The Sizewell C Project

8.14 Water Framework Directive Compliance Assessment Report
Part 2 of 4

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SIZEWELL C PROJECT: WFD COMPLIANCE ASSESSMENT

PART 2: MAIN DEVELOPMENT SITE

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2.1 Introduction to Part 2

a) Introduction

2.1.1. SZC Co.[1] is currently developing proposals to build and operate a new nuclear power station comprising two UK European Pressurised Reactors™ (EPRs) at Sizewell in Suffolk, north of the existing Sizewell B power station: 'the Sizewell C Project'. This report provides part of an assessment of whether the Sizewell C Project is compliant with the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 2017/407), which implement Directive of the European Parliament and Council (EC) 2000/60/EC establishing a framework for community action in the field of water policy (generally known as the Water Framework Directive (WFD)) in the UK.

2.1.2. The report is provided in support of SZC Co.'s application for development consent to the Planning Inspectorate and a separate application for a Water Discharge Activity (WDA) environmental permit to the Environment Agency for the Sizewell C Project. The DCO application is also accompanied by an **Environmental Statement** (**ES**) (Doc Ref. Book 6) and a **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10).

2.1.3. This **WFD Compliance Assessment Report** is divided into four parts, as follows:

- **Part 1**: Introduction and method.
- **Part 2**: Main development site.
- **Part 3**: Associated development sites.
- **Part 4**: Cumulative effects assessment.

2.1.4. This document (**Part 2**) presents the results of the WFD Compliance Assessment for the Sizewell C Project activities proposed at the main development site. The process followed reflects the methodology set out in **Part 1**.

[1] NNB Generation Company (SZC) Limited, whose registered office is at 90 Whitfield Street, London, W1T 4EZ; referred to in this document as 'SZC Co.'.

b) Structure of Part 2

2.1.5. This report is divided into five further sections:

- **Section 2.2**: Project Description – A detailed description of the proposed development components which could impact the water environment during the construction and operational phases. Decommissioning is not considered in this assessment as it would be the subject of an additional WFD Compliance Assessment at a later date once decommissioning details are available.
- **Section 2.3**: Stage 1 Screening – Initial screening of water bodies potentially at risk and partitioning of the scheme into activities for assessment.
- **Section 2.4**: Stage 2 Scoping – Identification of which water bodies potentially could be impacted by the activities and which quality elements could be at risk.
- **Section 2.5**: Stage 3 Compliance Assessment – Detailed assessment to determine whether the scoped in activities will cause water body deterioration and whether this deterioration will have a significant non-temporary effect on the status of one or more WFD quality elements at water body level.
- **Section 2.6**: Summary – Summary of the main findings of the assessment and mitigation measures required to ensure compliance with the WFD.

2.2 Project Description

a) Purpose of this Section

2.2.1. This section provides a description of the proposed development at the Sizewell C main development site. This includes an outline description of the permanent development in **section 2.2b**, a description of proposed activities during construction in **section 2.2c**, and a description of proposed activities during operation in **section 2.2d**.

b) Description of the Permanent Development

i. Overview of permanent development

2.2.2. The Sizewell C main development site is located on the Suffolk Coast, approximately half way between Felixstowe and Lowestoft, to the north-east of the town of Leiston. The proposed nuclear power station would be located immediately to the north of the existing Sizewell B power station.

2.2.3. In summary, permanent development at the main development site would comprise the following building, engineering or other operations (more detail can be found in **Chapter 2** of **Volume 2** of the **ES** (Doc Ref. 6.3)):

Nuclear islands

2.2.4. Two nuclear islands, including two UK EPR™ reactor buildings and associated annexed buildings and structures containing the safety systems, fuel handing systems and access facilities, together with the adjacent emergency diesel generator buildings.

Conventional islands

2.2.5. Two conventional islands, each including a turbine hall and associated electrical buildings for the export and distribution of electrical power.

Operational building

2.2.6. An operational service centre (a multi-purpose building), which allows for access into the nuclear islands, including storage areas, workshops, store rooms, laboratories, data centre, offices and associated support and welfare facilities, including the staff restaurant.

Cooling water pumphouses and associated buildings

2.2.7. Two cooling water pumphouses with related infrastructure (one for each UK EPR™ reactor).

Ancillary buildings

2.2.8. Plant, office/access, storage and fuel and waste management.

2.2.9. National Grid 400 kilovolt (kV) substation, alterations to the existing National Grid substation and associated diversion of overhead lines.

2.2.10. Relocation of several Sizewell B ancillary buildings including the outage store, training centre; administrative buildings; visitor centre; and office, canteen and welfare facilities.

2.2.11. Associated buildings, structures and plant outside of the power station perimeter.

Marine works and associated infrastructure

2.2.12. The cooling water system and combined drainage outfall in the North Sea, including associated dredging and tunnelling works.

Other site structures, infrastructure and works, including highway works and earthworks.

2.2.13. These include:

- Overhead power lines and pylons connecting the conventional islands to the National Grid substation.
- Replacement of an existing National Grid pylon and power line south of Sizewell C.
- Installation of a cut-off wall and cut-off wall platform and associated deep excavations within the main platform.
- Vehicular and pedestrian crossing over the Sizewell Marshes SSSI south of Goose Hill in the form of a culverted embankment.
- A beach landing facility (BLF) proposed for freight and abnormal indivisible loads (AILs) arriving by sea, including associated dredging.
- Relocation of certain Sizewell B infrastructure, including: outage laydown area; up to 112 replacement car parking spaces; access roads; up to 576 outage car parking space; and, outage car park access roads.
- Diversion of rights of way including Bridleway 19.
- Power station access road, linking the SSSI crossing with a new roundabout onto Abbey Road (B1122).
- Up to 770 operational car parking spaces and up to 600 outage car parking spaces.
- Realignment of Lover’s Lane and Eastbridge Road (part) and other highway works.
- Onshore components of the marine infrastructure.
- Replacement vehicular access from Valley Road to adjoining farmland to the north.
- Realignment of the junction of the B1122 Abbey Road and Lover’s Lane.

- Flood defences and coastal protection measures.
- Water supply and drainage measures, including realignment of Sizewell drain.
- Landscape restoration works and planting.
- Fencing, lighting and other security provisions.
- Additional parking spaces at Kenton Hills car park.
- New sports facilities located on existing playing fields at Alde Valley school in Leiston.
- Fen meadow compensation areas located at Halesworth and Benhall.
- Temporary marsh harrier habitat improvement area (if required) at Westleton.

2.2.14. The following sections describe the main elements of the permanent development which, when constructed and operational, could impact on the water environment in more detail.

ii. Cooling water pumphouse and associated buildings

Cooling water intake and outfall tunnels and associated headworks

2.2.15. Seawater for cooling the power station would be abstracted via a series of intake structures and tunnels. Each UK EPR™ reactor unit would have a single dedicated 6 metre (m) internal diameter intake tunnel extending approximately 3 kilometres (km) out under the seabed. At the seaward end of each tunnel, two vertical shafts would extend upwards to provide a connection to the sea via a seabed-mounted intake head (one head per shaft). Each of the intake heads would comprise a concrete and steel headworks designed to abstract seawater at a depth of only a few metres above the seabed. A 'velocity capped' design, or a simplified version of the Hinkley Point C design, is proposed.

2.2.16. A single 8m internal diameter outfall tunnel serving both reactor units would return the cooling water to sea, with two vertical shafts at its seaward end each leading upwards to a single outfall headworks, again mounted on the seabed.

Forebays

2.2.17. There would be one forebay for each UK EPR™ reactor unit, each served by an intake tunnel. The forebays would serve to smooth the water flow into the cooling water system accounting for the tidal range of the North Sea. Each forebay would have a mechanically raked screen with associated collection gutter for removal of large debris, and any very large fish, and transport to the filtering debris recovery building.

Cooling water pumphouses

2.2.18. There would be one cooling water pumphouse for each UK EPR™ reactor unit, which would draw water from the forebays. The cooling water pumphouses would contain equipment supplying seawater as coolant for:

- The nuclear and conventional islands' auxiliary and safety cooling water systems.
- The condenser cooling system that cools the turbine exhaust steam and condenses it to liquid water for reuse as feed water within the secondary circuit.

2.2.19. Each cooling water pumphouse would incorporate screening systems including drum and band screens specifically designed to prevent the blockage of key elements of plant further downstream within Sizewell C.

2.2.20. Each drum screen would be made up of a horizontal axis drum whose outer circumference would be made up of panels of a smooth ('fish friendly') fine mesh. The inner circumference of each drum screen would have 'fish-friendly' elevator ledges or 'buckets', which would lift debris and marine organisms including fish. Continuous wash-water sprays would then flush the collected material into collection troughs which, in turn, flush into a gutter for onward flow to the filtering debris recovery pit. In normal operation, the drum screens would rotate at a low speed but if there is any indication of blockage both the rate of rotation and the flow rate of wash-water would be increased.

2.2.21. Each of the cooling water pumphouses would also have two sets of rotating band screens to remove debris from the lateral water channels, prior to passage through the fine bore heat exchanger systems that follow. The band screens would be made up of a continuous belt of linked mesh plates which would rotate around two horizontal rollers, one positioned at the foot of the waterway and one above, and similarly aligned with a catch bucket and gully for fish return that discharges into the filtering debris recovery pit.

Filtering debris recovery and fish recovery and return system

2.2.22. Plant for managing screen debris is positioned near to each cooling water pumphouse. It would consist of a pre-discharge section and a pre-discharge basin. The pre-discharge section would involve the continuation of the washwater gutter that would run from the drum and band screens to collect fish and other marine organisms directed from the screens, together with the gutter for collection of materials from the forebay raking screens.

2.2.23. Recovered fish and debris would be returned to the sea under gravity via a dedicated fish recovery and return (FRR) tunnel for each EPR^{TM}. The FRR system would be fully integrated within the cooling water infrastructure and its purpose would be to recover fish and other marine organisms that are entrapped in the cooling water system and caught on both the drum and band screens and return them to sea.

Outfall pond (surge chamber)

2.2.24. All abstracted sea water, which has served its cooling function and would thus have been warmed, would be conveyed back to the marine environment via an outfall pond (surge chamber), open to atmosphere that discharges into an outfall galleries. The outfall galleries leading from each of the outfall ponds (one per UK EPR^{TM} reactor unit) would then join to form a single outfall tunnel, discharging to sea.

iii. Other plant

2.2.25. Other development would include:

- A demineralisation station would be provided to process raw water delivered via the local water company mains and used in the UK EPR^{TM} reactor for power generation and cooling purposes.
- Two degassed water storage tanks would store degassed water from the demineralisation plant.
- An electro-chlorination plant to produce chlorine from seawater for dosing the cooling water to prevent biological fouling
- Auxiliary boilers would provide steam for heating the turbine and turbine gland sealing for start-up of both UK EPR^{TM} reactor units.
- A hydrogen, oxygen and chemical products storage facility (separate from the nuclear and conventional Islands).
- A sewage treatment plant located on the south-east boundary of the permanent site drainage system.
- Nuclear island and conventional island water storage tanks would store treated water to be used in the steam cycle to power the turbines.

- A fire-fighting water building for each unit would provide the fire-fighting water supply and house an emergency water provision to cool facilities on the nuclear island.

iv. Permanent drainage system

2.2.26. An **Outline Drainage Strategy** has been developed, provided at **Appendix 2A** of **Volume 2** of the **ES** (Doc Ref 6.3). The strategy has been developed following industry standards, guidance and best practice regarding the safe and sustainable management of surface water runoff. In addition to the key requirement of providing functional drainage, the strategy has been developed based on the following design principles:

- Control run-off at or close to where it hits the ground.
- Reduce the rate of run-off leaving any part of the site and discharging to nearby watercourses at greenfield rates where applicable.
- Use at or near-surface drainage features wherever practicable, slowing the rate of run-off entering into below ground drainage attenuation.
- Provide stages of water treatment.
- Select and combine appropriate drainage features or sustainable drainage system (SuDS) components to suit site constraints.
- Encourage habitats for wildlife in developed areas and opportunities for biodiversity enhancement.
- Contribute to the ecology and aesthetic value of developed areas.

2.2.27. Permanent site drainage systems would be installed to treat surface water run-off and then discharge it into the power station forebay(s), where it would mix with cooling water before being disposed to sea. In some areas, the permanent systems may utilise parts of the construction drainage infrastructure. The CDO would not be used in the operational period.

v. SSSI crossing

2.2.28. The SSSI crossing provides an essential pedestrian and vehicular connection across Sizewell Marshes SSSI, linking Sizewell C with the new access road. The design comprises a causeway with a culvert, through which Leiston Beck would flow.

2.2.29. Following the completion of the construction phase, the western-most access route across the causeway would be maintained to provide operational access to the power station. The easternmost part of the causeway would be appropriately landscaped, helping to create a landscape boundary between the power station development and its surroundings.

2.2.30. The width of the embankment at road level would be up to 35m and the overall width of the crossing at its base would be up to 65m. The culvert would be sized to facilitate the passage of fish, bats, otters and water voles through the structure, and a ledge would be installed to further encourage passage by otters, if deemed necessary following detailed design.

vi. Sea defences

2.2.31. The permanent sea defence known as the hard coastal defence feature (HCDF) would be in the form of a landscaped embankment built seaward of the outer security fence for Sizewell C. The baseline crest height of the embankment to protect against wave overtopping would be 10.2m Above Ordnance Datum (AoD). However, this would be increased up to 12.2m AoD to provide additional screening of Sizewell C from certain public viewpoints along Sizewell beach.

2.2.32. As with Sizewell B, an artificial linear dune / sacrificial berm comprising largely of shingle would extend along the frontage of the sea defences at a level on the shore above extreme high water-level spring tides and rising to a height of approximately 5m AoD known as the soft coastal defence feature (SCDF). The role of the sacrificial dune would be to minimise coastal erosion and release sediment to the beach face, which would only be activated during a storm event. It is likely that the dune would occasionally be eroded and require repair in order to maintain its volume.

