Sizewell C Project

Construction Water Discharge Activity Permit Application MDS/CWDA/13 (Combined Drainage Outfall) Water Environment Regulations Compliance Assessment

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CONTENTS

1 INTRODUCTION

1.1 Background

This assessment accompanies the application for a Construction Water Discharge Activity (CWDA) environmental permit, which is required for a proposed discharge to sea associated with the development of the Sizewell C (SZC) power station, hereinafter referred to as "the project". The project development itself and associated schemes are subject to the SZC (Nuclear Generating Station) Development Consent Order 2022 (referred to throughout this document as the 'DCO'). This permit application is being referred to as MDS/CWDA/13 within the SZC project.

The site of the SZC project currently under construction is centred at UK National Grid Reference (NGR) TM 47355 64128. It is located on the Suffolk coast, approximately mid-way between Felixstowe and Lowestoft, to the north-east of the town of Leiston. The site address being used for the construction works is Sizewell B power station, near Leiston, Suffolk, IP16 4UR (as the nearest operational facility).

The permit application covers several effluent sources that will be generated from construction-related activities taking place across the Main Development Site (MDS), referred to throughout this application as the 'site'. Reference is made in relation to the:

- Main Construction Area (MCA): this is the area, once construction is complete, that will house the nuclear reactors and supporting power plant infrastructure; and
- Temporary Construction Area (TCA): this is an area located to the north and west of the MCA that is being used for construction purposes only.

The effluent streams comprise elements of process wastewater (or trade effluent), foul domestic wastewater, surface water and groundwater pumped from excavations. Each effluent stream will need to be managed and/or treated accordingly to ensure that the risk of any pollution is avoided or minimised as far as reasonably practicable. Where effluent sources cannot be infiltrated back to ground, for example due to their nature, composition or volume, they will be managed and treated appropriately before being combined prior to being discharged to the North Sea. The discharge is proposed to be made to the sea via a pipeline which is referred to within the project as the 'Combined Drainage Outfall' (CDO).

The requirement for the CDO was identified during the development of the SZC project and was assessed as part of the DCO Water Framework Directive (WFD) Compliance Assessment[1]. This assessment considered whether the discharge from the proposed CDO could give rise to effects that would be in contravention to the requirements of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 2017/407) (WER) based on the design information and baseline data available at the time. Development consent was granted by the Secretary of State for Business, Energy and Industrial Strategy on 20th July 2022[2].

1.2 Purpose of this document

This document supports the CWDA permit application for the discharge of combined wastewater from the CDO to the North Sea. The following activities within either the MCA or TCA could be combined to form the discharge as follows:

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[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010012/EN010012-002239-SZC_Bk8_8.14_Water_Framework_Directive_Part_2_of_4.pdf

[2] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010012/EN010012-011164-SZC-Decision-Letter.pdf

- Discharge of treated surface water run-off from the MCA.
- Discharge of groundwater from the MCA, including water produced by the installation and development of wells.
- Discharge of treated foul water from the MCA.
- Discharge of treated foul water from the Eastern TCA.
- Discharge of treated foul water from the Western TCA.
- Discharge of treated water from a sweeper tip facility.
- Discharge of treated water from bentonite treatment plant.

Consideration is only given to the potential effects of the discharge. All other activities, such as the construction and presence of the CDO and associated infrastructure, are not within the scope of this assessment as they have already been considered within the DCO application documents (cf. **Section 1.1**).

1.3 Structure of document

This document presents the output of the WER Compliance Assessment in relation to the proposed water discharge activity. This document is intended to be read in conjunction with the completed GOV.UK permit application forms and other supporting documents submitted as part of the permit application.

This technical supporting document is set out as follows:

- Section 1: Introduction (this section).
- Section 2: Outline Project Description.
- Section 3: WER Compliance Assessment.

1.4 Definitions

The below table includes the acronyms used throughout this technical supporting document.

Abbreviation	Definition
AA	Annual Average
BEEMS	British Energy Estuarine and Marine Studies
BOD	Biological Oxygen Demand
CD	Chart Datum
CDO	Combined Drainage Outfall
CEFAS	Centre for Environment and Aquaculture Science
CWDA	Construction Water Discharge Activity
DCO	Development Consent Order
EQS	Environmental Quality Standards
EQSD	Environmental Quality Standards Directive
Ha	Hectares
HRA	Habitats Regulations Assessment

Abbreviation	Definition
INNS	Invasive non-native species
kg	Kilograms
LOD	Limit of Detection
MAC	Maximum Allowable Concentration
MCA	Main Construction Area
MDS	Main Development Site
MBBR	Moving Bed Biofilm Reactor
NGR	National Grid Reference
ODN	Ordnance Datum Newlyn
PBDE	Polybrominated diphenyl ethers
RBMP	River Basin Management Plan
SPA	Special Protection Area
SAC	Special Area of Conservation
SZC	Sizewell C
TCA	Temporary Construction Area
TMO	Temporary Marine Outfall
TraC	Transitional and coastal waters
WER	Water Environment Regulations
WFD	Water Framework Directive

2 PROJECT DESCRIPTION

2.1 Scope of permit application

The scope of the application relates to the discharge of wastewater resulting from the CDO via a marine dispersion head (diffuser system) in the Sizewell Bay area of the North Sea. The pipeline will run below sea-level and ground-level (below the Sizewell foreshore) and will come ashore at the CDO collection chamber in the MCA. The activities that could give rise to wastewater are summarised in **Table 2.1**. Full plant details and process descriptions are included within Sections 3 and 4 of the main permit application Technical Supporting Document.

