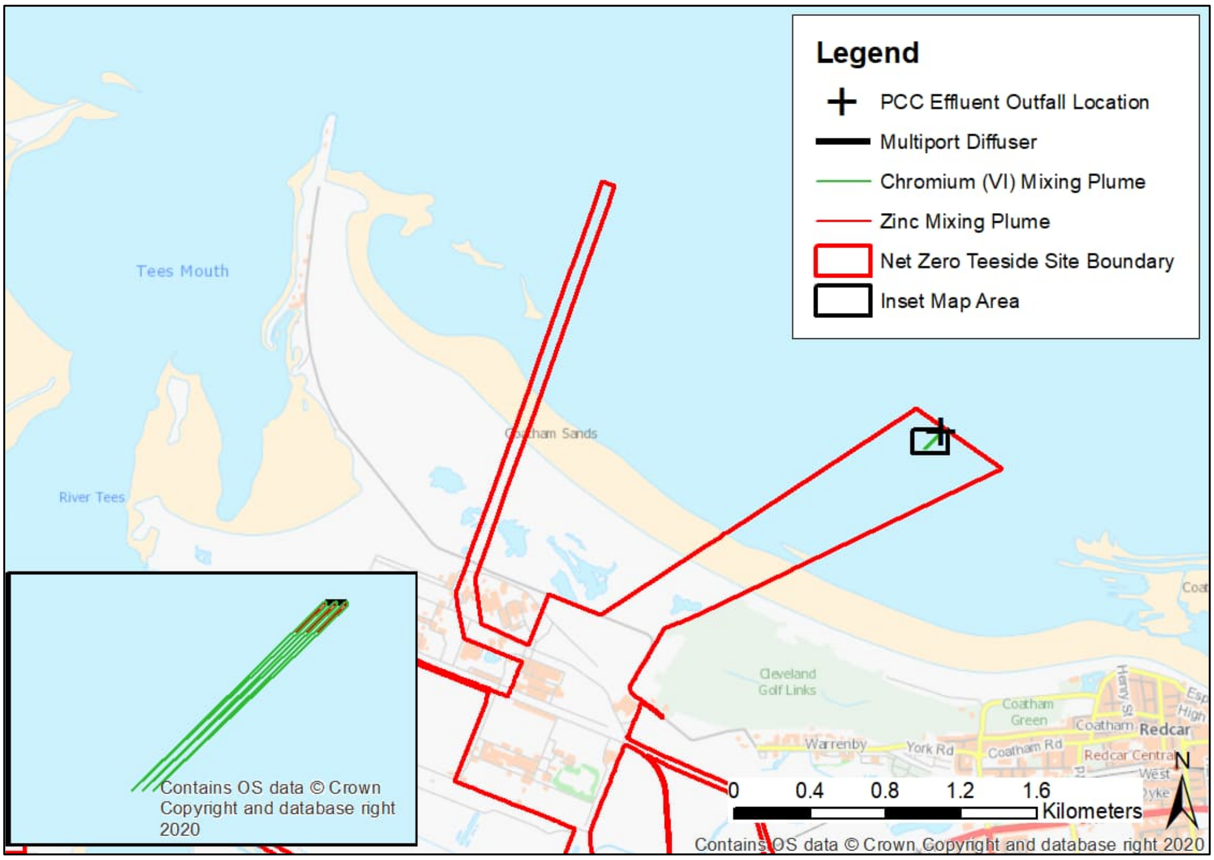


Figure 4-5: Surface Spreading Zones for Chromium (VI) and Zinc (Low Current Condition)

4.4.2 PCC Effluent with Surface Water Runoff

Table 4-3 below sets out the results of the far field modelling with consideration of effluent streams from the PCC processes when including a surface water runoff component. The port exit velocity under this scenario is 0.34 m/s and the EQS for all substances are met during the plume rising stage. Results are not presented for unionised ammonia because the effluent concentrations are already below the EQS (Table 2-5) and results for temperature are not presented for the summer scenario because the effluent temperature and ambient seawater temperature are expected to be similar. The results show that adding surface runoff to the discharged effluent dilutes contaminants and mixing zone sizes become small.

Table 4-3: CORMIX Near Field Modelling Results (Including Surface Runoff) – distances from discharge to where parameters drop below the EQS (m)

Season	Tide Condition	Mixing Zone Measurement	Chromium (VI)	Copper	Zinc	Temperature (+3°C)
Winter	Low Tide	Height above outfall	2.0	immediately on discharge	2.2	2.0
		Distance from outfall	4.4		5.6	4.4
		Plume Cross Section Width	0.6		0.7	0.6
	High Tide	Height above outfall	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall				
		Plume Cross Section Width				
	Maximum Current	Height above outfall	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall				
		Plume Cross Section Width				
	Minimum Current	Height above outfall	6.5	immediately on discharge	7.3	6.5
		Distance from outfall	0.3		0.4	0.3
		Plume Cross Section Width	0.6		0.7	0.6
Summer	Low Tide	Height above outfall	2.0	immediately on discharge	2.2	
		Distance from outfall	4.4		5.6	
		Plume Cross Section Width	0.6		0.7	
	High Tide	Height above outfall	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall				
		Plume Cross Section Width				
	Maximum Current	Height above outfall	Vigorous lateral mixing means that the EQS values for this parameter are met immediately on discharge			
		Distance from outfall				
		Plume Cross Section Width				
	Minimum Current	Height above outfall	6.6	immediately on discharge	7.3	
		Distance from outfall	0.3		0.4	
		Plume Cross Section Width	0.6		0.7	