2.2.33. The HCDF landscaping scheme would take into account landscape, biodiversity and recreational considerations. To create a semi-natural and less engineered appearance, the height of the HCDF would vary along its length. The feature would be similar in outward appearance to the Sizewell B sea defence, although its alignment would be further to the east. As with the frontage of Sizewell B, the artificial linear dune fronting the sea defence would be integrated into the landscaping scheme through the creation of semi-natural dune habitats.

vii. Beach landing facility

2.2.34. A permanent BLF would be required for the operational phase for delivery of AILs, such as the reactor pressure vessel, during maintenance. The landward termination of the BLF would be at approximately 6.0m AoD to provide the necessary depth to accommodate the required barges.

2.2.35. The BLF would include a temporary deck structure that can be removed when not in use, leaving minimum visible elements.

2.2.36. The BLF would extend up to approximately 37m seaward of the mean high water mark and approximately 70m seaward of the HCDF. Any coatings or treatments applied to the BLF would be suitable for use in the marine environment.

2.2.37. The BLF would consist of a piled platform, fenders (located at the seaward end), a ramp and mooring dolphins. There will be up to approximately 20 marine piles to ensure the BLF is transmissive to water and sediment flows.

2.2.38. Localised dredging will be necessary prior to piling and is likely to take approximately 12 weeks.

viii. Creation of water resource storage area and associated infrastructure

2.2.39. A temporary water resource storage area would be constructed, which is expected to provide a volume of up to approximately 25,000m^3 of non-potable water for use in the construction process and would provide the ability to store water over the winter period typically for use during the summer months. Water would be stored above groundwater level to ensure it is hydrologically separate and does not cause adverse effects to groundwater levels on- or off-site. Land cover would comprise dry Sandlings grassland and scrub mosaic.

2.2.40. The water resource storage area is likely to be part below existing ground level and part above existing ground level, with raised embankments as necessary up to approximately 3m in height. Tree/hedgerow planting is proposed to reinforce existing vegetation around the perimeter of the field, providing visual screening and connective habitat between Sandypytle Plantation and The Grove / proposed wet woodland habitat.

2.2.41. Design considerations would include: siting, to benefit from screening provided by established vegetation, notably Sandypytle Plantation; the shape and profile of earthworks, to reference local conditions and avoid an over engineered appearance; and, the establishment of planting, for wildlife and aid integration into the landscape. Pumping equipment and associated infrastructure would be located and designed to minimise visual effects.

ix. Wet woodland habitat and compensation land

2.2.42. The area to the south of the water resource storage area, extending along the edge of The Grove, would be designed in part to create wet woodland habitat. The area would also include a linear reedbed, which is likely to make the area more attractive to waterbirds. This, as well as the vegetated margins of the water resource storage area, should provide foraging opportunities for marsh harriers during the construction of Sizewell C. It would also provide additional flood compensation land. These works would be retained permanently.

x. Fen meadow compensation areas

2.2.43. The fen meadow compensation areas will provide a total of approximately 16ha of fen meadow habitat to compensate for the permanent loss of 0.5ha of fen meadow habitat from within Sizewell Marshes SSSI. The compensation areas will provide new lowland fen meadow habitat, including modified landforms to raise water levels, where necessary, new minor watercourses and associated planting.

2.2.44. Two sites will be provided to reduce the risk of compensatory fen meadow habitats not being successfully established. The fen meadow compensation lands are located to the south of Benhall and to the east of Halesworth.

xi. Leiston off-site sports facilities

2.2.45. The sports facilities created off-site in Leiston during the construction phase for the construction workers would be retained permanently for use by the public and Alde Valley Academy. The facilities would include one full-size pitch and two multi-use games areas.

c) Description of Construction Activities

2.2.46. Construction would commence following grant of DCO (assumed 2022, Year 1) and is likely to be completed approximately nine to twelve years later (Years 9 to 12).

2.2.47. Construction would be undertaken in five main phases:

- Phase 1: Site establishment and preparation for earthworks (Years 1 – 2).
- Phase 2: Main earthworks (Years 1 – 4).
- Phase 3: Main civils (Years 3 – 9).
- Phase 4: Mechanical and electrical installation (Years 4 – 11).
- Phase 5: Commissioning and land restoration (Years 10 – 12).

2.2.48. It has been assumed that works relating to the relocation of certain Sizewell B facilities would begin approximately two years prior to the start of Phase 1, pursuant to planning permission reference DC/19/1637/FUL issued by East Suffolk Council. More detail is provided in **Chapter 3** of **Volume 2** of the **ES** (Doc Ref. 6.3).

i. Overview of construction activities

2.2.49. The main platform area refers to the area within which the main construction activity would occur and where the permanent plant and buildings would be constructed, together with the foreshore works. It is bounded by the Sizewell B power station to the south, the Sizewell Marshes SSSI to the west and north and a gravel beach, with the North Sea beyond, to the east.

2.2.50. Construction works associated with the main platform include:

- Enabling works, prior to formal site establishment, including protected species mitigation works.
- Establishment of a construction area to include means of enclosure, demolition (including existing walls, fences, buildings and other above and below ground structures) and site clearance.
- Construction activity on certain land within Sizewell Marshes SSSI.
- Permanent realignment of the Sizewell Drain within Sizewell Marshes SSSI and permanent land take within the SSSI.
- Short-term stockpiling of material prior to completion of the temporary SSSI crossing.
- Construction of a temporary bridge over Sizewell Marshes SSSI, followed by a permanent causeway.
- Provision of temporary haul and access roads.
- Installation of a cut-off wall between Sizewell Marshes SSSI and the main platform, plus associated works.
- Ground preparation works including groundwater de-watering and excavation of unsuitable material within the area bound by the cut-off wall to the first suitable Crag layer, for subsequent infill with suitable material, sourced from within the temporary construction area and off-site. The first suitable Crag layer would be the first layer where material is deemed to have sufficiently predictable characteristics due to the absence of weathering that makes it suitable for construction of nuclear safety structures.
- Phased construction of coastal defence structures.
- Provision of welfare and office accommodation, storage and handling areas, facilities for and equipment for processing of excavated materials

and other temporary facilities, plant, cranes, machinery and other temporary works required.

- Backfilling within the cut-off wall up to foundation level of the permanent buildings and installing the permanent drainage system.
- Construction of marine launch chambers and boring of intake and outfall tunnels from within the main platform.
- Construction of permanent buildings and other above and below ground structures.
- Removal of temporary offices, welfare buildings, utilities and other infrastructure on the main platform to allow completion of groundworks and the main platform.

2.2.51. In addition, a temporary construction area is required to facilitate the construction of the power station. This land would primarily be located to the north of the Sizewell Marshes SSSI between the B1122 and the coast, to the north-west of the main construction area.

2.2.52. Works associated with the temporary construction area include:

- Enabling works, prior to formal site establishment, including protected species mitigation works, further archaeological advanced works where required, diversion / protection of existing utilities, and additional advanced planting in some areas.
- Establishment of the construction area to include means of enclosure, site clearance and site levelling as necessary to support construction on the main development site.
- Construction of drainage features, water management, boundary treatments and landscape works as necessary to support construction on the main development site.
- Highway works, including rights to create, divert and extinguish highways.
- Provision of a fabrication area for the construction of batching plants, water treatment plants, water pumping stations and water storage facilities.
- Construction of a temporary railway track with terminal facility for offloading goods, railway sidings and a passing loop for locomotives.
- Construction of marine launch chamber and boring of tunnels.

- Provision of temporary welfare and office accommodation, workshops and stores, storage and handling areas, compounds, facilities for and equipment for processing of excavated materials and other temporary facilities, plant, cranes, machinery and other temporary works required.
- Provision of a haul road.
- Provision of an access road for subsequent conversion into the permanent access road.
- Creation of earth bunds.
- Excavation of material, including material intended for use on the main platform, followed by subsequent infill of treated inert material.
- Stockpiling of excavated materials for subsequent re-use within the main development site.
- Provision of up to 1,000 car parking spaces and up to 50 heavy goods vehicles (HGV) parking spaces.
- Construction of a construction worker accommodation campus comprising residential buildings and providing up to 2,400 bed spaces plus plant associated with the operation of the accommodation campus and drop-off spaces.
- Construction of a covered accommodation campus multi-storey car park, to provide up to 1,300 car parking spaces.
- Construction of non-residential welfare and recreation buildings, plus plant associated with the operation of the accommodation campus and the provision of up to 300 car parking spaces, 60 disabled car parking spaces, 120 motorbike parking spaces and 120 pedal cycle spaces.
- Construction of permanent buildings and structures.
- Restoration of the temporary construction area following completion of construction works to a predominantly natural landscape in accordance with the **Outline Landscape and Ecological Management Plan** (Doc Ref. 8.2). Works to include restoring and making safe temporary work sites, including removal of temporary hardstanding areas, temporary structures and buildings, temporary rail infrastructure and other temporary work.

2.2.53. Land east of Eastlands Industrial Estate (LEEIE) would be used to support construction on the main platform and temporary construction area. This land is bounded to the north by Valley Road, to the east by Lover's Lane, to the south by King George's Avenue and to the west by Eastlands Industrial Estate.

2.2.54. Works associated with the LEEIE include:

- Stockpiling of materials.
- Provision of a 400-pitch caravan park with associated facilities for staff welfare and amenity, plus formation of a new vehicle access onto Valley Road.
- Construction of a freight management facility comprising up to HGV parking spaces and associated infrastructure, plus formation of a new vehicle access onto Lover's Lane.
- Stockpiling of materials and provision of a material transfer laydown area.
- Construction of a park and ride facility comprising up to 600 car parking spaces plus associated bus parking and terminal area.
- Formation of a new vehicle access onto King George's Avenue (compounds, temporary facilities, plant, machinery and other temporary works required).
- Construction of a temporary single railway track with railway sidings and a passing loop for the locomotive.
- Temporary landscaping and boundary treatment works.
- Restoration of LEEIE to a predominantly natural landscape in accordance with the **Outline Landscape and Ecological Management Plan** (Doc Ref. 8.2). Works to include restoring and making safe temporary work sites, including removal of temporary hardstanding areas, temporary structures and buildings, temporary rail infrastructure and other temporary works.

ii. Realignment of Sizewell Drain and permanent land take within the Sizewell Marshes SSSI

2.2.55. Sizewell Drain currently runs diagonally across the north-west corner of land that will become the main platform. The drain would therefore need to be realigned to pass along the western edge of the proposed platform and connect to Leiston Drain to the north.

2.2.56. Initial access to the current drain would be made via the north or south for vegetation clearance and species relocation. Ground improvement works may be necessary in the form of piles or equivalent, dependent on ground conditions.

2.2.57. The realigned drain would be provided with a falling gradient and width to provide, at minimum, the same capacity as the current alignment. Banks would be varied to provide a more natural appearance.

2.2.58. The trench for the realigned drain would be excavated from the east, using standard wheeled equipment. Sheet piling would be installed on the eastern bank of the realigned drain to the depth of the first suitable crag level. Matting may be used during the works to prevent settlement of machinery into the soft ground.

2.2.59. Once the realignment is complete, the reclaimed area would be infilled with granular material to provide a suitable ground conditions for the creation of the cut-off wall platform.

2.2.60. Further details of the likely construction method for individual sections of the realignment works are set out below.

Realignment works upstream of IDB DRN163G0201

2.2.61. For realignment works upstream of Internal Drainage Board (IDB) DRN163G0201, construction would take place solely from the main platform. The only exceptions to this would be:

- where vegetation clearance is required to provide adequate clearance for plant;
- for the supervision of construction works; and
- where new/repositioned structures are required to maintain water levels within the fen meadow habitat.

2.2.62. The drain would be realigned immediately following construction of the sheet piling. This would better enable construction of a stable bank for the realigned drain closest to the piling to take place.

2.2.63. Water levels would be monitored during piling and an allowance made for pumping of land drainage where required to ensure that temporary construction effects are controlled to within acceptable limits.

Realignment works downstream of IDB DRN163G0201

2.2.64. For realignment works downstream of IDB DRN163G0201, realignment of the drain would again immediately follow the installation of sheet piling. Access arrangements would be directly from the main platform. Due to the topography and water levels, a new water level control structure is likely to be required on the outer (west) bank to aid water level management in the adjacent wetland area, as described below, and therefore some construction is likely to be required on the outer (west) bank.

2.2.65. Apart from the above exception, construction access, and therefore any associated compaction of the underlying peat and any further temporary works, would be focused on the inner (east) bank to help protect the SSSI. A temporary crossing point may be required on IDB DRN163G0201 to provide access to Goodram's Fen whilst maintaining existing land drainage, until the realigned drain is in place.

Realignment works at Leiston Drain

2.2.66. Construction works will aim to minimise disturbance to Leiston Drain and would generally be limited to:

- works within approximately 10m of the new confluence of the Sizewell Drain and Leiston Drain;
- a further drain connection on the south bank of Leiston Drain to a relic drain; and
- small-scale works (as necessary) to modify the form and function of Leiston Drain.

2.2.67. Construction is likely to take place from the outer (north) bank of the channel where ground conditions are typically more stable. Where practicable, realignment works would take place concurrently with construction works to the SSSI crossing to minimise disturbance.

Water level control structures

2.2.68. There are currently many confluences between the Sizewell Drain and other tributary drains in the Sizewell Marshes SSSI, as its drainage network is generally artificially controlled. This includes the use of water level control structures, including sluices and simple piped connections. Monitoring shows them to be effective in contributing to the conservation of biodiversity interests in this SSSI.

2.2.69. As part of the realignment works, additional means of permanently manipulating water levels within the Sizewell Marshes SSSI are proposed. This would ensure water levels that would otherwise have changed as a result of the proposed development can be mitigated, where this is necessary to conserve biodiversity interests. Such control structures would include passage for fish, including eels.

2.2.70. IDB DRN163G0201 would incorporate temporary measures to provide pollution control, which would ultimately be removed to form an open connection with Sizewell Drain. It is also proposed that an area of deeper water is created here by excavating the channel bed to a greater depth in a stepped profile. Pipe dams would also be installed as necessary within the site boundary at the confluences with other minor ditches that would adjoin the realigned drain.

2.2.71. A water control structure would be installed in in the realigned Sizewell Drain, approximately 5-10m south of the confluence with Leiston Drain. Due to the capacity of Sizewell Drain, a tilting weir is likely to be necessary to provide an adaptive water management regime across the eastern areas of Sizewell Marshes, unless evidence shows that a pipe dam is sufficient at the detailed design stage.

2.2.72. Whilst the realignment works are taking place, short-term temporary blind bunds are likely to be necessary to restrict water flow. Blind bunds are currently present within parts of the SSSI.