Table 2.1 – Summary of wastewater streams

Discharge stream	Outline description	Indicative commencement date and period required	Discharge rate (l/s)
Treated surface water run-off from the MCA	This discharge stream would consist of water derived from rainfall and surface water run-off, consisting of two zones. Zone 1 would be managed via a series of temporary drainage/attenuation ponds, the locations of which are to be confirmed. These would facilitate the settlement of suspended solids. Water would then be pumped to the surface water treatment plant to treat run-off prior to discharge. Zone 2 would be drained via gravity to an attenuation feature, after which it would then be pumped to a surface water treatment facility. Surface water may also consist of waste potable, non-potable and surface water from activities including dust suppression, general cleaning of surfaces, vehicle cleaning, dewatering of road sweepings/silts.	October 2026 to ~2040	400
Treated groundwater from MCA, including water produced by the installation and development of wells	This discharge stream would be associated with the extraction of groundwater following cut-off wall construction. During the initial dewatering period (anticipated to be required for up to five months), a flow rate of 250l/s is required. Following this period (during the maintenance period) the flow rate is anticipated to approximately 50l/s.	March 2027 to ~2040	250 for five months then 50
Treated foul water from MCA	This discharge stream would arise from facilities and buildings within the MCA and would be treated in a domestic sewage plant. Sewage would be treated using Moving Bed Biofilm Reactor (MBBR) technology, which provides biological treatment and removes/reduces Biological Oxygen Demand (BOD) and ammonia. Chemical dosing may be required but this is dependent upon the MBBR package technology supplier's design. Final effluent water quality standards would be applied.	October 2026 to ~2040	24.8
Treated foul water from TCA	This waste stream would derive from TCA buildings and facilities, including the accommodation campus. This would be treated by two separate sewage treatment plants prior to discharge via the CDO. Final effluent water quality standards would be applied.	October 2026 to ~2040	20.7 (first plant) 4.5 (second plant)

Treated effluent from Sweeper Tip Facility	This waste stream would consist of waste potable, non-potable and surface water from activities including dust suppression, general cleaning of surfaces, vehicle cleaning, dewatering of road sweepings/silts. Final effluent water quality standards would be applied.	October 2026 to ~2040	3
Treated water from the bentonite plant	The bentonite plant is currently expected to be constructed in the MCA. Bentonite slurry (bentonite mixed with water) can act as a stabilising media when used in groundworks by exerting hydrostatic pressure on the surrounding ground. Bentonite slurry will be used for this purpose during the construction of the cut-off wall. Once the slurry has fulfilled its role it will be removed and transported (expected via pumping and/or tanker) to the bentonite plant. The slurry is typically treated and recycled through the plant, prior to the resultant wastewater requiring disposal.	October 2026 to ~2040	4.7

2.2 Operational parameters

The following design parameters have been used in this assessment:

- Outfall location is E 647980.033m, N 264343.190m.
- The water depth at the point of discharge would be 6.2m Ordnance Datum Newlyn (ODN).
- The pipeline will rise vertically through the marine dispersion head structure and terminate at a diffuser with four duckbill valves arranged in a horizontal cross at the end of the pipe to aid mixing and dispersion of the discharge.
- For the purposes of this assessment, it has been assumed that the flow rate from the CDO outfall is approximately 560.7l/s. This flow rate is largely attributed to groundwater and surface water and uses the upper estimate of an average flow for surface water.

2.3 Timeframe for operation

The CDO is anticipated to be operational from October 2026 and is expected to replace the Temporary Marine Outfall (TMO) constructed for the initial discharge of surface water run-off and groundwater during early construction phases. The discharge activities detailed within this document are anticipated to have differing durations, depending upon the activity to which the discharge relates. Some will therefore start and finish earlier than others in line with the current construction programme.

3 WER COMPLIANCE ASSESSMENT

3.1 Overall approach

This assessment uses the 'Clearing the Waters for All' (2023)[3]. guidance developed by the Environment Agency for the assessment of activities within transitional and coastal (TraC) waters. This guidance separates the assessment into three stages, as follows:

- Stage 1 Screening: This stage identifies the activities to be assessed, and which water bodies could potentially be affected by each activity.
- Stage 2 Scoping: This stage identifies whether there is a pathway for effect associated with the activities for any of the water bodies identified in Stage 1.
- Stage 3 Detailed assessment: This stage determines whether any activities that have been put forward from Stage 2 have the potential to cause deterioration and whether this deterioration will have a significant non-temporary effect on the status of one or more quality elements on a water body scale.

The outcome of each stage of the assessment is described below.

3.2 Stage 1 Screening

3.2.1 Overview

This section identifies the activities that need to be assessed and uses the Environment Agency's Catchment Data Explorer (Environment Agency, 2024)[4] to identify the water bodies that could potentially be affected by the activities.

3.2.2 Activities

As set out in Section 1.2, this assessment supports the CWDA permit application and only considers the proposed discharge from the CDO rather than construction of the plant infrastructure itself. As such, there is only one activity to be assessed the 'discharge of combined wastewater from the CDO to the North Sea'.

3.2.3 Water bodies

Figure 1 shows that outfall is located within the Suffolk coastal water body (GB650503520002). **Table 3.1** provides a summary of the baseline status information for the Suffolk coastal water body (GB650503520002) (Environment Agency, 2024)[4]. Information on habitat areas and history of harmful algae are taken from the water body summary tables available in the 'Clearing the Waters for All' guidance (Environment Agency, 2023)[3].