5. Far Field Modelling Results

5.1 Far Field Model Scenarios

The Delft3D model has been used to carry out far field modelling of DIN mixing from the proposed outfall location. Far field modelling of thermal effects has not been carried out because the distance from the outfall over which a temperature difference of 3°C is observed is extremely small and contained in the near field only (Section 4). Details of the far field model setup and representation of the outfalls and ambient conditions are provided in Appendix A – the model was used as set up by ABPmer without editing any of the model parameters or input data except for vertical layer spacing (Section 3.1), discharge flow rate and DIN concentration. DIN was modelled as a conservative tracer and the model was run to identify mixing zone concentrations through the water column and laterally within Tees Bay.

The Delft3D model was run for two discharge scenarios as summarised in Table 5-1. A constant flow rate and DIN concentration (calculated as set out in Section 2.2) is assumed in each scenario. The discharge for each scenario was modelled as a continuous discharge into the relevant model cell at full effluent concentrations – the model does not take account of mixing within the near field because the near field mixing zone is not expected to provide significant dilution of DIN in comparison to the far field.

Table 5-1: Discharge Scenario Input Data for Delft3D Model

Parameter	Without Surface Water Addition	With Surface Water Addition
Flow Rate (m^3/s)	0.31	0.40
DIN (mg/l)	26.34	12.21

The model outputs represent a worst case scenario because the model does not currently take account of wave action. This is likely to be important for mixing because the proposed outfall location is close to Coatham Rocks, a rocky outcrop extending into Tees Bay which is under water at high tide but will promote wave breaking and vertical mixing. The omission of wave action allows for worst case scenario impact prediction based on the currently available information.

5.2 Far Field Model Results

The far field model results are presented below based on the average percentage change in DIN concentration in the receiving waters and the duration of increases of over 1% above background in hours per day as this represents the long-term effect of any discharge. The maps use the consistent contour intervals shown in Figure 5-1. The 1% lower limit in the assessment reflects concentrations below which, in practice, changes in concentration would not be detectable and which are at the limit of accuracy of the model.

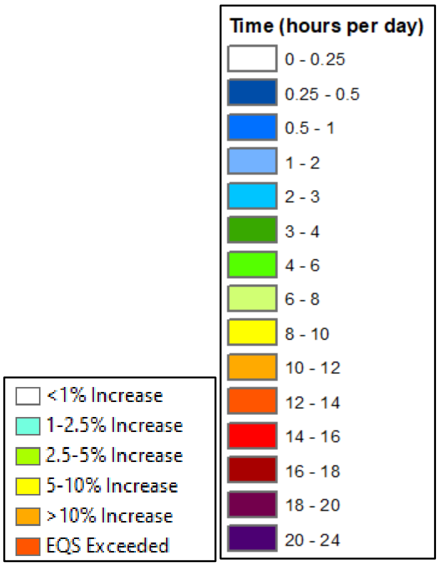


Figure 5-1: Legends for Far Field DIN Mixing Zone Mapping (left = percent change in DIN, right = duration of increase above 1%)