Installation of a cut-off wall and cut-off wall platform

2.2.73. The cut-off wall platform would be constructed around the perimeter of the location of the cut-off wall and would include a perimeter access corridor. The platform would be constructed to a level suitable to enable a uniform level to construct the cut off wall. There would be a retaining slope from the platform to the newly aligned Sizewell Drain.

2.2.74. The activities necessary to construct the cut-off wall would be:

- Installation of piles to a depth of approximately 12m to support soft strata during installation of the cut-off wall.
- Installation of a hydraulic cut-off wall to depths of approximately 50m below ground level. Machines would excavate the material, replacing it with bentonite in the short term. Bentonite would be used to stabilise the trench cutting during excavation.
- Bentonite would be produced on-site at a bentonite farm, which would mix the required solution as well as clean returned bentonite. Bentonite waste would either be removed to an approved landfill site or retained on-site and used in the fill of the borrow pits. Bentonite wastewater would be treated and either discharged via the combined drainage outfall (CDO) or tankered off-site.

- The cut-off wall would be anchored into the low permeability London Clay Formation at depth limiting the hydraulic connection with the wider groundwater regime in the overlying geological strata.

2.2.75. Arisings from the cut-off wall excavations would be stockpiled on the main platform prior to completion of the SSSI crossing, when they would then be transported via haul road to the temporary construction area stockpiles.

2.2.76. Groundwater abstracted during dewatering would be treated if necessary before it is either discharged to sea via the CDO in compliance with an environmental permit or stored onsite for reuse in supporting construction activities. To lower groundwater levels within the cut-off wall, a dewatering pumping system would be used in the crag sands to below the deepest earthworks excavation.

2.2.77. As part of the construction of the Sizewell C recirculated water outfall tunnels, tunnel boring machine launch chambers are required. These would be constructed within cofferdams within the cut-off wall and require locally deeper dewatering.

2.2.78. A secondary cut-off wall would also be installed at the toe of the embankment slope leading to the main platform. This cut-off wall would utilise sheet pile methods to prevent the surrounding peat and crag formations from slumping.

iii. Sizewell Marshes SSSI crossing

2.2.79. The Sizewell Marshes SSSI crossing would comprise an embankment and culvert, with the culvert of sufficient dimensions to leave the bank and channel of the Leiston Drain intact. The culvert would be sized to facilitate the passage of fish, bats, otters and water voles through the structure, and a ledge would be installed to further encourage passage by otters, if deemed necessary following detailed design. Appropriate lighting and noise protection measures would be deployed to ensure the culvert is viable for use by bats.

2.2.80. To ensure works to construct the cut-off wall can progress as soon as possible, early access from the temporary construction area to the main platform area would be provided using a short-term crossing and would be designed to cater for lighter site traffic and material deliveries. Prior to this, all construction traffic including materials, plant, equipment and labour would access the main platform via the Sizewell B site access route.

2.2.81. Two access routes would be provided on the SSSI crossing during the construction phase to enable segregation of general site traffic from heavy earthmoving plant for site safety.

iv. Borrow pits and stockpiling

2.2.82. Topsoil and subsoil would be stripped and preserved for future reinstatement of the borrow pits, by being stored as windrows around the perimeter of the borrow pit up to approximately 3.5m above ground level.

2.2.83. Excavation of the overburden, Crag Sands and gravels would then begin (to a depth of approximately 10m below ground level) and stored in a stockpile within the temporary construction area.

2.2.84. A settlement and infiltration lagoon would be provided for each borrow pit as they are excavated to capture surface water run-off contaminated with suspended solids.

2.2.85. Earthworks would commence alongside dewatering of the area within the cut-off wall area. Existing made ground materials would be removed and transported to the stockpile areas within the temporary construction area via the haul roads for re-use.

2.2.86. Materials such as alluvium, peat and clay, used for the borrow pit backfilling, are very soft materials. Whilst the alluvium would be pre-drained as much as possible during excavation from the main platform, the material would remain very wet and soft and constrains the methods of placement. Material would therefore be placed within the borrow pit and then treated if necessary, by lime or suitable other agent, during placement.

2.2.87. Once the borrow pit has been backfilled and after settlement it has the capacity to act as a stockpile. In order to limit surcharge accelerating the rate at which leachate is released to the groundwater and ensure ground stability, the stockpile height would be limited to 5m above existing ground level.

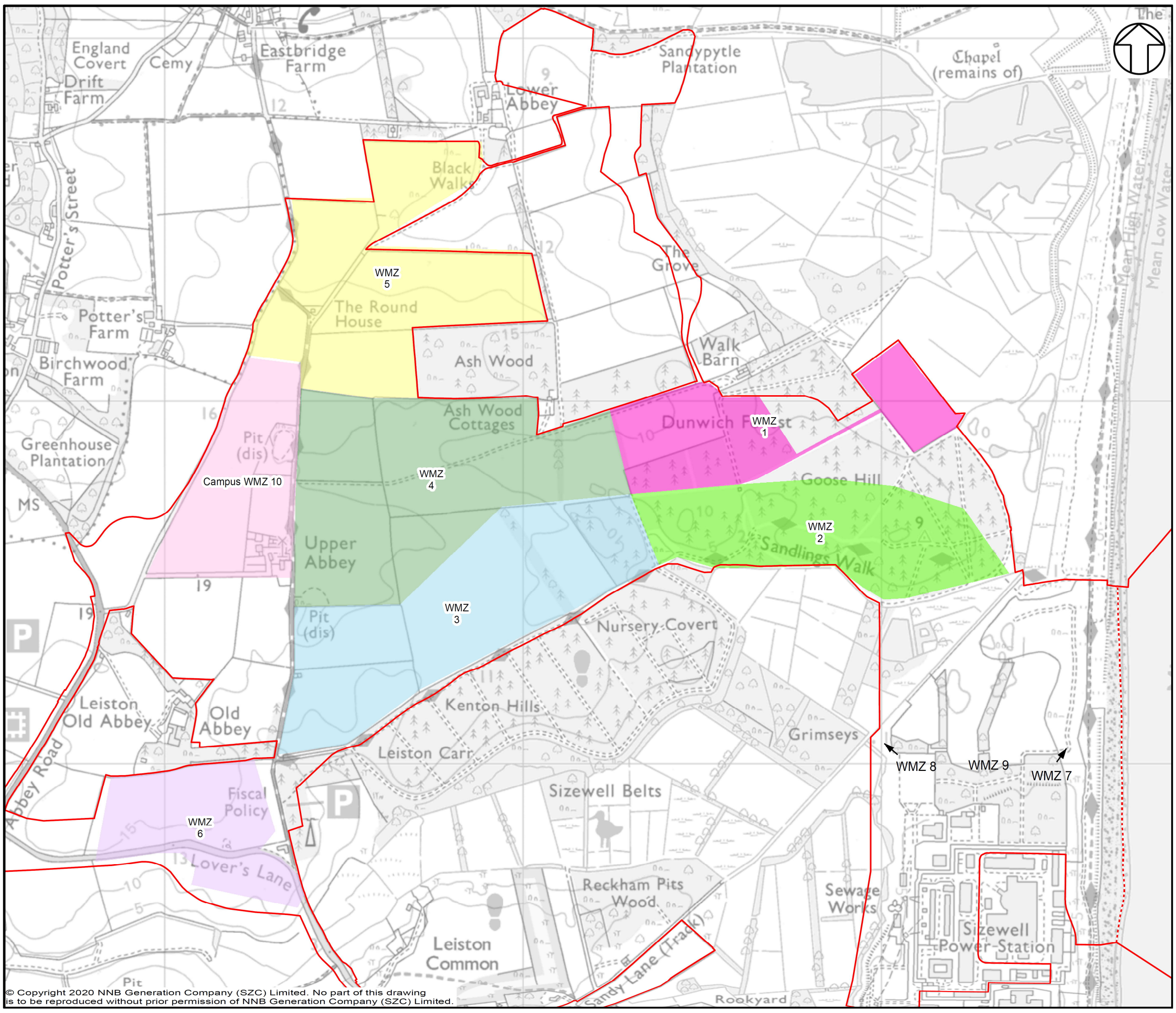
v. Construction drainage

2.2.88. An initial temporary drainage system would be installed for predominately managing surface water run-off. This would subsequently be replaced by a site construction drainage system which divides the construction site into 10 water management zone (WMZ) catchments. These zones have been further divided into three groups as follows (see **Plate 2.1**):

- Group 1 – WMZ 1, 2, 3 and 6 that discharge to both surface water and groundwater.
- Group 2 – WMZ 4, 5 and 10 that discharge to groundwater only.

- Group 3 – WMZ 7 and 8 that discharge to tidal waters only.

Plate 2.1: Water Management Zones during construction



2.2.89. WMZ 9 is the main construction area deep excavation. WMZ 7, 8 and 9 form part of the permanent station and these will be served by traditional piped systems.

Water Management Zone Numbers 1,2,3 and 6 (Group 1)

2.2.90. Surface water run-off in Group 1 would be drained through infiltration techniques by directing the road surface run-off into suitably located gullies, which will subsequently convey the surface water into a detention basin and allow infiltration. This would be primarily managed via a roadside infiltration trench and / or swales. This would ensure that surface water is treated close to source.

2.2.91. The infiltration trench would create temporary subsurface storage of stormwater runoff, thereby enhancing the natural capacity of the ground to store and drain water. Water would exfiltrate into the surrounding soils from the bottom and sides of the trench. The detention basin would balance what cannot be infiltrated during exceedance storms.

2.2.92. During construction, storm water runoff may have a high concentration of silts from fine particles contained within the soil or present on the surface of substrata. Over time this can blind the surface of the basin / pond or the faces or base of other structures such as porous surfaces or trenches causing them to become inoperable depending on the degree of silt contained in the runoff.

2.2.93. Strategically positioned filters, semi-permeable barriers and settling forebays would therefore be provided in the bigger structures as necessary. These would be cleaned out periodically thereby protecting the SuDS structures or runoff to watercourses.

2.2.94. Hydrocarbon loading from haul and access roads would be managed within SuDS structures. Almost all of the pollutant load is held within the fine particles in the runoff, removal of these fine particles would be carried out using proprietary measures as necessary.

2.2.95. Materials storage areas would include infiltration or swale measures to capture runoff locally and maximise the source control.

Water Management Zone Numbers 4 and 5 (Group 2)

2.2.96. The drainage strategy is to drain the surface water run-off through infiltration techniques, including trenches and detention basins. Where the runoff for material storage and borrow pit areas are located the surface water would be managed by providing trench infiltration or swales to capture runoff locally and maximise the source control philosophy.

2.2.97. The detention basin that forms part of the design would be retained for exceedance storms and balancing what cannot be infiltrated.

Water Management Zone Numbers 7,8 and 9 (Group 3)

2.2.98. The discharge from WMZs 7,8 and 9 shall be directly to the sea via the CDO. It is not feasible to attenuate these areas to greenfield runoff rates.

2.2.99. The large capacity of the CDO means that storage will not be required for exceedance events, however harvesting surface water for re-use on site will be undertaken where feasible.

Accommodation campus site

2.2.100. The accommodation campus is located to the west of the main construction area. No watercourses are available in the vicinity of the campus to facilitate a suitable connection for surface water discharge. Therefore, it would be necessary to store rainfall runoff below ground and allow gradual infiltration.

2.2.101. Given the depth to groundwater is considerable, there is opportunity to utilise other methods of surface water management including rainwater harvesting and treating surface water at source through detention and infiltration.

2.2.102. Accommodation blocks would allow for the collection and re-use of roof water where necessary. The harvested rainwater can be used for toilets, washing machines and other non-potable use, giving significant reductions in water usage.

2.2.103. Large parking areas, access ways between the buildings and other non-heavily tracked areas within the campus would use permeable surfacing where necessary to emulate the current drainage characteristics, whilst providing suitable treatment of any incidental oil spills. Where necessary, the run-off conveyed from the roof of the buildings within the campus will also be incorporated within the permeable surfacing sub-base.

2.2.104. Occasional tree pits would be utilised to provide storage and infiltration into the ground as close to source as possible, where necessary.

2.2.105. Shallow infiltration trenches along the perimeter of the campus and in the green space between the blocks would provide additional storage and infiltration if necessary.

Land east of Eastlands Industrial Estate

2.2.106. Infiltration is unlikely to be an effective technique for this area. The approach proposed for the LEEIE is to convey run-off from impermeable areas into storage areas located within the LEEIE area, with outfalls to Leiston Beck at greenfield rates.

2.2.107. Underground geocellular storage is proposed as part of the attenuation storage techniques in the LEEIE, with permeable surfacing above where possible, to allow for infiltration into the storage units below ground and reduce runoff. Oil interceptors would be provided as necessary.

2.2.108. To accommodate longer return period storms of large volumes, infiltration is proposed north of Sandy Lane via a piped connection across Lovers lane. The excess volume would be managed through a combination of natural infiltration and low flow greenfield runoff to the area in which it would have originally discharged.

2.2.109. Surface water within earth material storage areas would be managed through trenches or swales to capture runoff locally and maximise the source control philosophy. While earthworks such as topsoil would allow for infiltration, it is likely that silt will be generated from the stored topsoil. With infiltration being unlikely to be an effective technique for heavy or prolonged events, storage and conveyance, with outfall rates reduced to greenfield, would be used. Where runoff is conveyed to an underground attenuation feature, a treatment stage would be required to remove silt from the runoff.

vi. CDO construction

2.2.110. The CDO tunnel would be drilled beneath the seabed with arisings transported to landward for disposal. The CDO is likely to be approximately 400m long with an internal diameter of 1.2m terminating in a concrete block approximately 3m wide by 3m deep on the seabed (**Figure 2.1**). This process is predicted to take two months. Prior to placement of the head structures, dredging of approximately 1850m^3 would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with spoil disposed locally via a pipe that transports the dredge material 500m down drift. The heads would be prefabricated and lowered into place.

vii. Groundwater control during construction

2.2.111. To isolate the permanent platform construction site from groundwater influences and maintain a dry deep excavation for construction, a cut-off wall would be constructed around the area containing the main power station platform. The cut-off wall would be retained as part of the operational development.

2.2.112. To mitigate potential increases in groundwater levels in the vicinity of the platform due to the installation of the cut-off wall, the realigned Sizewell drain would assist in diverting the groundwater flow path.