[3] https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters

[4] https://environment.data.gov.uk/catchment-planning/

Figure 1 - Waterbodies and CDO Outfall Location

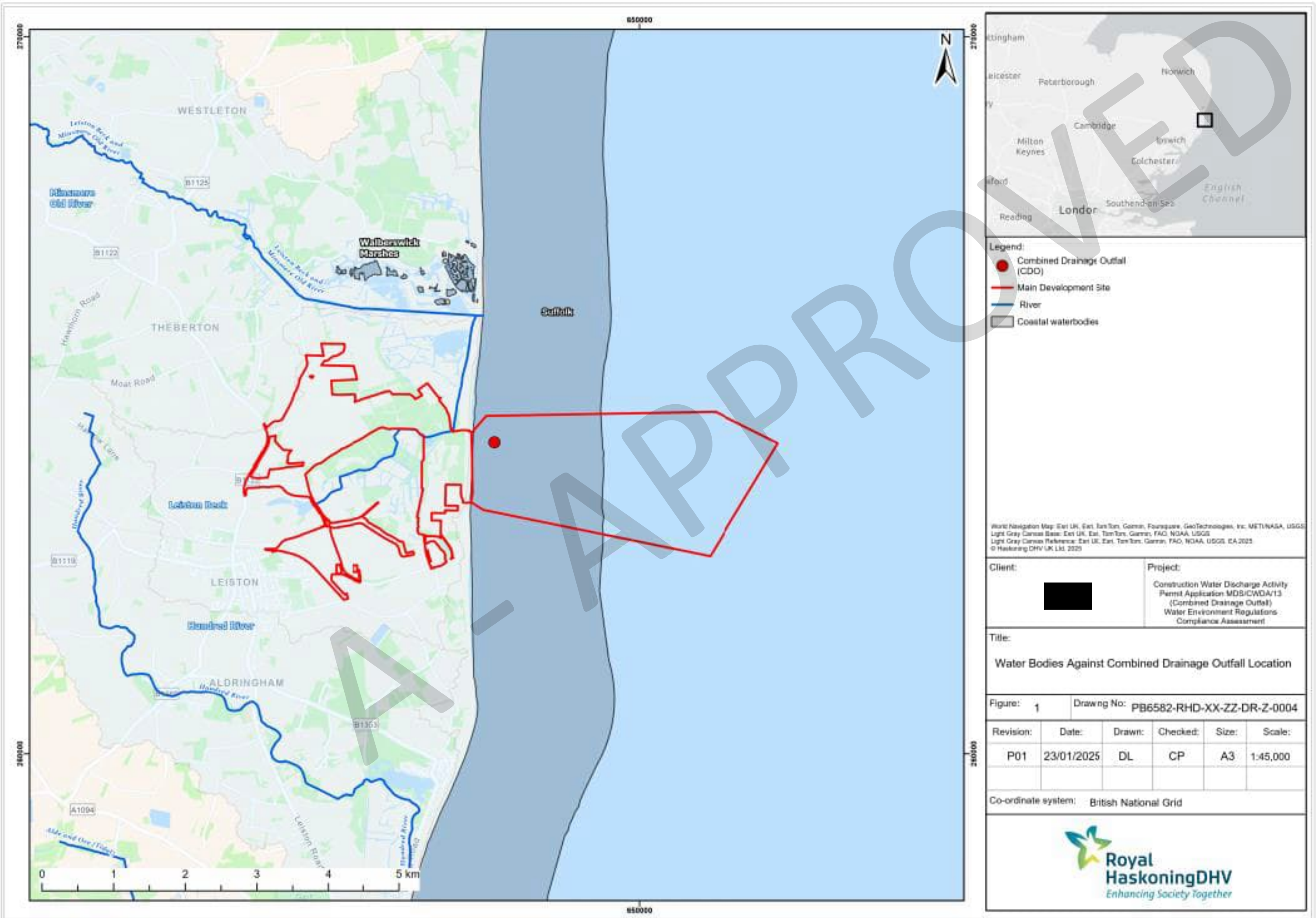

Table 3.1 – Summary of water body information for the Suffolk coastal water body GB650503520002

Parameter	Suffolk coastal water body GB650503520002
Water body area (km^2)	147.387
Overall water body status (2019)	Moderate
Ecological status (2019)	Moderate (dissolved inorganic nitrogen due to poor nutrient and livestock management – agriculture and rural land management, also water industry)
Chemical status (2019)	Fail (Polybrominated diphenyl ethers (PBDE), mercury and its compounds). No sector identified as being responsible. It is considered that natural conditions would return for the chemical parameters over time but not until 2063.
Target water body status and deadline	Moderate due to measures to improve the water body being considered disproportionately expensive.
Is the water body designated as heavily modified	Yes. Heavily modified for coastal and flood protection
Lower sensitivity habitats[5]	Cobbles, gravel and shingle (1929.57ha), intertidal soft sediment (816.46ha), rocky shore (1.78ha), subtidal sediments (10569ha)
Higher sensitivity habitats[6]	Polychaete reef (11.57ha), saltmarsh (197.49ha)
History of harmful algae	Not monitored
Phytoplankton classification (2019)	Good

3.3 Stage 2 Scoping

This section presents the results of the scoping assessment undertaken on the water body identified as being at risk using the method described in the Clearing the Waters for All guidance (Environment Agency, 2023)[3]. The results of this scoping stage determine which water body quality elements will require further assessment (i.e. Stage 3).

It may be possible for relatively straightforward reasons (e.g. no identifiable impact pathway) to scope out some quality elements during Stage 2. However, to do so requires sufficient project information to be available to allow reasoned and clear conclusions to be reached. Where there is uncertainty over the potential for an activity to have an effect, then a precautionary view has been taken, and the quality element scoped in.

3.4 Impacts on quality elements

The outcome of the scoping assessment for the 'discharge of combined wastewater from the CDO to the North Sea' i.e. the Suffolk coastal water body (GB650503520002) is presented in **Table 3.2**.

[5] Lower sensitivity habitats include cobbles, gravel and shingle; intertidal soft sediments like sand and mud; rocky shore; subtidal boulder fields; subtidal rocky reef; subtidal soft sediments.

[6] Higher sensitivity habitats include chalk reef; clam, cockle and oyster beds; intertidal seagrass; maerl; mussel beds, including blue and horse mussel; polychaete reef; saltmarsh; subtidal kelp beds; subtidal seagrass

Table 3.2 – Scoping for water body quality elements for activity 'discharge of combined wastewater from the CDO to the North Sea' to the Suffolk coastal water body GB650503520002