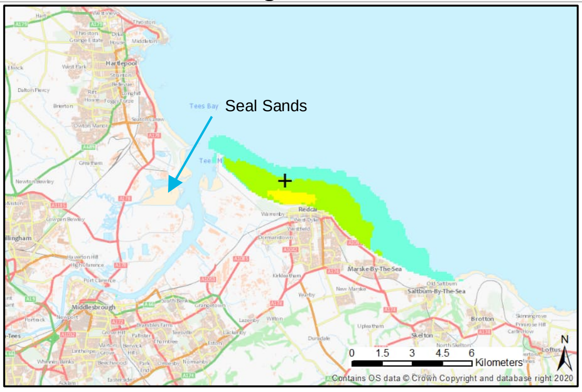
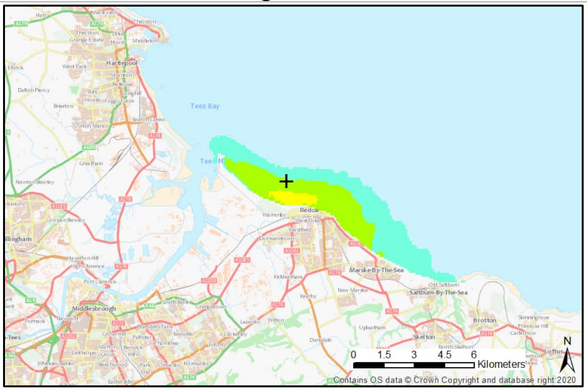
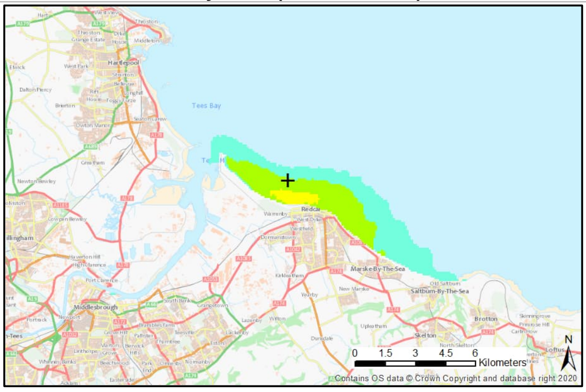
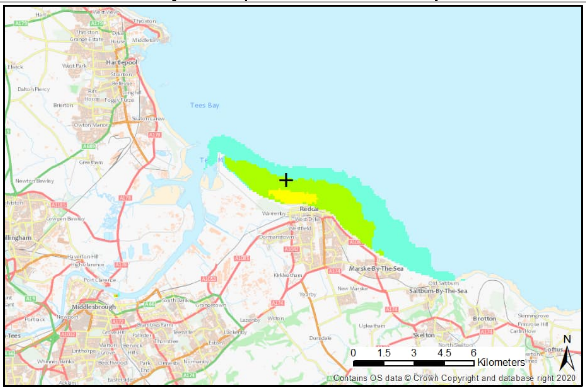
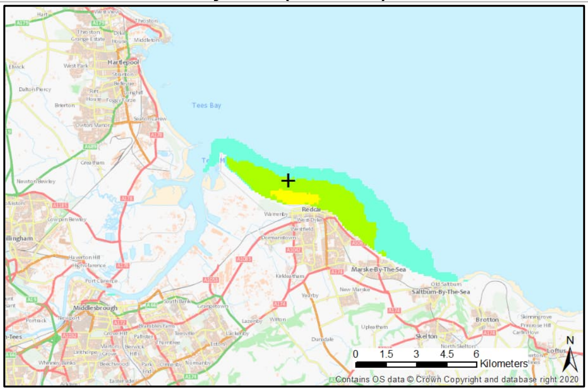
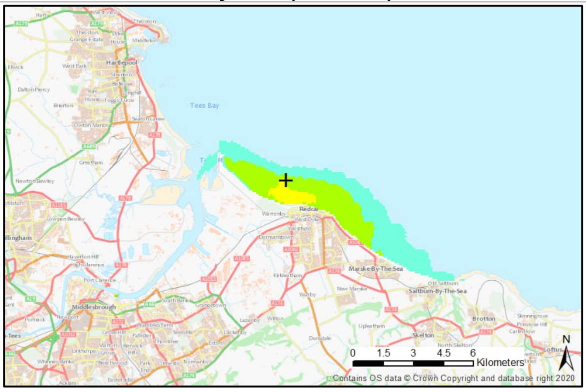
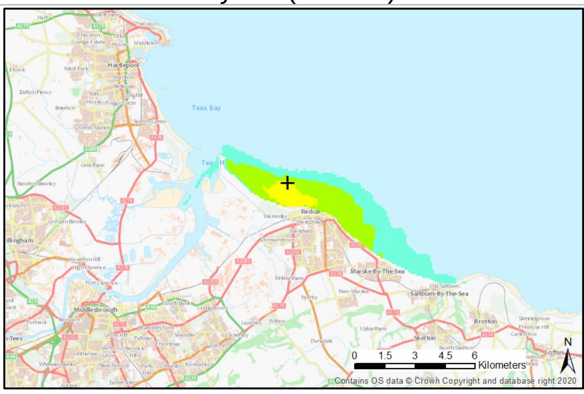
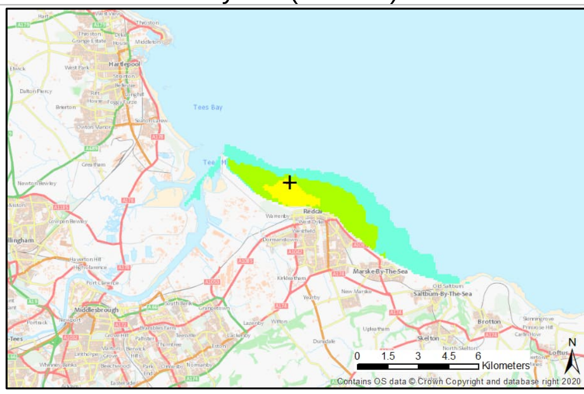
Average Increase	Average Increase
	
Layer 1 (surface 5%)	Layer 2 (surface 90-95%)
	
Layer 3 (82-90%)	Layer 4 (72-82%)
	