2.2.113. To lower groundwater levels within the cut-off wall, a dewatering pumping system would be used within the Crag Sands to below the deepest earthworks excavation. The water from the dewatering pumping system would pass along the water collection ring main to a groundwater treatment plant before it is either discharged to sea via the CDO or stored onsite for reuse in supporting construction activities.

viii. Cooling water infrastructure

2.2.114. The cooling water tunnels would extend approximately 3km offshore and would be bored using tunnel boring machines at depths of approximately up to 30m under the seabed. The tunnels would be lined with pre-cast concrete sections as they are bored.

2.2.115. The excavated material would be transported back to the tunnel entrance where any bentonite used in the tunnel boring process would be recovered for re-use before the excavated material is transported to the appropriate stockpile for use in the final landscaping. Spoil would be piped to a slurry treatment plant in the temporary construction area and dehydrated. Tunnelling would be a continuous activity requiring 24 hour working and preliminary estimates suggest this would take around 15 months to complete. Excavated material would be transported to on-site stockpiles. Bentonite and some polymers used in offshore drilling operations are included on the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) list of 'pose little or no risk to the environment' substances.

2.2.116. Connections between the intake and outfall structures and the bored tunnels would be made via lined vertical shafts bored from the seabed down to the tunnels. The shafts would be bored using a drilling technique and would be undertaken from a jack-up rig. Arisings would be disposed of locally on the seabed.

2.2.117. Each intake tunnel would terminate in two concrete headworks with dimensions of approximately 38m by 10m (excluding the 'nose' of the headworks, which is likely to add an extra 10m to the overall length). The headworks would protrude approximately 4m above the seabed. Prior to placement of the head structures, dredging of approximately 17,500m^3 per intake head would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with spoil to be deposited locally. The intake and outfall structures would be prefabricated offsite and floated into position over the connecting shafts before being lowered into position. The outfall headworks are likely to be smaller (16m by 16m) than the intake headworks, protruding approximately 4m above initial seabed level.

2.2.118. Seismic qualification would be achieved through the installation of drilled piles secured to the bedrock, if necessary.

ix. Commissioning of cooling water infrastructure and demineralisation plant

2.2.119. Early commissioning activities would include the commissioning of the demineralisation plant and cooling water system. Commissioning comprises two key phases as follows:

- Non-active commissioning to test the integrated function of the plant. This phase can be split into cold testing and hot functional testing. The latter requires the plant and equipment to be put through its design envelope up to and including full temperature and pressure conditions without nuclear fuel in place. No radioactive effluents are generated in this phase.
- Active commissioning, which commences with fuel delivery and active commissioning of the reactor components. Some radioactive effluents are generated in this phase.

2.2.120. Non-active commissioning would be undertaken during the construction phase. Cold testing would involve the cleansing and initial preparation of various plant components, the main activity being flushing of pipe work using demineralised water to remove surface deposits and residual debris from installation, including rust. The discharges from this commissioning testing would primarily comprise water containing suspended solids and iron oxide and small quantities for conditioning chemicals, as shown in **Table 2.1** below.

2.2.121. Given that the cooling water pumps would not have been commissioned (so the cooling water system would not be available), discharges would be made via the CDO. Note that hydrazine would be routed to a specific storage tank, which would enable the chemical to decompose before being discharged via the CDO. The maximum combined cold-flush commissioning discharge from each reactor unit would be $11.13m^3h^{-1}$.

Table 2.1: Summary of parameters in cold flush test water (Ref. 2.1)

Parameter	Concentration μgl^{-1}
Boron	7000
Lithium hydroxide	65
Hydrazine	0.004
Morpholine	28
Nitrogen	980
Phosphates	33.5
Suspended solids	31000
Iron	1000

x. Summary of discharges via the CDO

2.2.122. The CDO is required in order to dispose various sources of water to sea during construction. The location is shown in **Figure 2.1**. The sources can be summarised as follows:

- treated final effluent originating from the construction phase sewage treatment plant;
- treated surface water run-off from the deep excavation within the main platform;
- treated surface water run-off from the wider construction site, as required;
- groundwater, treated if required, from dewatering within the main platform cut-off wall;
- treated plant cold commissioning waters;
- treated concrete wash water; and
- treated water originating from tunnel construction.

2.2.123. The construction phase and associated facilities will require a foul network and sewage treatment. The workforce numbers would not exceed 10,000 therefore the site will not be required to comply with the Urban Waste Water Treatment Directive.

2.2.124. The construction phase sewage treatment plant will receive and treat all domestic foul water generated during construction and discharge via the CDO. Prior to CDO completion, construction site effluents would be tankered offsite.

2.2.125. Maximum discharge rates during construction are assumed to be $0.125m^3s^{-1}$. As different site discharges may be present at the same time, the timing and duration and source concentrations of the likely discharges are important. As a result, six hypothetical scenarios for assessment have been determined. These are summarised in **Table 2.2.**

Table 2.2: Summary of flows and potential scenarios discharging from the CDO (Ref. 2.1)

Scenario Reference	Activity and Week of Construction Period	Main Site Groundwater (ls^{-1})	Sewage (ls^{-1})	Tunnelling Wastes (ls^{-1})	Total Discharges (ls^{-1})	Comments
A	Week 1 discharge, 28-day duration	124	0	0	124	Worst case for metals
B	Week 17 tunnelling starts for intakes and outfall tunnels	15	0	7	22	-
C	Week 26 permanent sewage treatment works commences treatment	15	13.3	22	50.3	-
D	Week 49	15	13.3	26.7	55	Worst case sewage and potentially dissolved inorganic nitrogen (DIN). Additional nitrogen contributions from hydrazine during commissioning
D1			30	26.7	71.7	-
E	-	15	13.3	6	34.6	Worst case tunnel boring machine

xi. Sea defences

2.2.126. The HCDF would be constructed using rock armour. The rock armour would then be overlaid with site-won fill material and seeded to allow vegetation to take hold as early in the construction period as practicable.

2.2.127. The SCDF sediment, won from the HCDF excavation (if suitable), would be placed in the swale between the HCDF and the existing 5m bund and be constructed using terrestrial construction vehicles.

2.2.128. The construction sequence for the construction phase HCDF and SCDF is indicated below:

- The existing Bent Hills would be excavated in stages.
- Ground treatment of the underlying peat and clay layers would be required to ensure the stability of the finished embankment.
- Following the ground treatment, the area of the construction phase defences would be built up using rock armour. This would form the eastern part of the permanent sea defence.
- The eastern site access road would then be constructed on the sea defence platform, which also forms the cut-off wall platform.
- Site-won fill material would be placed over the rock armour and planted to soften views from the coastal path.
- SCDF sediment would be deposited in situ and landscaped

xii. Beach landing facility

2.2.129. The duration of dredging works required for the BLF is likely to be approximately 12 weeks.

2.2.130. Construction of the BLF deck would consist of steel deck panels. A small mobile crane would be used to lift each panel section and install. The crane would then crab forward until all panels are in place. Deck panels would be supported by cross beams supporting on piling together with bracing below deck level.

2.2.131. Piling for the BLF would be necessary to a depth of approximately 23m below sea bed level and impact piling is assumed. Piling would be undertaken either from a jack-up barge or by a piling rig in sequence from the advancing BLF bridge. Piling for dolphins would be carried out from a jack leg rig or barge.

The seabed at the outer four piles of the BLF together with the two fender structures is below low tide level.

2.2.132. Following completion of the piling works, remaining construction would be craned into position from the shore end by a mobile crane.

2.2.133. During long periods of downtime, such as the winter season, the deck panels to the BLF would be temporarily removed and stored.

xiii. FRR system

2.2.134. Two FRR systems would be constructed, one for each reactor. The small diameter FRR tunnels (approximately 0.65m internal diameter) would be drilled beneath the seabed with arisings transported to landward for disposal.

2.2.135. The FRR systems would be tunnelled, using a directional drilling technique, under the foreshore and seabed then terminating in a seabed outfall structure approximately 300m offshore.

2.2.136. The FRR outfall headwork is assumed to comprise a concrete block approximately 3m long, 4.5m high, and 3m wide, buried 2m into the sediment.

2.2.137. Prior to placement of the head structures, dredging of approximately 1,850m^3 would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with the spoil to be disposed on-site via a pipe that transports it 500m down drift. The heads would be prefabricated and lowered into place. It is predicted that it would take two months to construct the tunnels.

2.2.138. Scour protection around the head structures may be placed to limit downward scour and to ensure that scour generated from the structure keeps the area clear of sediment. The total footprint is likely to be around 210m^2 for each FRR system.

xiv. Fen meadow compensation lands

2.2.139. Works to establish the permanent fen meadow compensation sites would typically comprise:

- Manipulation of water levels through installation of water control structure(s).
- Creation of minor watercourses and bunds.

- Some limited reduction in land level through removal of the top layer of soil.
- Placement of turves imported from off-site.
- Spreading imported green hay.

xv. Leiston off-site sports facilities land

2.2.140. Works associated with the Leiston off-site sports facilities include:

- Topsoil would be removed where necessary.
- Installation of a pitch with a 10ft perimeter rebound fence. The pitch would include regulation drainage run-off and would be flood lit.
- Installation of two multi-use games area courts, each with permeable surfacing, a 10ft perimeter rebound fence and flood lighting.

xvi. Marsh harrier habitat improvement area

2.2.141. The marsh harrier improvement area, if required, is the off-site area to the west of Westleton which would be used to provide additional habitat for foraging marsh harrier due to any potential disturbance effects which might discourage marsh harriers from foraging over parts of the Minsmere South Levels and Sizewell Marshes SSSI during the construction period only. At the end of the construction of the power station, this land would be returned to arable use.

2.2.142. There are no construction works associated with the marsh harrier habitat improvement area for which development consent is necessary. As a result, these proposals are not considered further in the WFD Compliance Assessment.

d) Sizewell B relocated facilities

2.2.143. The Sizewell B relocated facilities is the area that certain Sizewell B facilities would be moved to in order to release other land for the proposed development.

2.2.144. A full description of works required for Sizewell B relocated facilities is provided within **Volume 1, Appendix 2A** of the **ES** (Doc Ref. 6.2). A summary of the works is also included below.

i. Coronation wood area

2.2.145. Initial construction activity comprises the felling and grubbing of Coronation Wood.

2.2.146. Once Coronation Wood has been cleared, construction of the western access road would commence to allow the separation of construction traffic from the main access road to Sizewell B at the earliest opportunity. A run off drain would be constructed to the west of the road to avoid surface water run-off from the site discharging into the Sizewell Marshes SSSI.

2.2.147. Following construction of the western access road to a standard suitable for the construction traffic, the remainder of the Coronation Wood development area would be levelled. Given the relatively constrained working area within Coronation Wood, an area within the northern part of the site (that was previously used for the construction of Sizewell B) has been identified for temporary stockpiling of excess material. The clean material would be spread across the existing field to a height no greater than 1m, leaving a 5m corridor around the perimeter for vehicular access and to act as a silt control area for any run-off. The side slopes would tend to be limited to 1:3 gradient for stability.

2.2.148. Once the Coronation Wood development area has been levelled, the training centre, replacement car park and laydown area would be constructed alongside the external infrastructure (roads and lighting), drainage and landscaping

ii. Outage store

2.2.149. Construction of the outage store would first require the demolition of the existing general store. Following site clearance and the diversion/ protection of existing services, temporary sheet piles to a maximum depth of approximately 20m may need to be installed to allow for the excavation of the basement to commence, the depth of which would broach the groundwater table. Following piling and the excavation of the basement, the depth below the groundwater table would be dewatered.

2.2.150. Temporary facilities, plant, cranes, machinery and other temporary works would be required.

iii. Outage car park and new access onto Sizewell Gap

2.2.151. Topsoil would be stripped from all relevant areas of Pillbox Field to prepare the area for construction activities. Where feasible, the topsoil would be re used on non-paved areas, such as on the embankments of the outage car park and vehicular access road.

2.2.152. Following the topsoil strip, earthworks would be undertaken to achieve the desired formation levels. Excavated material would be reused as fill, where appropriate, in order to minimise the requirement for import or export of material.

iv. Other Sizewell B relocated facilities works

2.2.153. The existing technical training centre would be refurbished and would temporarily house the Sizewell B visitor centre during this phase of construction. To allow for the construction of the new visitor centre, it is envisaged that the Sizewell B power station perimeter road immediately to the north of the coronation wood development area would be temporarily closed, with traffic diverted along the western access road. This would allow the contractor to set up cranes and laydown within this area.

2.2.154. Remaining facilities to be relocated would be demolished.

2.2.155. Temporary facilities, plant, cranes, machinery and other temporary works would be required.

2.2.156. To provide a suitable working area for construction a number of modifications would be made to the existing Sizewell B site access arrangements for vehicles and workers. These temporary access arrangements would be constructed before the existing facilities are taken out of use.

e) National Grid land

2.2.157. The National Grid land is the land required for the National Grid transmission network

i. National Grid substation

2.2.158. A new substation and extension to the existing National Grid substation would be required for Sizewell C. Realignment of the existing National Grid overhead line would also be required to connect the power station to the national electricity transmission system.

2.2.159. This National Grid construction site would accommodate construction offices, welfare facilities, car parking, workshops, spoil storage and material/equipment laydown and storage areas. Water, sewerage, electricity, and communication services would be provided either via mains connection or mobile supplies (such as bowsers, septic tanks, and generators).

2.2.160. Works to the National Grid substation would require the use of temporary water-tight working areas within the substation footprint, formed by scaffolding wrapped in tarpaulin or similar material, to facilitate clean working and weather-proof conditions where this is required, such as the jointing and termination of cables. These temporary water-tight working areas would be large enough to accommodate cranes or other forms of lifting systems.

2.2.161. The National Grid substation would connect into each of the four circuits on the National Grid 400 kilovolts overhead lines. To facilitate these connections, modifications to the existing overhead line would be required which would include a new pylon, removal of an existing pylon and the permanent realignment of a short section of the overhead line to connect to the substation.

ii. National Grid overhead line realignment works

2.2.162. The new pylon would require excavation around the pylon base for foundations and hardstanding areas, for erection of the pylon by crane.