Consider if the footprint of the activity:	Scoping assessment:	Decision:
Hydromorphology		
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status	The water body is not at high status.	No
Could significantly impact the hydromorphology of any water body	The combined wastewater would not release significant concentrations of suspended solids into the water column due to the proposed treatment processes therefore there is no pathway for effect on sediment transport processes. The inclusion of diffusers as part of the marine dispersion head would also reduce any potential effects associated with seabed scour from the discharge.	No
Is in a water body that is heavily modified for the same use as the proposed activity	No, the water body is heavily modified for coastal and flood protection.	No
Biology (habitats)		
Is 0.5km^2 or larger	Given that the extent and nature of the plume is not defined (i.e. modelling is likely to be required), there is the potential that the plume could extend to cover greater than 0.5km^2 or be more than 1% of the water body's area.	Yes
Is 1% or more of the water body's area		
Is within 500m of any higher sensitivity habitat		
Is 1% or more of any lower sensitivity habitat		
Biology (fish)		
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	The discharge would not be in an estuary and fish are not a compliance parameter for coastal water bodies. Additionally, given the location of the discharge in an unrestricted water body, migration routes are unlikely to be impacted. The discharge would not entrain or impinge fish species.	No
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)		
Could cause entrainment or impingement of fish		
Water quality		
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	There is the possibility that the concentration of suspended solids could impact on water quality for more than 14 days given the time over which the CDO could be discharging and the proposed permitted level of 250mg/l. All other parameters would be controlled via treatment processes and effluent quality requirements.	Yes – suspended sediment concentrations

Consider if the footprint of the activity:	Scoping assessment:	Decision:
Is in a water body with a phytoplankton status of moderate, poor or bad	No, the current status classification is good.	No
Is in a water body with a history of harmful algae	Not monitored	No
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if: The chemicals are on the Environmental Quality Standards Directive (EQSD) list	There is the potential for the combined wastewater to contain parameters on the EQSD, particularly related to the discharge of groundwater from excavations and domestic foul water.	Yes
If your activity uses or releases chemicals (for example through sediment disturbance or building works). Consider if the activity disturbs sediment with contaminants above Centre for Environment and Aquaculture Science (Cefas) Action Level 1		

3.4.1 Impacts on Invasive Non-Native Species (INNS)

The discharge would not introduce INNS given the proposed treatment processes for the activities. Groundwater is unlikely to contain INNS. This element is therefore scoped out of further assessment.

3.4.2 Impacts on River Basin Management Plan (RBMP) improvement and mitigation measures

The Environment Agency has not published any specific details of any mitigation or improvement measures for the Suffolk coastal water body (GB650503520002). This element is therefore scoped out of further assessment.

3.4.3 Impacts on protected areas

The 'Clearing the Waters for All' guidance (Environment Agency, 2023)[3] recommends further assessment of potential impacts on any protected areas within the water body and within 2km of a proposed new project activity. **Figure 2** and **Table 3.3** show that there are several protected areas within 2km of the proposed development; the Outer Thames Estuary Special Protected Area (SPA), Minsmere-Walberswick SPA and Ramsar, Minsmere to Walberswick Heaths and Marshes Special Area of Conservation (SAC) and the Southern North Sea SAC. Given the proximity of these protected areas to the discharge location, each has been scoped in for further consideration in Stage 3 of this assessment (**Section 3.4.5**).

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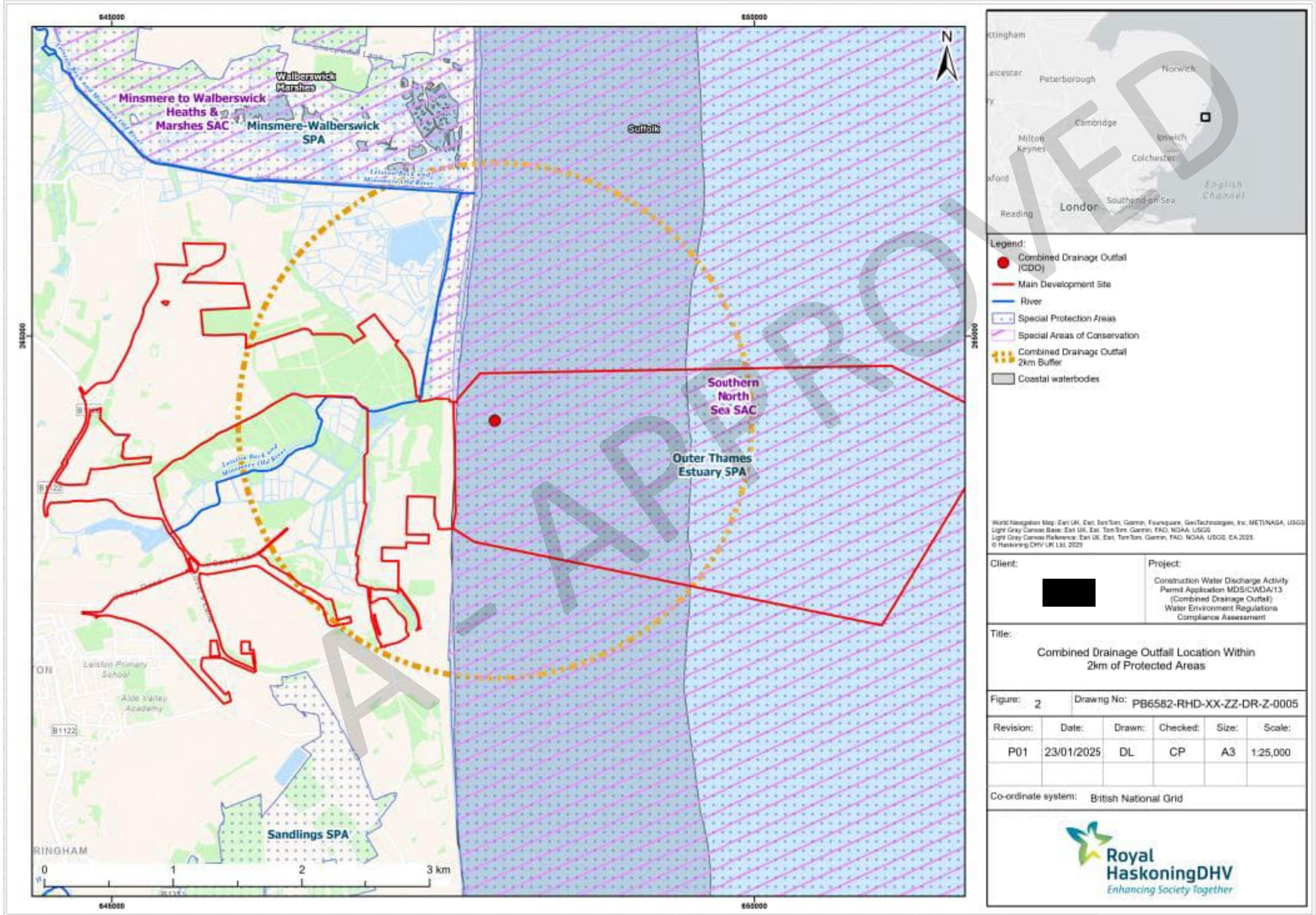
Table 3.3 – Summary of protected areas for the Suffolk coastal water body within 2km