Layer 5 (58-72%)	Layer 6 (35-58%)
	
Layer 7 (10-35%)	Layer 8 (bed to 10%)

Figure 5- 2 Average Percentage Increase in DIN Concentrations over a tidal cycle (Surfacewater Runoff Excluded from Effluent)

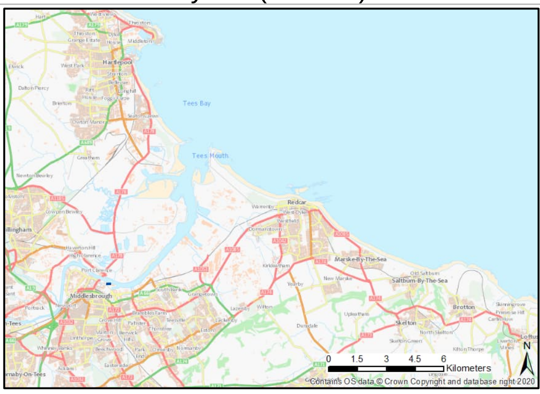
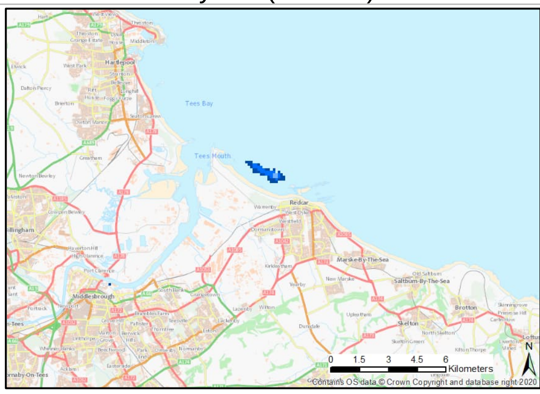
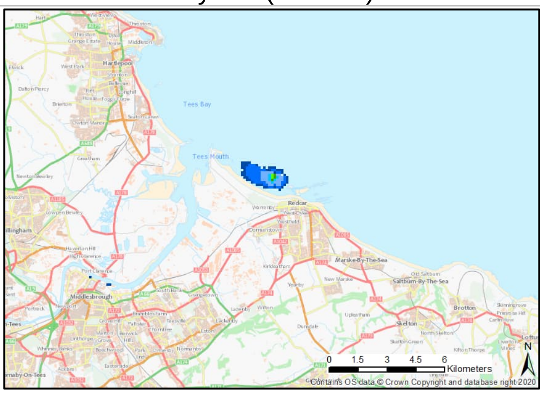
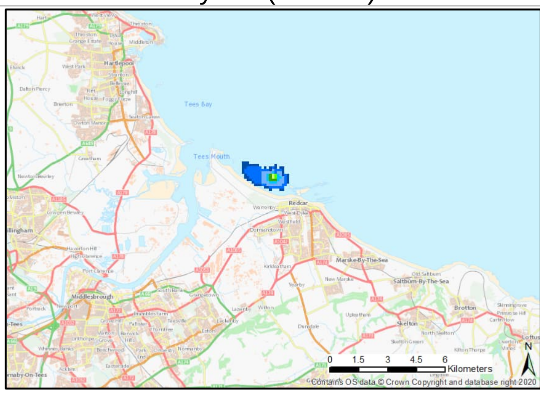
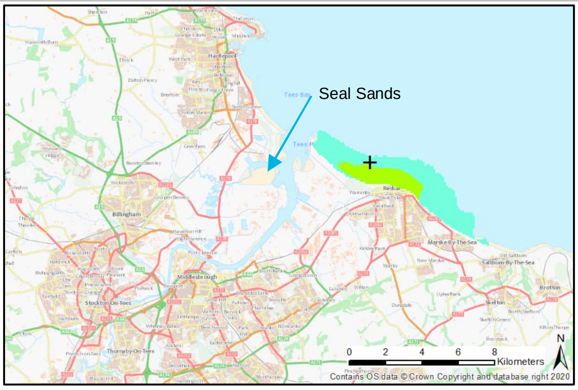
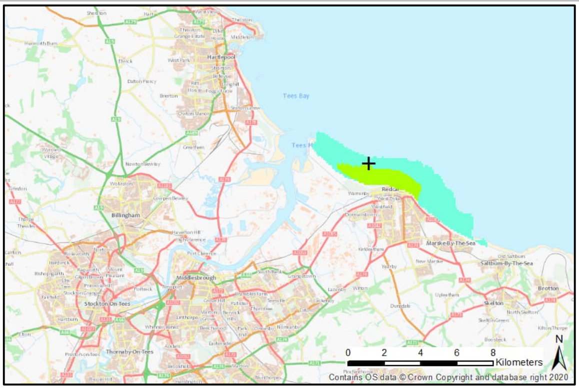
Duration of EQS Exceedance	Duration of EQS Exceedance
 Layer 1 (surface 5%)	 Layer 2 (surface 90-95%)
 Layer 3 (82-90%)	 Layer 3 (72-92%)
 Layer 5 (58-72%)	 Layer 6 (35-58%)
 Layer 7 (10-35%)	 Layer 8 (bed to 10%)