2.2.163. Protective measures may be required at sensitive locations along the new overhead alignment such as roads or footpaths, when installing the new conductors and connecting into existing circuits. These measures may include erection scaffolding, temporary controls around roads or footpaths along the diversion.

2.2.164. Temporary working areas and access tracks would be required to construct the new/replacement pylon within the Sizewell Marshes SSSI, string the conductors and dismantle the existing pylon.

2.2.165. Temporary vehicle access would be required to each of the two pylon working areas.

2.2.166. Once the replacement/new pylon is constructed overhead line circuits would be transferred. Removal of the existing piling and associated foundations up to a depth of approximately 1m would take place. Subsoil and topsoil would be reinstated.

2.2.167. Temporary facilities, plant, cranes, machinery and other temporary works would be required.

iii. Construction and environmental management

2.2.168. A **Code of Construction Practice (CoCP)** (Doc Ref. 8.11) has been prepared for submission with the DCO application for the Sizewell C Project. The CoCP sets out the measures and controls that SZC Co. will require its contractors to adopt during construction and removal and reinstatement phases of the proposed development, where appropriate. In summary, the CoCP sets out the following:

- General construction environmental management arrangements, including details of the environmental management system.
- How construction environmental management arrangements will be implemented, reviewed and monitored.
- Community and stakeholder engagement arrangements that will be implemented during the construction period.
- General measures relating to topics such as training and competence, construction consents, workforce code of conduct, working hours and construction site layout.
- Measures relating to waste management and resource use, land quality, ecology, landscape, cultural heritage, noise and vibration, air quality, water environment, traffic and transport, amenity and recreation, carbon emissions and emergency arrangements.
- Any site-specific controls to be applied at any of the Sizewell C Project sites.

2.2.169. The construction environmental management measures and controls included in the **CoCP** (Doc Ref. 8.11) have been identified through the Environmental Impact Assessment (EIA) process and would act to deliver environmental protection, or minimise impacts on the environment and human receptors, as far as reasonably practicable.

f) Description of Operation Activities

i. Cooling Water System

2.2.170. Sizewell C would require a continuous supply of seawater via the two intake tunnels at $132m^3s^{-1}$ at mid tide level for cooling; of which approximately 91% would supply the main cooling water systems and the remainder would supply the essential and auxiliary systems. After being used within the power station, the seawater would then be discharged back to the Greater Sizewell Bay (GSB), via the outfall tunnel, with a mean excess temperature of between 10˚C and 12.5˚C above ambient background.

2.2.171. Returned abstracted water would be the main waste stream from Sizewell C and would represent approximately 99.9% by volume of the total overall daily discharge of non-radioactive effluent. Several smaller waste streams would be combined with the returned abstracted cooling water before being discharged to the GSB and these (alongside the cooling water) are detailed in **Table 2.3**. Note that all operational liquid effluents would be discharged to the sea via the outfall ponds and the cooling water outfall infrastructure, aside from the seawater volumes associated with the FRR systems, which would use two dedicated discharge lines to the sea.

Table 2.3: Proposed waste streams

Waste Stream	Effluent Type	Brief Overview
A. Cooling water	Trade – returned abstracted water	Cooling water return – characterised by thermal content and seasonally dosed chlorine from an electro-chlorination plant to prevent biofouling of the condensers and essential plant.
B. Nuclear island	Trade – known volume	From operations within the nuclear island – excludes steam generator blowdown system; includes reactor boron water make-up system.
C. Steam generator blowdown	Trade – known volume	Effluent from steam generator blowdown system. Could potentially contain hydrazine, ammonia, morpholine and ethanolamine to prevent corrosion and control pH.
D. Conventional island	Trade – known volume	Effluent from turbine hall and uncontrolled area floor drains, excluding effluent from the steam generator blowdown system.
E. Site drainage	Trade – known volume	Includes roof and road surface water drainage. Effluent associated with water potentially contaminated with hydrocarbons from the areas where oils are used would pass through oil / water separators before flowing to bypass separators before joining the main discharge. Penstocks closed in event of significant oil / chemical spill or fire. Waste separated from various process streams sent for offsite disposal.
F. Production of demineralised water	Trade – known volume	Effluent from the production of demineralised water. Would generate effluents characterised by high alkaline or acidity as a result of use of sulphuric acid and sodium hydroxide to regenerate resins. Batch treatment using acids and alkalis would result in a neutral pH. Includes liquid from the processing system.
G. Domestic sewage	Domestic sewage – known volume	Sanitary effluent from administration and mess facilities which would be treated before joining the main discharge.
H. Effluent from the FRR system	Trade – known volume	Comprises water used to operate the FRR system that returns fish and other organisms to the sea via a dedicated fish return outfall, One for each EPR™ unit. Includes the return of dead and moribund biota. Contains inputs from Stream E, which is discharged to the forebay.

2.2.172. Process effluent would be produced to remove waste from the plant systems and to maintain the best operating conditions and maximise efficiency. There may be a requirement to discharge sediment due to periodic desilting of the forebays. Should desilting be required, the preferred option would be to return the sediment to the cooling water system for discharge back out to sea.

2.2.173. Various treatment systems for waste streams B-G to reduce contaminant concentrations and to enable recycling of boron and water in the primary circuit would be in place. Each effluent would be received in monitoring tanks and then sampled before being discharged. If the sample exceeds environmental permit limits then the effluent can be re-circulated through the treatment system and either discharged when within environmental permit specification or tankered offsite for licensed disposal.

2.2.174. The operation of Sizewell C includes several scenarios. These can be summarised as follows:

- Standard operation – this refers to the situation when both units are operating normally at their full capacity with all four cooling water pumps operational.
- Outage – this refers to the situation when a unit is shut down for planned routine maintenance and / or refuelling. An outage would be expected to take place approximately every 18 months per unit. The length of these outages would vary according to the maintenance and inspections required but would typically be up to two months in duration.
- Maintenance test (RF3) – this refers to the situation when both reactor units are operational, one on 100% load with two cooling water pumps running and the other unit on 90% load with only a single cooling water pump in operation. The plant could be operated under this configuration as a result of both planned and unplanned situations. The remaining cooling water pump would be subject to maintenance during this period. This could occur for up to a month.
- Maintenance test (RF2) – this refers to a theoretical situation where both units are operating at 100% with only a single cooling water pump serving each unit – that is only 50% cooling water capacity. Note that the waste heat from the reactors remains approximately the same, causing the excess temperature at the outfall to rise from to up to 23.2°C. This is unlikely to occur but represents a worst case in terms of cooling water flow and is used to characterise short term (24 hour) discharges.

ii. Chlorination

2.2.175. Based on the risk of biofouling at Sizewell C, chlorination of the cooling water system and critical plant would be required. Operational policy is to continuously dose during the growing season to achieve a minimum total residual oxidant (TRO) dose of 0.2mgl^{-1} in critical sections of the plant and at the inlet to the condensers. Testing of this system would be undertaken during commissioning but it is assumed that this would only occur once the full cooling water system is in place and operational.

2.2.176. The chlorination strategy is likely to be continuous dosing of critical land based plant using an electrochlorination plant (rather than intermittent dosing) as part of waste stream. It is currently expected that the Sizewell C intake heads, tunnels and forebays would not be chlorinated. The expected discharges from the chlorination process include:

- Residual oxidants in the form of free chlorine and chlorinated compounds.
- Trihalomethanes, which are present as bromoform.

2.2.177. For Sizewell C, the TRO concentration at the outfall would depend on the chlorination strategy applied within the power station. BEEMS Technical Report TR316 (Ref. 2.2) presents an analysis of the possible chlorination options for Sizewell C and a recommendation for a preferred strategy that is based upon minimising environmental effects whilst maintaining the safe operation of the plant. Chlorination would only be undertaken when sea water temperatures are above 10ºC, and therefore the risk of biofouling is greater. However, if required, spot dosing at lower temperatures may also be undertaken.

iii. Commissioning

2.2.178. Hot functional testing (HFT) tests the reactor under high temperature and pressure prior to the loading of nuclear fuel into the reactor. The chemical substances discharged during the hot functional testing would be the same as those discharged during the normal operation of Sizewell C and would be discharged via the cooling water outfall. There would not be any radioactive effluents produced.

iv. FRR system

2.2.179. The FRR system would provide a safe return of the more robust organisms from the drum and band screens directly into the marine environment and would be designed to minimise impacts on impinged fish and invertebrate populations. However, some species such as clupeids are highly sensitive to mechanical damage caused by impingement on the screens and incur high mortality rates.

2.2.180. The return of dead and moribund biota retains biomass within the local food web and represents a source of organic carbon with the potential to enhance secondary production of carnivorous zooplankton and through detrital pathways.

v. Beach landing facility

2.2.181. It is assumed that dredging during this phase would be limited to clipping and sidecasting by plough. The nature or frequency of the dredging would depend on the bathymetric profile and can be expected to vary by season, with more dredging required in winter when sand suspension and infilling rates would be higher on average. The assessment assumes two to four dredges on the outer bar and once every two weeks on the inner bar. The proposed dredge area is shown in **Figure 2.2**.

vi. Summary of source terms for the assessment of water quality effects – flows

2.2.182. The mean cooling water intake flow required is $132m^3s^{-1}$. For the discharge associated with this, it is assumed that the maximum annual loadings of any parameters from the waste streams would be discharged at a constant rate over the course of a year and be mixed in the cooling water flows prior to discharge to the environment.

2.2.183. For screening purposes (first stage of assessment for chemical parameters) and under normal operational flow, it is assumed that the worst-case cooling water intake (and therefore discharge) flow, into which all discharges would be mixed, would be $116m^3s^{-1}$. This is based on a single EPR^{TM} unit having a minimal operational cooling water flow of $58m^3s^{-1}$ under low tide conditions. Screening also considers the maintenance scenario RF2 which refers to a theoretical situation where both units are operating at 100% with only a single pump serving each unit; that is only 50% cooling water capacity. This equates to $66m^3s^{-1}$ at mid tide level. Where parameters fail the screening tests, detailed modelling is undertaken for more realistic flow scenarios.

2.2.184. Earlier versions of the modelled parameters (i.e. those that failed the screening test) were based on an unconfirmed flow of $125m^3s^{-1}$ (with a 24-hour loading equivalent $62.5m^3s^{-1}$). Where increased loadings of parameters have been identified with the increase in confirmed flow to $132m^3s^{-1}$, modelling has been revisited and outputs recalculated. For example, chlorination modelling using the value of $125m^3sec^{-1}$ as a maximum discharge does not account for inputs from all circuits within the system, some of which were chlorinated so chlorine related inputs were remodelled for the increased $132m^3sec^{-1}$ to allow for the additional inputs. However, for hydrazine, the additional $7m^3s^{-1}$ does not contain any additional hydrazine so the original modelling already represents a potential worst case so this modelling was not redone.

2.2.185. The assessment for the thermal discharge has also not been revisited. This is because it is considered that the small increase in flow associated with a 132m^{3}s^{-1} intake flow would not significantly alter the thermal output modelled based on the 125m^{3}s^{-1} intake flow. On this basis, the thermal uplift in the discharged cooling water is assumed to be 11.6˚C (125m^{3}s^{-1}) and 23.2˚C for the maintenance scenario (62.5m^{3}s^{-1}).

vii. Summary of source terms for the assessment of water quality effects – chemical substances

2.2.186. Full detail on the source terms for the assessment undertaken on the potential effects of all discharges is provided in BEEMS Technical Report TR306 (Ref. 2.1). **Table 2.4** summaries the loading of different chemicals to be used during operation as 24 hour and annual loads. The thermal uplift in the discharged cooling water is assumed to be 11.6ºC for normal operational flow and 23.2ºC for the maintenance scenario.

Table 2.4: Summary of source terms used to inform the WFD Compliance Assessment for the operation of the power station (Ref. 2.3)

Substance	Circuit Conditioning (kg y^{-1})	Sanitary Waste Discharge (kg y^{-1})	Producing Demineralised Water (kg y^{-1})	Maximum Annual Loading (kg y^{-1})	Maximum 24 Hour Loading (kg d^{-1})
Boric acid[2]	14000	-	-	14000	5625
Boron	2448	-	-	2448	984
Lithium hydroxide	8.8	-	-	8.8	4.4
Hydrazine	24.3	-	-	24.3	3
Morpholine	1680	-	-	1674	92.3
Ethanolamine	920	-	-	920	24.75
Nitrogen as N	10130	1595	-	11725	332
Unionised ammonia (NH_3)	-	-	-	958	27
Phosphates	800	-	-	790	352.5
Detergents	-	-	624	624	-

[2] Dissociation boric acid in seawater so equivalent boron concentration in discharge is presented and assessed

Substance	Circuit Conditioning (kg y^{-1})	Sanitary Waste Discharge (kg y^{-1})	Producing Demineralised Water (kg y^{-1})	Maximum Annual Loading (kg y^{-1})	Maximum 24 Hour Loading (kg d^{-1})
Suspended solids	2800	2080	88000	92880	875
BOD	-	1387	-	1378	3.8
COD	5050	-	-	5050	330
Aluminium	5.26	-	-	5.26	1.1
Copper	0.42	-	-	0.42	0.08
Chromium	8.37	-	-	8.37	1.7
Iron	34.97	-	46000	46035	257
Manganese	3.33	-	-	3.33	0.67
Nickel	0.44	-	-	0.44	0.09
Lead	0.3	-	-	0.3	0.07
Zinc	5.6	-	-	6.0	1.2
Mercury[3]	-	-	-	0.099	0.001
Cadmium[3]	-	-	-	0.37	0.005
Chloride	-	-	87100	87100	450
Sulphates	-	-	98400	98400	2000
Sodium	-	-	52400	52400	855
Amino tri-methylene phosphonic acid (ATMP)	-	-	9100	9100	45
Hydroxyethane diphosphonic acid (HEDP)	-	-	890	890	4.5
Acetic acid	-	-	14	14	0.1
Phosphoric acid	-	-	12	12	0.1
Sodium polyacrylate	-	-	8030	8030	40
Acrylic acid	-	-	165	165	1
Chlorine- TRO	-	-	-	-	150ugl^{-1}
Chlorine bromoform	-	-	-	-	190ugl^{-1}

[3] Cadmium and mercury loading are derived from trace contamination of raw materials.

viii. Discharges from the FRR system

2.2.187. Calculation of the total biomass of moribund biota that potentially would be discharged from the FRR system is based on the level of abstraction (pump rates) for the planned Sizewell C intakes and information on the seasonal distribution of species, as well as the length weight distribution of the species impinged for Sizewell B (BEEMS Technical Reports TR339 (Ref. 2.4) and TR381 (Ref. 2.5)).

g) Description of Decommissioning Activities

2.2.188. Before decommissioning can take place, there is a requirement for the operator to undertake an EIA and prepare an ES under the relevant EIA Regulations, such as Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (Ref. 2.6) and the Marine Works (Environmental Impact Assessment) Regulations 2007 (Ref. 2.7). This will also include the requirement for a WFD Compliance Assessment.