Water body name and ID	Protected area driver	Protected area name/reference
Suffolk GB650503520002	Conservation of Wild Birds Directive	Outer Thames Estuary SPA Minsmere-Walberswick SPA and Ramsar.
	Habitats and Species Directive	Minsmere to Walberswick Heaths and Marshes SAC
	Habitats and Species Directive	Southern North Sea SAC

Figure 2 - Protected Areas within 2km of the CDO



3.4.4 Summary of Stage 2

The scoping assessment has demonstrated that the 'discharge of combined wastewater from the CDO to the North Sea' could potentially affect the biological and chemical quality elements in the Suffolk coastal water body (GB650503520002) (**Table 3.4**). Additionally, several protected areas are within the 2km of the CDO (**Table 3.3**). These elements have therefore been scoped in for further consideration in Stage 3 (**Section 3.4.5**).

Table 3.4 – Summary of scoping for the 'discharge of combined wastewater from the CDO to the North Sea'

Activity	Water body	Quality elements	RBMP mitigation measures	Protected areas within 2km
Discharge of combined wastewater via the CDO to the North Sea	Suffolk GB650503520002	Water quality – chemical and suspended sediment concentrations Biology - habitats	None identified within the RBMP for Suffolk	Outer Thames Estuary SPA Minsmere-Walberswick SPA and Ramsar. Minsmere to Walberswick Heaths and Marshes SAC, Southern North Sea SAC

3.4.5 Stage 3 Detailed assessment

Section 3.3 demonstrates that the 'discharge of process wastewater from the CDO to the North Sea' could potentially impact on the chemical status of the water body and subsequently marine habitats (including several protected areas) of the Suffolk coastal water body (GB650503520002). There is also the possibility that effects on suspended sediment concentrations within the water body could occur. This section provides further assessment to determine whether the activity could affect water body status and considers the potential for cumulative effects with other aspects of the SZC project.

3.4.6 Detailed Assessment for activity 'Discharge of combined wastewater from the CDO to the North Sea'

3.4.6.1 Assessment method - chemistry

Screening of the chemicals likely to be found in the discharge has been undertaken in line with the Environment Agency's guidance 'Surface water pollution risk assessment for your environmental permit'[7]. These screening tests check the risk from hazardous chemicals to the environment. If the screening tests show there is a risk to the environment then modelling is required. There are three stages to chemical screening:

1. Identify the pollutants likely to be released.
2. Gather data on the pollutants – this requires monitoring of the environment into which the discharge would be made.
3. Carry out screening tests for coastal/estuarine waters.

For the screening tests, concentrations of the pollutants in the discharge are then compared to the Environmental Quality Standard (EQS). These can either be Maximum Allowable Concentrations (MAC) or Annual Averages (AA). MAC allows for an assessment of short-term environmental impacts and AA allows for

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

an assessment of long-term effects. It should be noted that not all pollutants have both types of EQS. An outline description of each test is provided below:

- Test 1: Is the concentration of the pollutant more than the EQS concentration? If yes, then Test 2 is carried out. If no, the parameter can be screened out.
- Test 2: Is the discharge to the low water channel (i.e. where water is mainly fresh)? If yes, then freshwater tests are required. If not, then Test 3 is carried out.
- Test 3: Is the discharge into an area with restricted dilution or dispersion? If yes, then modelling is required. If not, then Test 4 is carried out.
- Test 4: Determine the distance between the discharge point and the nearest point where water depths are shown on nautical charts as 0 (i.e. Chart Datum (CD)). If the location is less than 50m offshore from where the seabed is at CD or the seabed at the discharge location is less than 1m below CD, then modelling is required.
- Test 5: Calculate the maximum effective volume flux (which relates to water depth) by multiplying the effluent discharge rates by the release concentration of the pollutant. The average background concentration of the pollutant (in the environment) is then subtracted from the EQS. The maximum effective volume flux is then divided by this result. A comparison against the EQS is then made; if the end result is greater than the EQS, then modelling is required.

A final screening test considers the total annual load of a particular substance. This test calculates a total annual input in kilograms (kg) of key pollutants and compares this total to the relevant significant load limit. Substances relevant to this test are cadmium (limit 5kg a year) and mercury (limit 1kg per year). The annual load is calculated by determining the total volume discharged over a year and multiplying this by the concentrations of the substance.

Where a substance fails a screening test, modelling is then undertaken, in the first instance using CORMIX to consider the near-field effects. Where indications are that concentrations could exceed thresholds in the far-field, full hydrodynamic modelling is required.

3.4.6.2 Discharge scenarios

The CDO could discharge wastewater from a number of wastewater streams. Discharge characteristics for each wastewater stream and how they have been dealt with in the assessment is summarised in **Table 3.5**.

Table 3.5 – Wastewater stream and method for assessment

Discharge stream	Discharge rate	Comments regarding assessment
Treated surface water run-off from the MCA	Maximum flow rate 400l/s - based on a 1 in 30 year storm. Upper estimate of an average flow – 250l/s.	Surface water is anticipated to be treated via water management zones and therefore the risk of contamination is low. This waste stream is therefore not included within the screening assessment calculations. Addition of this flow would dilute the concentrations associated with the streams included in the assessment therefore the calculations are precautionary.
Treated groundwater from MCA	250l/s for five months then 50l/s	Both flows are considered within the screening tests as the groundwater is shown to contain concentrations of EQSD chemicals, including un-ionised ammonia.
Treated domestic foul water from MCA	24.8l/s	Sewage flows are accounted for in the un-ionised ammonia calculations. Trace metal concentrations are not anticipated to be discharged within these wastewater streams due to the proposed treatment processes therefore these flows are not considered in the EQS screening calculations.
	4.5l/s	

Discharge stream	Discharge rate	Comments regarding assessment
Treated TCA domestic foul water	20.7l/s	
Treated effluent from Sweeper Tip Facility	3l/s	Likely to be treated to acceptable quality therefore risk of contaminants is low. This wastewater stream is therefore not included in the EQS screening calculations.
Bentonite plant	4.7l/s	Effluent would not contain contaminants. This wastewater stream is therefore not included in the EQS screening calculations.