Figure 5-2: Duration of EQS Exceedance (Surfacewater Runoff Excluded from Effluent)

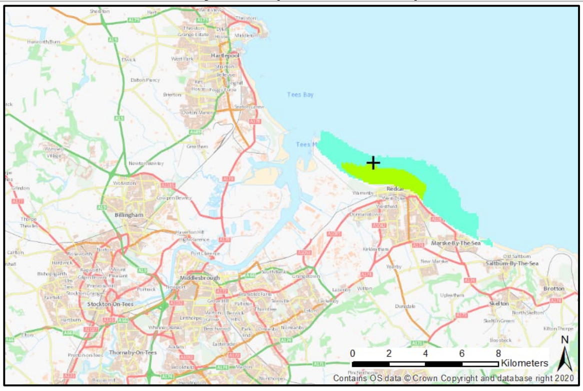
Average Increase	Average Increase



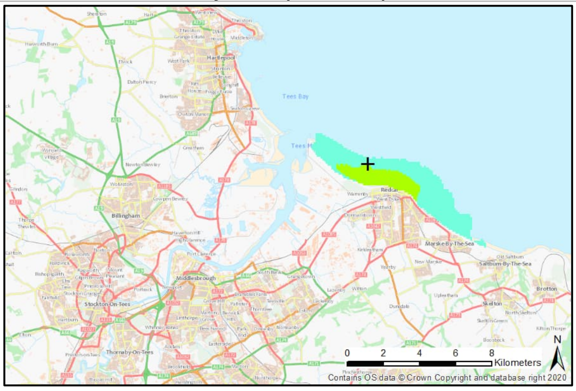
Layer 1 (surface 5%)



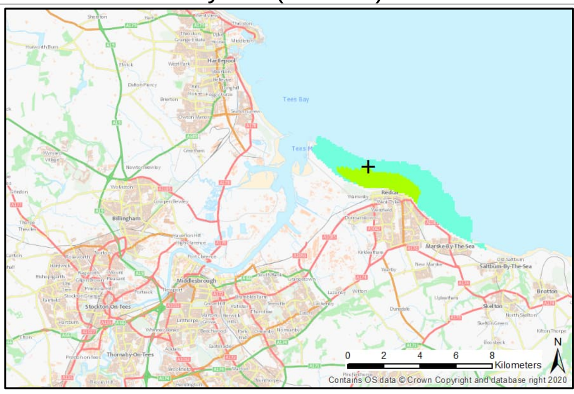
Layer 2 (90-95%)



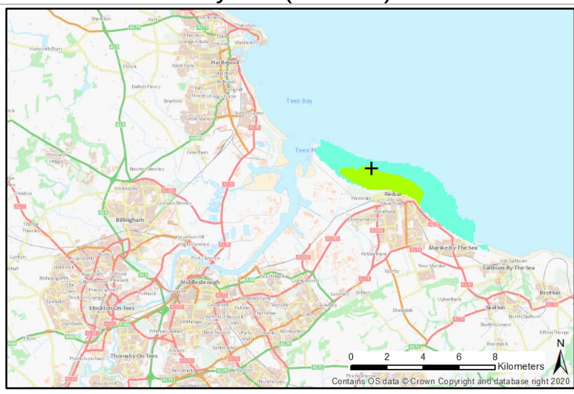
Layer 3 (82-90%)



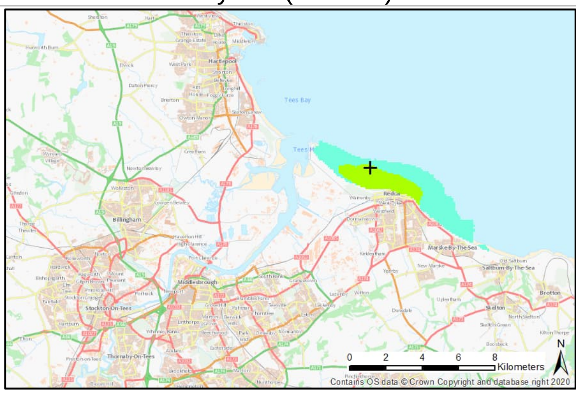
Layer 4 (72-82%)



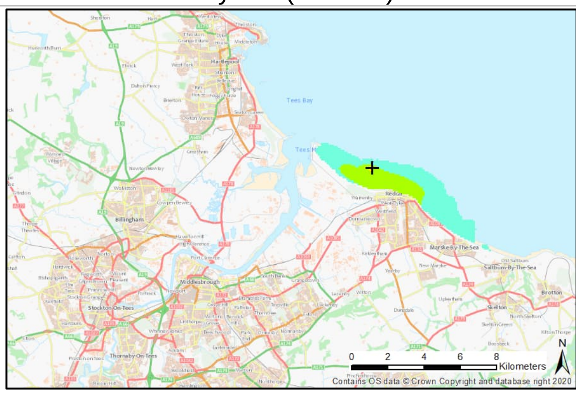
Layer 5 (58-72%)