2.2.189. For the Sizewell C EPR^{TM} reactor units, the preparation and submission of the EIA and associated supporting documents (such as the WFD Compliance Assessment) will take place in the years leading up to End of Generation. The WFD compliance undertaken at that time would take full account of the environmental impacts of decommissioning.

2.2.190. **Chapter 5** of **Volume 2** of the **ES** (Doc Ref. 6.3) provides further detail but the following effects are outlined that could potentially affect the water environment.

i. Geology, land quality and groundwater

2.2.191. Decommissioning works may require the excavation of below ground services and structures. These works are not considered to result in significant physical effects to soils and geological receptors. The works will be undertaken to manage and minimise physical impacts to soils and geological receptors arising from changes in soil erosion, soil compaction and ground instability issues.

2.2.192. It is not predicted that extensive contaminated soils would be present on site, or that extensive contaminated groundwater would be encountered during decommissioning works. A ground investigation would be undertaken as part of the decommissioning phase to provide further information on the ground conditions at the site following operation. In the unlikely event that soil or groundwater contamination is identified, it will be subject to appropriate management and remediation prior to commencement or during the execution of the decommissioning works.

2.2.193. Waste soils may be generated during decommissioning works through the removal of services and infrastructure and the reprofiling of the site. Materials would be managed to allow the re-use of suitable soils / materials as part of the decommissioning phase. Soil / material required for the backfilling of voids would be generated on site as far as is practical.

2.2.194. It is unlikely that groundwater dewatering would be required during decommissioning, therefore no significant effect on groundwater level and flow is predicted and therefore compliance with WFD requirements would be expected to be achieved.

ii. Surface water

2.2.195. When the cooling water outfall and associated infrastructure are no longer available during decommissioning, the surface water runoff that flows into the outfall would need to be managed as necessary in the interim period during the works by diverting flows to suitable discharge locations which may include surface watercourses and / or to the intertidal zone.

2.2.196. Best practices will be implemented during the works to avoid the discharge of sediment laden water off site into surface watercourses. Due to the distance of the decommissioning area from the site boundary, there would be sufficient land area to allow effective management of runoff to ensure that sediment release does not occur.

2.2.197. No significant effects on surface water receptors are predicted as a result of the decommissioning works and therefore compliance with WFD requirements would be expected to be achieved.

iii. Marine water

2.2.198. During decommissioning, the need for cooling water discharge from the reactors to the marine environment will cease hence impacts related to thermal discharges will cease. The generation of operational effluents will come to an end; thus the discharge of chemical and radiological substances will reduce over time. The cessation of cooling water intake will result in beneficial effects with respect to a reduction of the entrainment of fish and other marine organisms.

2.2.199. It is proposed to remove the intake and outfall structures but these works would be very limited in spatial scale and of limited duration. The effects associated with the removal of the intake and outfall structures would be no worse than those identified for their construction. No significant effects are predicted as a result of the decommissioning works and therefore compliance with WFD requirements would be expected to be achieved.

iv. Overall comment on decommissioning

2.2.200. Given the above, further consideration is not given to decommissioning within this WFD Compliance Assessment.

2.3 Stage 1: Screening

a) Purpose of this section

2.3.1. This section divides the works proposed within the main development site into activities for assessment and identifies the WFD water bodies that are potentially at risk from these activities using:

- The most up to date development proposals.
- High level guidance provided by the Environment Agency.
- The information included on water body extent in the Environment Agency's Catchment Data Explorer (Ref. 2.8).

b) Identification of activities

2.3.2. The works proposed within the main development site have been separated into activities in line with the requirements of Clearing the Waters for All (Ref. 2.9). These are listed in **Table 2.5**. Note that the various proposals for water storage and fen meadow compensation land for example are considered separately in **section 2.3c**. This is because they have been specifically designed to provide benefits to the natural environment and therefore provide potential benefits to WFD water body catchments.

2.3.3. The implications of activities associated with the proposed Sizewell B Relocated Facilities project have been assessed in detail in a separate WFD Compliance Assessment (**Appendix 2C**). It is assumed that these would be in place prior to the commencement of the activities considered in this assessment, and would therefore form part of the baseline.

Table 2.5: Summary of main development site activities

Reference Number	Activity	Sub-activities Included
Construction		
C1	Initial site preparation	Construction of new access road, temporary construction areas and SSSI crossing / main site access roads, excavation of borrow pit, stockpiling of materials, installation of surface water drainage system, rerouting of ditches, installation of temporary site utilities, site clearance, construction of cut off wall, preparation of temporary site infrastructure, and archaeological mitigation. The activity also includes activities proposed for the LEEIE, including stockpiling, park and ride facilities, vehicle access arrangements, caravan facilities, freight management and railway infrastructure, and temporary landscaping.

Reference Number	Activity	Sub-activities Included
C2	Earthworks for platform development	Excavation of large amount of spoil comprising soil, made ground, peat, alluvium and Crag sand to reach the foundation depths for the buildings and other structures, and pumping and discharge of groundwater during construction of the main platform and cut off wall. Bulk backfill to the underside of the foundation levels of the main building, and archaeological mitigation.
C3	Construction of marine structures	Construction of intakes, outfall, CDO, BLF, FRR, coastal defence features – also includes dredging and drilling required for the installation of structures. Note: intake and outfall heads are located outside of the WFD water body boundary.
C4	Discharge of waste water	Includes sewage effluent (from construction facilities and temporary accommodation), groundwater from dewatering, and surface water (including via the CDO, once constructed).
C5	Discharge of cold test commissioning water	Initial stages of non-active commissioning to be discharged via the construction discharge system.
Operation		
O1	Presence of power station platform and cut-off wall	Permanent presence and operation of all developments on the main platform, including the surface water drainage system.
O2	Presence of permanent access road	Permanent presence and operational use of the main site access road (including SSSI crossing), short access roads and walkways.
O3	Presence of marine structures and BLF	Permanent presence and operation of all marine structures, including dredging to maintain access to BLF.
O4	Presence of flood defence structures	Permanent presence and operation of the HCDF and SCDF.
O5	Discharge of foul and surface water via the cooling water system	Includes sewage treatment works discharge and any surface water entering the cooling water discharge (waste stream G in **Table 2.3**).
O6	Intake of cooling water	Intake of a continuous supply of water to cool the operational infrastructure.
O7	Discharge of trade effluent via the cooling water system	This includes all waste streams as detailed in **Table 2.3** and implications of the thermal properties of the discharge (waste streams A to F).

Reference Number	Activity	Sub-activities Included
O8	Discharge of polluting matter from the FRR system	Discharge of polluting matter relating to the functioning of the FRR system (waste stream H).

c) Water body identification

2.3.4. **Figure 2.3** shows the WFD water bodies in the vicinity of the main development site. A screening exercise has been undertaken to identify which of the water bodies have the potential to be impacted by the main development site activities. The results of this exercise are shown in **Table 2.6**.

2.3.5. **Appendix 2A** provides summary data for each water body detailed above. The data used in **Tables A1** to **A11** in **Appendix 2A** was provided by the Environment Agency in December 2018.

Table 2.6: Results of screening exercise

Water body name and ID number	Type	Description	Screened in?	Justification
Leiston Beck[4] GB105035046271	River	Heavily modified for land drainage. Currently at moderate ecological potential due to pressures on hydromorphology and high phosphate concentrations. Approximately 2.7km^2 of the main development site is located within the catchment of this water body, which has a total area of 15.7km^2	Yes	Screened in as the main development site is located within the catchment of this water course.
Minsmere Old River GB105035046270	River	Heavily modified for land drainage. Currently at moderate ecological potential due to pressures on fish populations. Approximately 0.24km^2 of the catchment falls within the main development site boundary, with the remainder of the 70.1km^2 catchment located to the north and west of the site	Yes	Screened in as the main development site could impact on this water course.
Suffolk GB650503520002	Coastal	Heavily modified for flood and coastal protection. Currently at moderate ecological potential due to elevated concentrations of dissolved inorganic nitrogen.	Yes	Screened in because activities associated with the main development site would need to occur within this water body.
Walberswick Marshes GB610050076000	Coastal (Lagoon)	Heavily modified for flood protection. The water body is currently at good ecological potential. The water body is located in Minsmere Marshes, immediately to the north of the Minsmere Old River water body and adjacent to the Suffolk coastal water body	Yes	Screened in because of hydrological connectivity to water bodies that potentially could be impacted.
Blyth (S) GB510503503700	Transitional	Heavily modified for flood and coastal protection. Currently at moderate ecological potential due to elevated concentrations of dissolved inorganic nitrogen.	Yes	Screened in on the basis that activities in the Suffolk coastal water body could impact on this water body.

[4] It is noted that downstream of Lovers Lane (the narrow section of road between the temporary construction area and land east of Eastlands Industrial Estate), the main channel of Leiston Beck is known locally as Leiston Beck. For clarity and consistency in this WFD assessment, this channel is referred to as Leiston Beck for the entirety of its length.

Water body name and ID number	Type	Description	Screened in?	Justification
Alde and Ore GB520503503800	Transitional	Heavily modified for flood protection. Currently at moderate ecological potential due to elevated concentrations of dissolved inorganic nitrogen.	Yes	Screened in as activities in the Suffolk coastal water bodies could impact on this water body.
Waveney and East Suffolk Chalk and Crag GB40501G400600	Groundwater	Underlies the proposed development area. Currently at poor quantitative status as a result of an unfavourable water balance and poor chemical status due to diffuse pollution pressures and potential impacts on a drinking water protected area.	Yes	Screened in as the main development site is located within this groundwater body.

2.3.6. This demonstrates that the following water bodies potentially could be impacted by the proposed development:

- Leiston Beck (GB105035046271).
- Minsmere Old River (GB105035046270).
- Suffolk (GB650503520002).
- Walberswick Marshes (GB610050076000).
- Blyth (S) (GB510503503700).
- Alde and Ore (GB520503503800).
- Waveney and East Suffolk Chalk and Crag (GB40501G400600).

2.3.7. These water bodies have therefore been screened in for further assessment. Potential impacts arising from each Sizewell C Project activity are considered in more detail in Stage 2 (**section 2.4**).

D) Consideration of compensatory proposals

2.3.8. This section screens the proposals for fen meadow and water storage areas against the WFD water bodies to identify whether there is the potential for effect.

i. Identification of activities

2.3.9. The works have been separated into activities in line with the requirements of the Environment Agency's Clearing the Waters for All guidance. These are listed in **Table 2.7**.

Table 2.7: Summary of activities

Reference Number	Activity	Sub activities included
Construction		
C1	Site preparation at water resource storage area, wet woodland habitat and flood compensation land	Earthworks to create the storage area, construction of an embankment with a maximum height of 3m, and construction of a trenched water supply pipe.
C2	Site preparation for fen meadow compensation land	Includes installation of water control structures and limited excavation to reduce ground levels and create minor watercourses.

Reference Number	Activity	Sub activities included
Operation		
O1	Presence of water resource storage area, wet woodland habitat and flood compensation land	Operational use of the water resource storage area and permanent presence of the wet woodland and flood compensation land
O2	Presence of fen meadow compensation land	Permanent presence of fen meadow compensation land

ii. Water body identification

2.3.10. **Figure 2.4** shows the WFD water bodies in the vicinity of the proposals. A screening exercise has been undertaken to identify which of the water bodies have the potential to be impacted by these proposals. The screening exercise for these two sites differs slightly from the main development site in **section 2.3b)** above in that a comment made as to whether scoping is required. The results of this exercise are shown in **Table 2.8**.

Table 2.8: Summary of screening exercise for the proposed compensatory proposals

Water body name and ID number	Type	Description	Screened in?	Justification
Construction				
Leiston Beck GB105035046271	River	Both schemes are located within this water body catchment. Heavily modified for land drainage. Currently at moderate ecological potential due to pressures on hydromorphology and high phosphate concentrations.	No	The sites identified for fen meadow compensation are considered to have suitable hydrological regimes which could be modified. Fen meadow establishment would also depend on appropriate management potentially including the import of 'green hay' from Sizewell Marshes SSSI or other areas of fen meadow and potentially some use of turf transfer from the part of Sizewell Marshes SSSI subject to land-take, provided in **Chapter 14** of **Volume 2** of the **ES** (Doc Ref. 6.3). Further work is ongoing to develop site-specific plans to maximise the likelihood of successful fen meadow establishment. As a result of existing suitability, only relatively minor works required to support this habitat. With mitigation in place in the form of an appropriate construction method statement and operational management plan, no likely significant effects associated with the construction and operation of these sites have been identified. The construction of the embankment and excavation work associated with the creation of the water resource storage area, wet woodland habitat and flood compensation land will be remote from the main river channel. The supply of fine sediment and contaminants will be controlled through the use of construction-stage measures outlined in the **CoCP** (Doc Ref. 8.11). No impacts on Leiston beck are therefore predicted.

Water body name and ID number	Type	Description	Screened in?	Justification
Waveney and East Suffolk Chalk and Crag GB40501G400600	Groundwater	Underlies the proposed development area. Currently at poor quantitative status as a result of an unfavourable water balance and poor chemical status due to diffuse pollution pressures and potential impacts on a drinking water protected area.	No	The proposed compensatory areas do not require heavy engineering.
Operation				
Leiston Beck GB105035046271	River	Both schemes are located within this water body catchment. Heavily modified for land drainage. Currently at moderate ecological potential due to pressures on hydromorphology and high phosphate concentrations.	No	No effects predicted during operation.
Waveney and East Suffolk Chalk and Crag GB40501G400600	Groundwater	Underlies the proposed development area. Currently at poor quantitative status as a result of an unfavourable water balance and poor chemical status due to diffuse pollution pressures and potential impacts on a drinking water protected area.	No	No effects predicted during operation.