Four scenarios are therefore considered in the screening tests to encompass the worst-case discharges for metals and un-ionised ammonia. These scenarios are:

1. Peak groundwater discharge at 250l/s – worst-case for metals. This has been termed Case A.
2. Peak groundwater discharge at 250l/s plus treated foul water (treated sewage) at 50l/s = 300l/s. This only applies to the un-ionised ammonia assessment, as dilution of the metals in the groundwater would decrease the concentration of metals meaning this scenario is less precautionary than Case A for groundwater with respect to metals. This has been termed Case A1.
3. Post peak groundwater discharge at up to 50l/s groundwater. This has been termed Case B.
4. Post peak groundwater discharge at up to 50l/s groundwater combined with maximum treated sewage discharges of up to 50l/s treated sewage = total flow 100l/s. Again, this only applies to the un-ionised ammonia assessment, as dilution of the metals in the groundwater would decrease metal concentrations, meaning that this scenario is less precautionary than Case B for groundwater. This has been termed Case B1.

3.4.6.3 Data used

Water quality measurements from boreholes undertaken in the years 2014 and 2020 have been used to characterise concentrations of contaminants in the groundwater. Both datasets have been included in determining the background and the full datasets and discussions around concentrations and limits of detection (LOD) is provided in British Energy Estuarine and Marine Studies (BEEMS) TR588[8]. In summary, the concentrations assessed are the 95th percentile values, from whichever of the 2014 or 2020 data is higher, to provide a worst-case assessment. These are presented in **Table 3.6**.

Table 3.6 Summary of groundwater concentrations used in the screening assessment

Substance	Background concentration (µg/l)	Notes
Arsenic	11.7	2020 and 2014 values very similar
Cadmium	2	Value set at LOD for 2020 dataset – the 2014 indicates the true value is likely to be much less (measured in 2014 at 0.08 µg/l) however the value from 2020 was taken forward as a precaution
Chromium	18.7	Cr includes both Cr(III) and Cr(VI); the relative proportions of each oxidative state are not known, therefore it is precautionarily assumed that all

[8] BEEMS Technical Report TR588 Sizewell C Construction water discharge assessment; Groundwater

Substance	Background concentration (µg/l)	Notes
		measured Cr is Cr(VI) for comparison with the EQS which is for Cr(VI) only. 2014 value used.
Copper	23	2020 value taken forward – significantly higher than 2014 value of 4.1µg/l
Iron	18,960	2020 value taken forward – significantly higher than 2014 value of 1,500µg/l
Nickel	10	2020 and 2014 values similar
Lead	10	Value set at LOD – the 2014 indicates the true value is likely to be much less (1.1µg/l measured in 2014) however the value from 2020 was taken forward as a precaution
Mercury	0.5	Value set LOD – the 2014 indicates the true value is likely to be much less (0.021µg/l measured in 2014) however the value from 2020 was taken forward as a precaution
Zinc	55	2020 value taken forward – significantly higher than 2014 value of 17.7µg/l
Ammoniacal Nitrogen (N)	5,577	2014 value taken forward – significantly higher than 2020 value of 1,938µg/l
Un-ionised ammonia (freshwater)	22.9	2014 value taken forward – significantly higher than 2020 value of 8.0µg/l
Un-ionised ammonia (seawater)	102.1	2014 value taken forward – significantly higher than 2020 value of 35.5µg/l

For the treated sewage, the total ammoniacal nitrogen (as N) is not expected to exceed 20,000µg/l therefore this value has been applied to the sewage component of the flow.

For background concentrations, these are calculated from monitoring data sampled monthly between March 2014 and September 2015. Full details are provided in BEEMS TR314[9]. The background concentrations used in this assessment are presented in **Table 3.7**.

Table 3.7 Background levels used in the assessment

Substance	Background concentration (µg/l)
Arsenic	1.07
Cadmium	0.05
Chromium	0.57
Copper	2.15
Iron	100
Nickel	0.79
Lead	1
Mercury	0.02
Zinc	15.12
Ammoniacal nitrogen (NH_4-N)	11.38
Un-ionised ammonia (NH_3-N)	0.19

Results from the screening assessment for heavy metals are presented in **Table 3.8** for both Case A and Case B. The proposed discharge would not be to a low water channel (Test 2) or to an area of reduced

[9] BEEMS Technical Report TR314. Sizewell supplementary water quality monitoring data 2014/2015. Cefas, Lowestoft.

dilution/dispersion (Test 3), the water depth at the CDO is at 6.2m ODN, and the location is approximately 300m offshore (Test 4). The requirement for modelling for the CDO discharge is therefore based on the results of Tests 1 and 5.

Table 3.8 Screening results for Cases A and B

Substance	Concentration in effluent (µg/l)	Background concentration (µg/l)	Screening test result[10]	
			Case A	Case B
Arsenic	11.7	1.07	Pass	Pass
Cadmium	2	0.05	Pass	Pass
Chromium	18.7	0.57	Fail	Fail
Copper	23	2.15	Fail	Pass
Iron	18,960	100	Fail	Pass
Nickel	10	0.79	Pass	Pass
Lead	10	1	Fail	Pass
Mercury	0.5	0.02	Pass	Pass
Zinc	55	15.12	Fail	Fail

It should be noted that the background levels of zinc are above the EQS and therefore Test 5 cannot be applied. Zinc is therefore only screened against Test 1. It should also be noted that the chromium assessment is based on measurements of all oxidative states of chromium (i.e. Cr(III) and Cr(VI)) while the EQS is based on hexavalent chromium (Cr(VI)) only. The precautionary assumption is that all chromium in the discharges is of the more toxic hexavalent form. For Case B (50l/s) the results of Test 1 are the same as Case A (250l/s) as the Test is independent of flow. Test 5, however, shows that the lower flow in Case B leads to several metals passing Test 5 that failed for Case A.