Layer 6 (35-58%)



Layer 7 (10-35%)



Layer 8 (bed to 10%)

Figure 5-3: Average Percentage Increase in DIN Concentrations over a tidal cycle (With Surfacewater Runoff in Effluent)

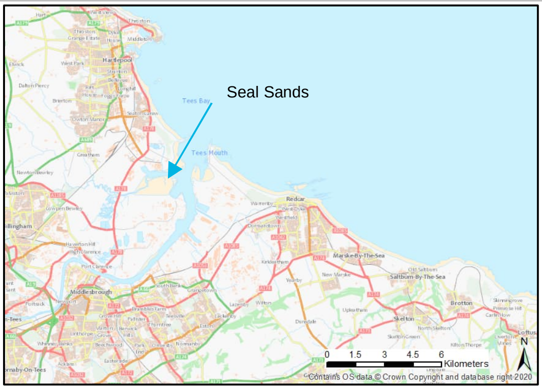
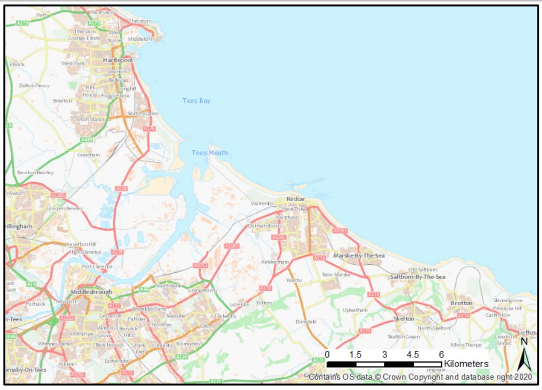
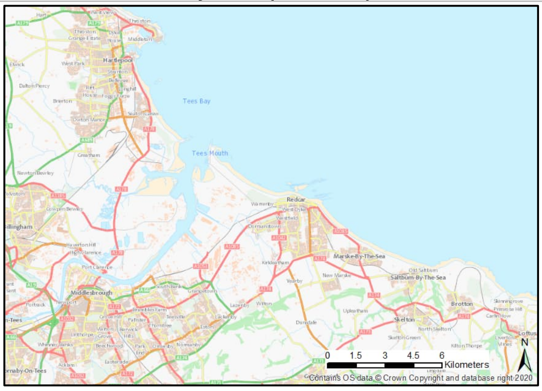
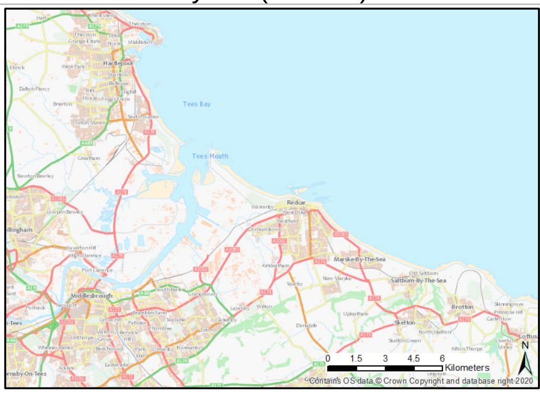
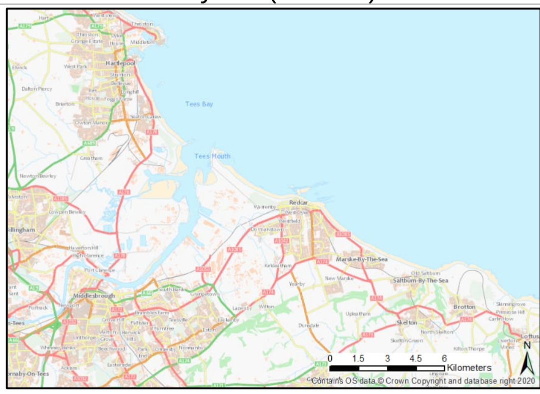
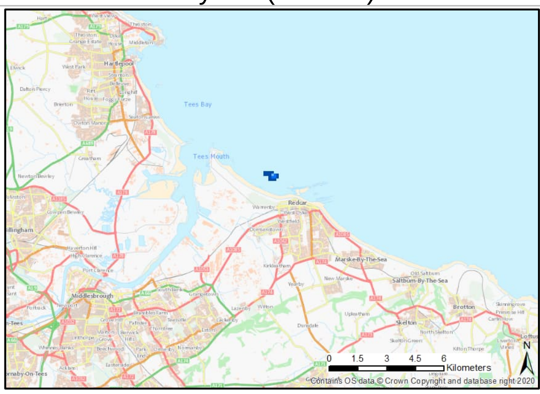
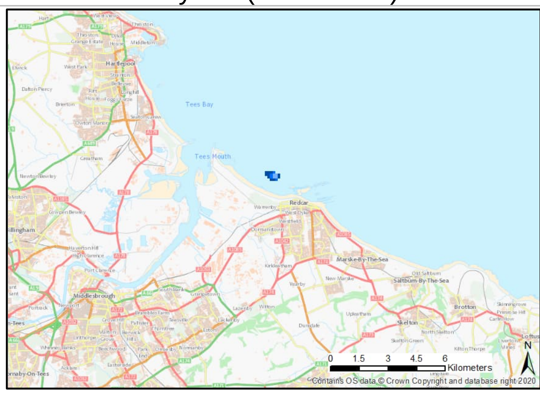
Duration of EQS Exceedance	Duration of EQS Exceedance
 Layer 1 (surface 5%)	 Layer 2 (90-95%)
 Layer 3 (82-90%)	 Layer 4 (72-82%)
 Layer 5 (58-72%)	 Layer 8 (bed to 10%)
 Layer 7 (10-35%)	 Layer 8 (bed to 10%)