2.3.11. **Appendix 2A** provides summary data for each water body detailed above. The data used in **Tables A1** to **A11** in **Appendix 2A** was provided by the Environment Agency in December 2018.

2.4 Stage 2: Scoping

a) Purpose of this section

2.4.1. This section presents the results of the scoping assessment undertaken on the water bodies identified in **section 2.3c)** of this report, using the method outlined in **Part 1**.

2.4.2. This assessment examines the potential for activities at the main development site to impact upon WFD water bodies and their quality elements. The results of this scoping stage determine which water bodies and quality elements will require further assessment as part of the Stage 3 Compliance Assessment.

2.4.3. It may be possible for relatively straightforward reasons (e.g. no identifiable impact pathway) to scope out some scheme activities during Stage 2 of the WFD Compliance Assessment process. 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 activity scoped in for further assessment. Activities to be considered have been informed by feedback gained via consultation with the Environment Agency.

b) Impacts of project activities on water body quality elements

i. Water bodies considered in this assessment

2.4.4. The scoping stage considers the following WFD water bodies:

- River water bodies: Leiston Beck (GB105035046271) and Minsmere Old River (GB105035046270).
- Coastal water bodies: Suffolk (GB650503520002) and Walberswick Marshes (GB610050076000).
- Transitional water bodies: Alde and Ore (GB520503503800) and Blyth (S) (GB19593593700).
- Groundwater bodies: Waveney and East Suffolk Chalk and Crag (GB40501G400600).

ii. Assessment of potential mechanisms for impact

2.4.5. The scoping questions presented in **Part 1** have been applied to each water body individually for each of the construction and operational stage activities listed in **Table 2.5**. The results of the scoping assessment are provided in **Appendix 2B** of this document and summarised in **Table 2.9**.

2.4.6. **Table 2.9** also identifies connected water bodies that could be indirectly affected by the impacts of the proposed activities on the water body in which they take place.

Table 2.9: Main development site activities with the potential to affect water body quality elements and status

Activity	Water body	Quality element scoped in	Indirect effects scoped in on water bodies with direct connectivity
Construction			
C1 Initial site preparation	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and groundwater dependent terrestrial ecosystems (GWDTEs), saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River
		Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective	
C2 Earthworks for platform development	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	

Activity	Water body	Quality element scoped in	Indirect effects scoped in on water bodies with direct connectivity
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River
		Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective	
C3 Construction of marine structures	Suffolk	Water quality: Chemical and physico-chemical.	None
		Biology: Habitats	
C4 Discharge of foul, surface and any other water	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag
		Physico-chemistry: General, specific pollutants	
		Biology: Aquatic flora, benthic invertebrates, fish	
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs	Leiston Beck Minsmere Old River
		Quality: Diffuse pollution, GWDTEs, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River
	Suffolk	Water quality: Chemical and physico-chemical	Walberswick Marshes Blyth (S) Alde and Ore
		Biology: Habitats	
C5 Discharge of commissioning water via CDO	Suffolk	Water quality: Chemical and physico-chemical	Leiston Beck Minsmere Old River
		Biology: Habitats	

Activity	Water body	Quality element scoped in	Indirect effects scoped in on water bodies with direct connectivity
			Walberswick Marshes Blyth (S) Alde and Ore
Operation			
O1 Presence of power station platform and cut-off wall	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River
O2 Presence of permanent SSSI crossing / main site access road	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Minsmere Old River Waveney and East Suffolk Chalk and Crag
O3 Presence of marine structures	Suffolk	Hydromorphology Water quality: Chemical and physico-chemical Biology: Habitats	None

Activity	Water body	Quality element scoped in	Indirect effects scoped in on water bodies with direct connectivity
O4 Presence of flood defences	Suffolk	Hydromorphology	None
O5 Surface and foul water discharge via cooling water system	Suffolk	Water quality: Chemical and physico-chemical Biology: Habitats	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore
O6 Intake of cooling water	Suffolk	Biology: Phytoplankton and fish. Fish is not a compliance parameter for coastal water bodies so the potential effect is considered on the transitional water bodies only which could be impacted indirectly.	Blyth (S) Alde and Ore
O7 Discharge of trade effluent from cooling water system	Suffolk	Water quality: Chemical and physico-chemical Biology: Habitats and Fish	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore
O8 Discharge of polluting material via the FRR system	Suffolk	Water Quality: Physico-chemical	None

2.4.7. **Table 2.9** demonstrates that the proposed construction activities have the potential to directly and indirectly impact upon one or more quality element supported by the water bodies that were screened in to the assessment in **section 2.3c)**. That is:

- C1 Initial site preparation: This activity could have direct effects on the hydromorphology, physico-chemistry and biology of Leiston Beck and the Minsmere Old River, and direct effects on the quantity and quality of the Waveney and East Suffolk Chalk and Crag groundwater body. The activity could also result in indirect effects on the Suffolk coastal water body.
- C2 Earthworks for platform development: This activity could have direct effects on the hydromorphology, physico-chemistry and biology of Leiston Beck and the Minsmere Old River, and direct effects on the quantity and quality of the Waveney and East Suffolk Chalk and Crag groundwater body. The activity could also result in indirect effects on the Suffolk coastal water body.
- C3 Construction of marine structures: This activity could directly impact upon the physico-chemistry and biology of the Suffolk coastal water body.
- C4 Discharge of foul, surface and any other water: This activity could directly affect the hydromorphology, physico-chemistry and biology of Leiston Beck and the Minsmere Old River, the quantity and quality of the Waveney and East Suffolk Chalk and Crag groundwater body, and the physico-chemistry and biology of the Suffolk coastal water body. The activity could also result in indirect effects on the Walberswick Marshes, Blyth (S) and Alde and Ore water bodies.
- C5 Discharge of cold test commissioning water: This activity could directly impact upon the physico-chemistry and biology of the Suffolk coastal water body. The activity could also result in indirect effects on the Leiston Beck, Minsmere Old River, Walberswick Marshes, Blyth (S) and Alde and Ore water bodies.

2.4.8. **Table 2.9** also demonstrates that the proposed operational activities have the potential to directly and indirectly impact upon one or more quality element supported by these water bodies. That is:

- O1 Presence of power station platform and cut off wall: This activity could directly affect the hydromorphology and physico-chemistry of Leiston Beck and the Minsmere Old River, and the quantity and quality of the Waveney and East Suffolk Chalk and Crag groundwater body.

The activity could also result in indirect effects on the Suffolk coastal water body.

- O2 Presence of permanent SSSI crossing / main access road: This activity could directly affect the hydromorphology, physico-chemistry and biology of Leiston Beck. The activity could also result in indirect effects on the Minsmere Old River and the Waveney and East Suffolk Chalk and Crag groundwater body.
- O3 Presence of marine structures and BLF: This activity could directly impact upon the hydromorphology, physico-chemistry and biology of the Suffolk coastal water body.
- O4 Presence of flood defence structures: This activity could directly impact upon the hydromorphology of the Suffolk coastal water body.
- O5 Discharge of foul and surface water via the cooling system: This activity could directly impact upon the physico-chemistry and biology of the Suffolk coastal water body. The activity could also result in indirect effects on the Leiston Beck, Minsmere Old River, Walberswick Marshes, Blyth (S) and Alde and Ore water bodies.
- O6 Intake of cooling water: This activity could directly affect the biology of the Suffolk coastal water body, and indirectly affect the Blyth (S) and Alde and Ore water bodies.
- O7 Discharge of trade effluent via the cooling water system: This activity could directly impact upon the physico-chemistry and biology of the Suffolk coastal water body. The activity could also result in indirect effects on the Leiston Beck, Minsmere Old River, Walberswick Marshes, Blyth (S) and Alde and Ore water bodies.
- O8 Discharge of polluting material via the FRR system: This activity could directly impact upon the physico-chemistry of the Suffolk coastal water body and therefore have indirect effects on biology (habitats).

2.4.9. The potential impacts of these activities on each water body are, therefore, considered in more detail in Stage 3 (**section 2.5**).

c) Impacts of project activities on Invasive Non-native Species (INNS)

2.4.10. Any activities which use equipment that has been used on another site where INNS species are located could potentially be at risk of spreading INNS. Non-native species can also be introduced in ballast water of construction and delivery vessels if not treated effectively.

2.4.11. Section 14(1) of the Wildlife and Countryside Act 1981 makes it illegal to plant or otherwise cause to grow in the wild any plant which is included in Part II of Schedule 9 of the Act.

2.4.12. Contractors will be required to undertake a biosecurity risk assessment and a management plan put in place to avoid potentially facilitating the spread of non-native species during construction.

2.4.13. A general strategy will be to establish a viable vegetation cover quickly, before invasive plant species can become established. Any invasive species that colonise an area during construction will be removed and disposed of as required.

2.4.14. Any imported soils will be subject to appropriate control processes to ensure they are free of any seeds / roots / stems of any invasive plant covered under the Wildlife and Countryside Act 1981.

2.4.15. The potential for non-native species to be introduced during ballast water activities will be managed by compliance with the International Maritime Organisation (IMO) Ballast Water Management Convention.

2.4.16. As a result, the risk of introducing INNS is not considered further within the WFD Compliance Assessment.

d) Impacts of project activities on River Basin Management Plan (RBMP) improvement and mitigation measures

i. RBMP measures applicable to each water body

2.4.17. **Table 2.10** summarises the RBMP mitigation measures for heavily modified water bodies (HMWBs) and RBMP improvement measures (for other water bodies) for each of the water bodies considered in the scoping assessment (Ref. 2.10). This includes those that have already been implemented (in place) and those that are proposed for future implementation (not in place). Note that detailed definitions of these measures (including the pressures and impacts that they are used to address) are provided by the Environment Agency in their Guide to Mitigation Measures in Artificial and Heavily Modified Water Bodies (Ref. 2.11).

2.4.18. This shows that several of the water bodies that have been scoped in to the assessment do not have any RBMP mitigation or improvement measures listed as either in place or not in place (Suffolk, Walberswick Marshes, Alde and Ore, and Waveney and East Suffolk Chalk and Crag). These water bodies are, therefore, not considered further in this part of the assessment.

2.4.19. However, RBMP mitigation measures that are already in place have been identified in the Minsmere Old River and Blyth (S) water bodies, while additional RBMP mitigation measures that are not yet in place have been identified for the Leiston Beck and Minsmere Old River water bodies.

Table 2.10: RBMP mitigation or improvement measures identified for each water body

WFD water body	RBMP mitigation measure (in place)	RBMP mitigation measure (not in place)
Leiston Beck GB105035046271	None identified	Remove obsolete structure Remove or soften hard bank Preserve or restore habitats In-channel morph diversity Re-opening culverts Alter culvert channel bed Flood bunds Set-back embankments Floodplain connectivity Fish passes Reduce fish entrainment Enhance ecology Changes to locks etc. Selective vegetation control Vegetation control Vegetation control timing Invasive species techniques Retain habitats Sediment management strategy Maintain channel bed / margins Woody debris Water level management Align and attenuate flow

WFD water body	RBMP mitigation measure (in place)	RBMP mitigation measure (not in place)
Minsmere Old River GB105035046270	Selective vegetation control Vegetation control Vegetation control timing Invasive species techniques Sediment management strategy	Remove obsolete structure Remove or soften hard bank Preserve or restore habitats In-channel morph diversity Re-opening culverts Alter culvert channel bed Flood bunds Set-back embankments Floodplain connectivity Fish passes Reduce fish entrainment Enhance ecology Changes to locks, etc. Retain habitats Maintain channel bed / margins Woody debris Water level management Align and attenuate flow Educate landowners
Suffolk GB650503520002	None identified	None identified
Walberswick Marshes GB610050076000	None identified	None identified
Blyth (S) GB510503503700	Preserve or restore habitats	None identified
Alde and Ore GB520503503800	None identified	None identified
Waveney and East Suffolk Chalk and Crag GB40501G400600	None identified	None identified

ii. Assessment of potential mechanisms for impact

2.4.20. An assessment of potential impacts from the Sizewell C Project on the RBMP mitigation measures that are already in place in the Minsmere Old River and Blyth (S) water bodies is presented in **Table 2.11**. This demonstrates that the proposed activities would not counteract or adversely affect the delivery of the majority of RBMP mitigation measures. However, construction activities have the potential to increase sediment supply to the Minsmere Old River and could, therefore, have implications for the ongoing delivery of sediment management measures in this water body.

2.4.21. An assessment of potential impacts from the proposed development on the RBMP measures that are not yet in place in the Leiston Beck and Minsmere Old River water bodies is presented in **Table 2.12**. This demonstrates that the proposed project activities would not prevent the future implementation of the majority of the RBMP mitigation measures that are not yet in place in Leiston Beck or the Minsmere Old River. However, several measures that are not yet in place potentially could be impacted by the proposed activities, as follows:

- Construction activities have the potential to increase sediment supply to the Leiston Beck and, therefore, could have implications for the future delivery of sediment management measures in this water body.
- Discharges from the site drainage system during construction have the potential to conflict with the implementation of measures to align and attenuate flows and limit the detrimental effects of pipes, inlets, outlets and offtakes in both Leiston Beck and the Minsmere Old River.
- The construction and permanent operational presence of the power station platform and the SSSI crossing would lead to a reduction in the area of the functional floodplain in Leiston Beck. This potentially could conflict with proposed measures to improve floodplain connectivity in the water body.