With respect to total annual load, as with screening above, the flow from groundwater has been applied to calculate the total mass as the other elements of the flow (treated sewage) are not expected to contribute significant metal concentrations to the discharge. Results of this assessment are presented in **Table 3.9**.

Table 3.9 Results of total annual load test for cadmium and mercury

Substance	Rate 1 (flow + duration)	Rate 2 (flow + duration)	Concentration µg/l	Annual Load (kg)	Limit (kg)
Cadmium (2020)	250l/s 152.5 days	50l/s 212.5 days	2.0	8.424	5
Cadmium (2014)			0.19	0.800	5
Mercury (2020)			0.5	2.106	1
Mercury (2014)			0.021	0.088	1

For cadmium, the annual load is estimated to be 0.8kg if the 2014 dataset is used. Applying the 2020 data results in considerably higher estimates due to the low precision LOD for many samples. With the 2020 data (assuming a concentration of 2.0µg/l equivalent to the maximum LOD), the estimated total cadmium load would be 8.424kg. However, this result is not considered reliable due to the influence of the high LOD in many samples.

For mercury, the annual load is estimated as 0.088kg if the 2014 data are used. However, using the 2020 mercury value, which was set at the maximum LOD of 0.5µg/l, the total annual load would exceed the limit at

[10] Fail indicates parameter has failed both Test 1 and Test 5.

2.106kg/year. Again, the achieved mercury detection limit in 2020 was significantly higher than the target detection limit, and therefore it is reasonable to assume that mercury will be present in the discharge at levels below 0.5µg/l and therefore the annual load is unlikely to be breached.

Given the considerable range in figures for the total annual loads for both parameters between the two datasets, it is proposed that monitoring to establish accurate total load discharges to ensure the annual load limits are not exceeded is undertaken. If measured concentrations are elevated and the total load limits are forecast to be exceeded following recalculation, mitigation will be required and could include flow control or treatment of the effluent. However, following the initial peak dewatering period, the flow rate will be lower and therefore the total loads will be reduced. As such, after the first year, the annual loads will be substantially reduced below the allowable limits.

3.4.6.4 Modelling

Substances which do not pass the screening tests require modelling to determine the extent of the mixing zone (i.e. the area in excess of the EQS). For relatively small discharges, near-field modelling can be sufficient to demonstrate the size of the mixing zone and this is often the first step for further assessment. As for the other construction discharges at Sizewell, BEEMS TR588[8] uses the near-field modelling software CORMIX US EPA supported mixing zone model to calculate dilution of the discharge over distance.

Case A was used, as this represents the largest flow and therefore greatest overall mass of substances in the discharge. The dilution required to reach the EQS is calculated as follows:

- Step 1: Discharge concentration minus the background concentration.
- Step 2: Discharge concentration minus the EQS.
- Step 3: Step 2 divided by step 1 (to give the percent mixing required to reach EQS).
- Step 4: Step 3 divided by (100 minus step 3) (to give the dilution ratio, add 1 for dilution factor).

For zinc the background concentration is greater than the EQS concentration so it is not possible to mix the discharge below the EQS. Following consultation with the Environment Agency, modelling is based on the background concentration plus 3% of the relevant EQS therefore the adjusted threshold is 15.12+0.237=15.357µg/l.

CORMIX output provides a dilution curve which can then be converted to distance to EQS using the above stepped methodology. This represents an instantaneous plume in a single direction, not a plume area, therefore an approximation of the plume footprint is calculated based on worst-case tidal conditions (i.e. the long axis is 5.9 times the short axis, as shown by particle tracking reported in BEEMS TR306[11]). The results are presented in **Table 3.10**.

[11] BEEMS TR306 BEEMS Technical Report TR306. Sizewell Marine Water and Sediment Quality Synthesis Report MSR2/5. Cefas, Lowestoft.

Table 3.10 Calculation of distance to EQS

Substance	Concentration µg/l	Background µg/l	EQS (AA) µg/l	Mixing to EQS (%)	Dilution factor to EQS	Range to EQS (m)
Chromium	18.7	0.57	0.6	99.83	604	750
Copper	23	2.15	3.76	92.28	12.95	6
Iron	18,960	100	1000	95.23	20.96	12
Lead	10	1	1.3	96.67	30.00	17
Zinc	55	15.12	15.357	99.41	168.27	317

Table 3.10 shows that the mixing zone for copper, iron and lead, will be constrained to the immediate area around the outfall and will fall to the EQS levels within 20m (or within 212m^2, 0.02 Hectares (ha) based on the tidal ellipse). Given the size of the mixing zone compared to the size of the Suffolk coastal water body, a non-temporary deterioration in the water body is not predicted.

For chromium and zinc the range to EQS was calculated as being 750m and 140m respectively. The mixing zones for these metals are therefore best characterised by full-scale hydrodynamic modelling. For Sizewell C, this was undertaken using GETM, a 3D hydrodynamic model and run for a full month to cover the range of tidal conditions (full details are provided in BEEMS TR588[9]).

Table 3.11 details the areas of the mixing zones predicted by GETM for chromium and zinc. These equate to 0.15% of the water body for chromium and 0.02% for zinc. Given these relatively small areas in relation to the scale of the water body, a non-temporary effect on water quality is not predicted.

Table 3.11 GETM model results – mean areas are shown against the AA

Substance	AA EQS µg/l	Surface area > EQS (km^2)	Bottom area >EQS (km^2)
Chromium	0.6	0.221	0
Zinc	15.357	0.035	0

3.4.6.5 Unionised ammonia

Un-ionised ammonia concentrations have been calculated using the Environment Agency calculator (following the formulas in Clegg & Whitfield,1995[12]).

Table 3.12 provides the calculated final mix concentration of ammoniacal nitrogen based on the relative contributions of groundwater and treated sewage and the output of the screening stage in **Table 3.13**.