Figure 5-4: Duration of EQS Exceedance (Surfacewater Runoff Included in Effluent)

Figure 5-2 and 5-3 show the following for modelling of effluent discharges without surface water present in the effluent:

- The average impact of the effluent discharge over the tidal cycle is to increase DIN concentrations in a small part of the Tees Bay by up to 10% around the outfall and by 1-5% in the wider area. There are no areas of significant size which show exceedances of the EQS as an average condition over the tidal cycle. There are small areas within the Tees Estuary at Tees Mouth specifically in the dredged channel of the Tees where average DIN concentrations increase but this is limited mainly to less than 1%, and to less than 2.5% at any location. Also this effect is concentrated in the lower half of the water column of the dredged channel of the Tees and not at the location of the Seal Sands mudflats where average DIN concentrations show a less than 1% increase above background.
- For the maximum increase over the tidal cycle the EQS around the outfall in Tees Bay is predicted to be exceeded, however, the duration of EQS exceedance at any given location around the outfall is short due to the rotating and reversing current directions over the tidal cycle. The duration is limited to 0.25 to 2 hours per day.
- The duration over which concentrations of DIN are increased by more than 1% have been calculated and show that DIN concentrations within the Tees Estuary are increased over approximately half of the tidal cycle, on the flood tide only. These results also show that areas away from the immediate coastline of Tees Bay experience an increase in DIN concentration of more than 1% for less than 10 hours per day, with areas north of Tees Mouth showing this increase for less than 2 hours per day

Figure 5-4 and 5-5 show the following for modelling of effluent discharges when a surface water runoff component is present in the effluent:

- The average impact of effluent discharge over the tidal cycle within Tees Bay is limited to less than 5% except in extremely localised areas at the outfall. DIN concentrations in Tees Bay still increase by 1-2.5% over a wider area. There are no increases in average DIN concentration within the Tees Estuary including the mudflats at Seal Sands.
- The assessment of maximum impact across the tidal cycle shows that the DIN EQS concentration is only exceeded close to the outfall and that the duration of EQS exceedance at any given location around the outfall is up to 1 hour per day.
- DIN concentrations along the coastline in Tees Bay are increased by more than 1% throughout the tidal cycle but this reduces to less than half the tidal cycle for more distant locations. Concentration in the Tees Estuary at Tees Mouth are increased by 1% for less than 6 hours per day on the maximum flood tide.

The extent of EQS breaches is extremely limited in terms of extent and duration. Some increase in average DIN concentrations is expected throughout the water column over a wider area and this will include impacts on the deeper parts of the Tees channel at Tees Mouth but does not include the mudflats at Seal Sands. This report aims to quantify the impact of the proposed discharges on water quality in Tees Bay and the River Tees estuary only; the resulting impacts on ecological receptors will be discussed in the WFD assessment.

6. Summary and Conclusions

Near field and far field water quality modelling has been carried out to support the design of the PCC site in respect of surface water and process effluent management. This Intermediate Design Stage report utilises information available at the time of publication and draws on hydrodynamic water quality modelling carried out at the Initial Design Stage. There is now significant additional information available concerning the future design and operation of the PCC site which enables more refined estimates of future discharge rates, location, pollutant loads and effluent discharge temperature compared to the previous assessment. However, there are different options for the final design and some aspects such as outfall details, pipe size and surface water drainage rates are still to be finalised. It is therefore envisaged that the water quality assessment will be revisited post consent to verify the predicted water quality impacts of effluent discharges at the Final Design Stage. This Intermediate Design Stage report seeks to assess the likelihood of significant adverse impacts on the water environment arising from future discharges of wastewater from the PCC Site to Tees Bay.