Table 3.12 Total flow and ammoniacal nitrogen concentrations of groundwater and treated sewage discharges

Case	Groundwater flow l/s	Groundwater ammoniacal Nitrogen µg/l	Treated sewage flow l/s	Sewage ammoniacal Nitrogen µg/l	Final Flow l/s	Final ammoniacal Nitrogen Concentration µg/l
A	250	5,577	0	0	250	5,577
A1	250	5,577	50	20,000	300	7,981

[12] Clegg S. L. and Whitfield, M. 1995. A chemical model of seawater including dissolved ammonia, and the stoichiometric dissociation constant of ammonia in estuarine water and seawater from -2° to 40 °C. *Geochimica et Cosmochimica Acta* **59**, 2403 – 2421.

B1	50	5,577	50	20,000	100	12,789

Table 3.13 Screening results for un-ionised ammonia

Scenario	Un-ionised ammonia Concentration µg/l	Background µg/l	EQS AA µg/l	Result
Case A – Freshwater	23	0.19	21	Pass
Case A – Seawater	102	0.19	21	Pass
Case A1 – Freshwater	33	0.19	21	Pass
Case A1 – Seawater	146	0.19	21	Pass
Case B1 – Freshwater	53	0.19	21	Pass
Case B1 – Seawater	234	0.19	21	Pass

All un-ionised ammonia cases pass the screening test and therefore do not require further assessment. A non-temporary deterioration in the water body is not predicted.

3.4.6.6 Water quality – suspended sediment

In terms of background concentrations, water sampling undertaken in 2010-2011 and again in 2014-2015 indicates that the background suspended sediment concentrations nearshore show considerable variability with values ranging from 9mg/l to 437mg/l (BEEMS TR588)[8]. Additional assessment using satellite derived suspended particulate matter determined that the long-term average was 55.3mg/l (Eggleton *et al.,* 2011)[13].

An assessment threshold of 100mg/l has been determined based on the WFD turbidity criteria (i.e. the level at which the turbidity classification would be changed from 'intermediate' (10<100 mg/l) to 'turbid' (100 – 300 mg/l). Screening against this threshold has been undertaken, the results of which are presented in **Table 3.14**. The screening results indicate that suspended sediment in the discharge will disperse rapidly. Additionally, background measurements indicate that 250mg/l is within the range of suspended sediment concentrations experienced at the site. Overall, therefore, a non-temporary deterioration in the water body is not predicted.

Table 3.14 Screening results for suspended sediment

Scenario	Total flow l/s	Concentration in effluent mg/l	Background mg/l	Threshold mg/l	Result
Combined[14]	560.7	250	55.3	100	Pass
Peak groundwater	250	250	55.3	100	Pass
Main flow of groundwater	50	250	55.3	100	Pass

3.4.6.7 Biology (habitats)

As outlined in **Section 3.2**, copper, iron, lead, chromium and zinc are predicted to be in excess of EQS or background plus 3% EQS where the baseline already exceeds the EQS in the case of zinc. However, only concentrations of zinc and chromium would exceed the EQS outside of the near-field area. Whilst exposure to

[13] Eggleton, J., Dolphin, T., Ware, S., Bell, T., Aldridge, J., Silva, T., Forster, R., Whomersley, P., Parker, R., Rees, J. 2011. Natural variability of REA regions, their ecological significance & sensitivity. MEPF-MALSF Project 09-P114. Cefas, Lowestoft, 171 p

[14] Comprises surface water, groundwater and wastewater from treatment facilities with surface water as an upper estimate of an average flow.

moderate concentrations of heavy metals can produce a variety of non-lethal effects on benthic organisms, the concentrations at the seabed are significantly less than those predicted at the surface see **Table 3.11** which demonstrates seabed effects outside of the near-field are not predicted. A non-temporary effect on benthic invertebrates on a water body scale is therefore not predicted.

3.4.6.8 Protected areas

The Outer Thames Estuary SPA, Minsmere-Walberswick SPA and Ramsar, Minsmere to Walberswick Heaths and Marshes SAC and the Southern North Sea SAC are located within 2km. WER Compliance Assessments require the consideration of the potential effects on a range of quality elements (hydromorphological, physico-chemical, chemical and biological), many of which support ecological interest features for which protected areas are designated. A Habitats Regulations Assessment (HRA) supporting information package is presented in Appendix D to the permit application which assesses the potential effects on designated site interest features from the discharge of the combined wastewater.

3.4.6.9 Cumulative effects

The CDO discharge may overlap with both the desalination outfall discharge and therefore combined effects are possible. The effects of the desalination plant discharge are considered in Appendix E to the CWDA-78 permit application supporting document. The maximum surface plume from the CDO extends close to, but not quite overlapping the desalination plant outfall. As a worst-case it is possible that the plumes from the two discharges may occur simultaneously without any overlap, and therefore the combined area in excess of the relevant EQS would be the sum of the two areas (noting that the CDO discharge is buoyant and creates a surface plume whereas the desalination plume is dense and results in a plume at the seabed).

Overlapping plume areas may marginally increase the concentration but the total area in excess of the EQS could not be larger than the total of the two separate plumes combined.

The largest estimated plume footprint for metals (for zinc) discharged from the desalination plant is up to 0.630 ha (0.0063 km^2) at the bed, combined with the surface CDO plume (0.035 km^2) for zinc, a total area of 0.041 km^2 may be exposed to average zinc levels above the defined criteria. This equates to 0.03% of the Suffolk coastal water body. Overall, therefore the scale of effects which would occur in relation to the size of the water body is small and therefore a non-temporary deterioration in the water body is not predicted.

The chromium plume was the largest plume from the CDO (up to 0.22 km^2), however chromium from the desalination plant discharge is expected to be very low, with a maximum footprint of 0.001 ha (0.00001 km^2). Combined effects would therefore be negligible.

3.4.6.10 Summary

The Stage 3 Further Assessment did not identify any parameters at risk of deterioration such that class status for any of the parameters would decrease. As a result, the discharge of combined wastewater from the CDO to the North Sea is assessed as being compliant with the requirements of the WER.