The discharged effluent at the PCC site will comprise cooling water blowdown from the proposed gas fired power station, filtration reject water, condensed and process water from a carbon capture facility, return treated effluent flows from Bran Sands Wastewater Treatment Works and surface water runoff. The blowdown water and filtration reject water will be sourced from the non-tidal River Tees and will contain background river water contaminants. These will be concentrated by up to 5 times within the blowdown water component. The condensed water is a much smaller stream but can contain up to 5 mg/l of ammonia, however the process water is expected to consist of highly purified water only. Return flows from Bran Sands will comprise treated wastewater and is included as part of arrangements to treat effluent with very high concentrations of ammonia which are generated on the PCC site at Bran Sands WwTW while preserving nutrient neutrality within Dabholm Gut and the River Tees Estuary. The surface water runoff component of the effluent will be routed through oil interceptors to remove contamination and combined with the runoff with the other wastewater streams and discharging the final combined effluent to Tees Bay.

Water quality data for the River Tees has been provided by Northumbrian Water and combined with information on PCC condensed and process water quality and Bran Sands effluent quality to characterise final discharge effluent flows and loads. The calculations have been carried out for effluent streams which include or exclude the surface water runoff component.

Pollutant concentrations within the effluent have been compared with EQS standards for Tees Bay under the WFD (note there are some gaps in the data, e.g. lack of hydrocarbon concentration information for the River Tees Water). The available information does show that concentrations of chromium (VI), copper, zinc, un-ionised ammonia and DIN in the effluent may exceed EQS concentrations locally, especially if excluding the surface water runoff component of the effluent. The effluent from the PCC site may also be discharged at temperatures exceeding ambient temperatures in Tees Bay. On the basis of the available information, the near field mixing zone modelling has been carried out to assess the water quality impacts for copper, chromium (VI), zinc, unionised ammonia and temperature using the flow rates and effluent temperatures and pollutant loads summarised in Table 6-1. Concentrations of DIN in the effluent are too high to be sufficiently diluted within the near field and DIN mixing has therefore been assessed using the far field model only.

Table 6-1: Flows and Pollutant Loads for Modelled Discharge Scenarios

Parameter	Without Surface Water Runoff	Surface Water Runoff Included	EQS
Temperature (°C)	19	15	3^{o}C above ambient

Dissolved Inorganic Nitrogen (mg/l)[1]	26.34	12.21	0.567
Un-ionised Ammonia (µg/l)	36	16	21
Copper (µg/l)[2]	10.6	4.98	Mean = 3.76 µg/l dissolved
Zinc (µg/l)	57.2	28.1	Mean = 6.8 µg/l dissolved plus ambient (1.1 µg/l) = 7.9 µg/l

The near field modelling has been carried out for summer and winter conditions at four stages across the tidal cycle – low tide, high tide, maximum current velocity and minimum current velocity. Water level and current data at each stage in the tidal cycle have been extracted from a Delft3D hydrodynamic model of Tees Bay and the River Tees constructed and calibrated in 2019 and included as Appendix A of this report. The current proposal is to discharge the effluent via a new outfall with multiport diffuser located in an area with an average water depth of approximately 9 m.

The near field modelling shows that the impact of the discharge is not significant for metals, temperature and unionised ammonia all stages of the tidal cycle. The chemical contaminants (excluding DIN) are diluted to below the EQS within a very short distance of the outfall and generally before the mixing plume reaches the water surface. Thermal effects are also extremely small, with the temperature of the mixing plume falling below 3°C above ambient conditions within a very short distance. Surface temperatures are not increased by more than 3°C for any combination of effluent discharge option and tidal stage.

The far field modelling for DIN shows that:

- Average increases in the concentrations of DIN at the mudflats in Seal Sands do not exceed 1% above background. Average Tees Estuary DIN concentrations are increased in the Tees Mouth area by up to 2.5% within the dredged channel of the river in the bottom half of the water column. The duration of impact is less than 10 hours per day, falling to less than 6 hours per day if surface water is present in the effluent.
- Average DIN concentrations in Tees Bay do not exceed the EQS for either scenario over any significant area. The maximum DIN concentration in Tees Bay exceeds the EQS in the lower 58% of the water column over an area of approximately 2.7 km^2 around the discharge point when surface water is excluded from the effluent. The average duration of this exceedance at a given location is short, at 0.25-2 hours per day. If surface water is included in the effluent then the EQS is breached only in the lower 35% of the water column, over a smaller area and the duration of the exceedance is shorter.
- Average DIN concentrations along the coastline in Tees Bay increase up to 5% under both discharge scenarios, with increases of up to 10% closer to the outfall and in deeper water and increases of 1-2.5% over a wider area closer to the water surface. The area affected is reduced by the inclusion of surface water runoff in the effluent. Due to the rotating and reversing current direction, DIN concentrations at most locations are increased for less than half the tidal cycle although concentrations along the coastline are shown to be elevated at all tidal stages.

The extent of EQS breaches is extremely limited in terms of extent and duration. Whilst some average increase in DIN concentrations is expected throughout the water column over a wider area average increases in the concentrations of DIN at the mudflats in Seal Sands are minimal, not exceeding 1% above background.

Annex C – H1 Screening Tool

See separate Annex C folder containing H1 tool