Table 2.11: Potential project impacts on RBMP mitigation measures (in place)

RBMP mitigation measure (in place)	Minsmere Old River GB105035046270	Blyth (S) GB510503503700
Vegetation control Selective vegetation control Vegetation control timing	No mechanism for impact	N/A
Invasive species techniques	Potential risks to INNS are considered in **section 2.4c).**	N/A
Sediment management strategy	Sizewell C Project activities during construction have the potential to increase sediment loadings in the water body and have been scoped in to the assessment in **section 2.4d)**. These activities, therefore, could affect existing sediment management measures that are in place in the water body.	N/A
Restore or preserve habitats	N/A	No mechanism for impact

Table 2.12: Potential project impacts on RBMP mitigation measures (not in place)

RBMP mitigation measure not in place	Leiston Beck GB105035046271	Minsmere Old River GB105035046270
Remove obsolete structure	No mechanism for impact	No mechanism for impact
Remove or soften hard bank	No mechanism for impact	No mechanism for impact
Preserve or restore habitats	No mechanism for impact	No mechanism for impact
In-channel morphological diversity	No mechanism for impact	No mechanism for impact
Re-opening culverts	No mechanism for impact. Note that the potential impacts of the proposed new crossing over Leiston Beck have been scoped in to the assessment.	No mechanism for impact
Alter culvert channel bed	No mechanism for impact	No mechanism for impact
Flood bunds	No mechanism for impact	No mechanism for impact
Set-back embankments	No mechanism for impact	No mechanism for impact
Floodplain connectivity	The construction and permanent operational presence of the power station platform and the SSSI crossing would lead to a reduction in the area of the functional floodplain in Leiston Beck. This potentially could conflict with proposed measures to improve floodplain connectivity in the water body.	No mechanism for impact
Fish passes	No mechanism for impact. Note that the potential impacts of the proposed new crossing over Leiston Beck have been scoped in to the assessment.	No mechanism for impact
Reduce fish entrainment	No mechanism for impact	No mechanism for impact
Enhance ecology	No mechanism for impact	No mechanism for impact
Changes to locks, etc.	No mechanism for impact	No mechanism for impact
Selective vegetation control	No mechanism for impact	Measure in place – see **Table 2.11**

RBMP mitigation measure not in place	Leiston Beck GB105035046271	Minsmere Old River GB105035046270
Vegetation control	No mechanism for impact	Measure in place – see **Table 2.11**
Vegetation control timing	No mechanism for impact	Measure in place – see **Table 2.11**
Invasive species techniques	Potential risks to INNS are considered in **section 2.4c)**.	Measure in place – see **Table 2.11**
Retain habitats	No mechanism for impact	No mechanism for impact
Sediment management strategy	Sizewell C Project activities during construction have the potential to increase sediment loadings in the water body and have been scoped in to the assessment in **section 2.4d)**. These activities, therefore, could also affect existing sediment management measures that are in place in the water body	Measure in place – see **Table 2.11**
Maintain channel bed / margins	No mechanism for impact	No mechanism for impact
Woody debris	No mechanism for impact	No mechanism for impact
Water level management	No mechanism for impact. New control structures to be installed during the realignment of Sizewell drain (a tributary of Leiston Beck) would help to improve water level management in that part of the catchment and, therefore, could help to implement this mitigation measure	No mechanism for impact
Align and attenuate flow	Sizewell C Project activities during construction have the potential to change flow patterns in receiving surface waters and have been scoped in to the assessment (cf. **section 2.4d)**). Any outfalls associated with the drainage system could potentially conflict with the implementation of this measure, which aims to align and attenuate flows to limit the detrimental effects of pipes, inlets, outlets and offtakes	Sizewell C Project activities during construction have the potential to change flow patterns in receiving surface waters and have been scoped in to the assessment (cf. **section 2.4b)**). Any outfalls associated with the drainage system could potentially conflict with the implementation of this measure, which aims to align and attenuate flows to limit the detrimental effects of pipes, inlets, outlets and offtakes

RBMP mitigation measure not in place	Leiston Beck GB105035046271	Minsmere Old River GB105035046270
Educate landowners	No mechanism for impact	No mechanism for impact

2.4.22. **Table 2.11** and **Table 2.12** indicate that the following RBMP mitigation measures potentially could be affected by the proposed Sizewell C Project activities:

- Minsmere Old River: Sediment management strategy (in place); and align and attenuate flow (not in place).
- Leiston Beck: Sediment management strategy (not in place); align and attenuate flow (not in place); and floodplain connectivity (not in place).

2.4.23. These measures, therefore, have been carried through to the further assessment presented in Stage 3 (**section 2.5**).

e) Impacts of project activities on protected areas

i. Protected areas in each water body

2.4.24. Protected areas within each of the WFD water bodies identified during the screening phase are listed in **Table 2.13** and shown in **Figure 2.5**. This demonstrates that there are a variety of areas protected under the Nitrates Directive (91/676/EEC), Habitats and Species Directive (Council Directive 92/43/EEC), Conservation of Wild Birds Directive (2009/147/EC) and Bathing Water Directive (2006/7/EC) associated with the water bodies that have been scoped in to this assessment.

Table 2.13: List of Protected areas within each WFD water body

Water body name and ID number	Protected Area Driver	Protected area name/reference
Leiston Beck GB105035046271	Nitrates Directive	Nitrate Vulnerable Zones (NVZ) 415, 661
	Habitats and Species Directive	Minsmere to Walberswick Heaths and Marshes Special Area of Conservation (SAC)
	Conservation of Wild Birds Directive	Minsmere-Walberswick Special Protection Area (SPA) and Ramsar
Minsmere Old River GB105035046270	Nitrates Directive	411, 417, 415, 412, 661
	Habitats and Species Directive	Minsmere to Walberswick Heaths and Marshes SAC
	Conservation of Wild Birds Directive	Minsmere-Walberswick SPA and Ramsar
Suffolk GB650503520002	Bathing Water Directive	Lowestoft (South of Claremont Pier), Lowestoft (North of Claremont Pier), Southwold The Denes, Southwold The Pier

Water body name and ID number	Protected Area Driver	Protected area name/reference
	Nitrates Directive	NVZ 661, 413, 660
	Conservation of Wild Birds Directive	Outer Thames Estuary SPA, Minsmere-Walberswick SPA and Ramsar, Alde-Ore Estuary SPA and Ramsar, Benacre to Easton Bavents SPA and Ramsar
	Habitats and Species Directive	Minsmere to Walberswick Heaths and Marshes SAC, Orfordness-Shingle Street SAC, Alde-Ore and Butley Estuaries SAC, Benacre to Easton Bavents Lagoons SAC
Walberswick Marshes GB610050076000	Nitrates Directive	NVZ 415, 661
	Habitats and Species Directive	Minsmere to Walberswick Heaths and Marshes SAC
	Conservation of Wild Birds Directive	Minsmere-Walberswick SPA and Ramsar
Blyth (S) GB510503503700	Nitrates Directive	NVZ 415, 661
	Conservation of Wild Birds Directive	Minsmere-Walberswick SPA and Ramsar
Alde and Ore GB520503503800	Nitrates Directive	NVZ 420, 660
	Shellfish Water Directive	Butley River, Alde
	Habitats and Species Directive	Orfordness-Shingle Street SAC, Alde-Ore and Butley Estuaries SAC
	Conservation of Wild Birds Directive	Alde-Ore Estuary SPA and Ramsar
Waveney and East Suffolk Chalk and Crag GB40501G400600	Nitrates Directive	NVZ 78, 79, 166, 168
	Drinking Water Protected Area	Waveney and East Suffolk Chalk and Crag

ii. Assessment of potential mechanisms for impact

2.4.25. The Environment Agency's 'Clearing the Waters For All' (Ref. 2.9) guidance recommends further assessment of potential impacts on any protected areas that are within 2km of a proposed new project activity. This 2km Zone Of Influence (ZOI) has been adopted across all water bodies for each project activity and the results of the process are summarised in **Table 2.14**.

2.4.26. Note that where a plume could extend over a large distance, further assessment is required if the protected area is within 2km of the plume outline. However, given that detailed plume information was not available at the time of undertaking this scoping exercise, scoping has been undertaken based on initial model output with justification provided in **Table 2.14**.

2.4.27. **Table 2.14** demonstrates that a large proportion of the protected areas associated with each relevant water body are outside the 2km ZOI and, therefore, have not been considered further in this assessment.

2.4.28. Several Natura 2000 protected areas, including the Minsmere to Walberswick Heaths and Marshes SAC and SPA, the Outer Thames Estuary SPA and the Sandlings SPA are located within the 2km ZOI. WFD Compliance Assessments require the consideration of the potential effects on WFD quality elements (hydromorphological, physico-chemical, chemical and biological), many of which support ecological interest features for which the Natura 2000 protected areas are designated. The **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10) therefore builds on the output of this assessment to assess the potential effects on designated site interest features. Therefore, to avoid duplication with the **Shadow Habitats Regulations Assessment Report**, impacts on the designated site interest features themselves are not considered here.

2.4.29. The following areas protected under other Directives are located within the Sizewell C Project's ZOI and are not considered elsewhere:

- Surface water NVZ 415 and 661.
- Groundwater NVZ 78 and 166.
- Southwold The Denes and Southwold The Pier Bathing Waters.

2.4.30. These protected areas have therefore been scoped in for further assessment in Stage 3.

Table 2.14: Summary of scoping assessment for protected areas

Water body name and ID	Protected area name	Discussion	Further assessment required?
Leiston Beck GB105035046271	NVZ 415, 661	415 and 661 are located within 2km of the main development site. Activities C1, C2 and C4 could potentially release nutrients	415 and 661 for activities C1, C2 and C4
	Minsmere to Walberswick Heaths and Marshes SAC Minsmere-Walberswick SPA	Located within 2km of the main development site	Considered in **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10). No further assessment required
Minsmere Old River GB105035046270	NVZ 411, 417, 415, 412, 661	415 and 661 already scoped in. Activities C1, C2 and C4 could potentially release nutrients	415 and 661 for activities C1, C2 and C4
	Minsmere to Walberswick Heaths and Marshes SAC Minsmere-Walberswick SPA	Located within 2km of the main development site	Considered in **Shadow Habitats Regulations Assessment Report**. No further assessment required
Suffolk GB650503520002	Lowestoft (South of Claremont Pier), Lowestoft (North of Claremont Pier), Southwold The Denes, Southwold The Pier	These sites are not located within 2km of main development site, however, given that the cooling water plume (which contains treated sewage) could potentially extend to within 2km of Southwold, further assessment on these two bathing waters is required. All other plumes are predicted to be localised to the activity and therefore are scoped out.	Southwold The Denes and Southwold The Pier for activity O5
	NVZ 661, 413, 660	661 already scoped in. Others are not within 2km.	661 for activities O5 and O7.
	Outer Thames Estuary SPA, Minsmere-Walberswick SPA, Alde-Ore Estuary SPA,	Outer Thames Estuary SPA and Minsmere-Walberswick SPA are located within 2km. Alde-Ore Estuary SPA and Benacre to Eastern Bavents SPA not located within 2km.	Considered in **Shadow Habitats Regulations Assessment Report**. No

Water body name and ID	Protected area name	Discussion	Further assessment required?
	Benacre to Easton Bavents SPA		further assessment required
	Minsmere to Walberswick Heaths and Marshes SAC, Orfordness-Shingle Street SAC Alde-Ore and Butley Estuaries SAC Benacre to Easton Bavents Lagoons SAC	Minsmere to Walberswick Heaths and Marshes SAC is located within 2km. All others are not located within 2km.	
Walberswick Marshes GB610050076000	NVZ 415, 661	415 and 661 already scoped in. Activities O5 and O7 could potentially release nutrients.	415 and 661 for activities O5 and O7
	Minsmere to Walberswick Heaths and Marshes SAC	Located within 2km of the main development site	Considered in **Shadow Habitats Regulations Assessment Report**. No further assessment required
	Minsmere-Walberswick SPA		
Blyth (S) GB510503503700	NVZ 415, 661	415 and 661 already scoped in. Activities O5 and O7 could potentially release nutrients.	415 and 661 for activities O5 and O7
	Minsmere-Walberswick SPA	Located within 2km of the main development site	Considered in **Shadow Habitats Regulations Assessment Report**. No further assessment required

Water body name and ID	Protected area name	Discussion	Further assessment required?
Alde and Ore GB520503503800	NVZ 420, 660	Not located within 2km.	No further assessment required
	Butley, River Alde shellfish waters	These are not located within 2km of the main development site and are considered far enough away from the site to be at risk.	No further assessment required
	Orfordness-Shingle Street SAC Alde-Ore and Butley Estuaries SAC	Located within 2km of the main development site	Considered in **Shadow Habitats Regulations Assessment Report**. No further assessment required
	Alde-Ore Estuary SPA		
Waveney and East Suffolk Chalk and Crag GB40501G400600	NVZ 78, 79, 166, 168	78 and 166 are located within 2km.	78 and 166 for activities C1 and C2
	Waveney and East Suffolk Chalk and Crag Drinking Water	Not located within 2km.	No further assessment required

f) Summary of Stage 2

2.4.31. **Table 2.15** summaries the activities and quality elements scoped in to Stage 3 (**section 2.5**). The potential effects have been separated into direct effects (i.e. the activity occurs within or adjacent to the WFD water body) and indirect effects (i.e. the water body could be impacted via connectivity to the water body in which the activity occurs).

Table 2.15: Summary of scoping results

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Construction					
C1 Initial site preparation	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (not in place)	415 661
		Physico-chemistry: General, specific pollutants			
		Biology: Aquatic flora, benthic invertebrates, fish			
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415
		Physico-chemistry: General, specific pollutants			
		Biology: Aquatic flora, benthic invertebrates, fish			
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River	N/A	78 116
		Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			
	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River	Sediment management (not in place)	415

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
C2 Earthworks for platform development		Physico-chemistry: General, specific pollutants	Suffolk Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	661
		Biology: Aquatic flora, benthic invertebrates, fish			
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415
		Physico-chemistry: General, specific pollutants			
		Biology: Aquatic flora, benthic invertebrates, fish			
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River	N/A	78 116
		Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			
C3 Construction of marine structures	Suffolk	Water quality - chemical and physico-chemical.	N/A	N/A	N/A
		Biology – Habitats			
C4 Discharge of foul, surface and any other water	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661
		Physico-chemistry: General, specific pollutants			

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
		Biology: Aquatic flora, benthic invertebrates, fish			
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661
		Physico-chemistry: General, specific pollutants			
		Biology: Aquatic flora, benthic invertebrates, fish			
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs	Leiston Beck Minsmere Old River	N/A	N/A
		Quality: Diffuse pollution, GWDTEs, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River		
	Suffolk	Water quality – chemical and physico-chemical	Walberswick Marshes Blyth (S) Alde and Ore	N/A	N/A
		Biology - Habitats			
C5 Discharge of commissioning water via CDO	Suffolk	Water quality – chemical and physico-chemical	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	N/A
		Biology - Habitats			
Operation					
O1 Presence of power station	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River	Floodplain connectivity (not in place)	N/A

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
platform and cut-off wall		Physico-chemistry: General	Suffolk Waveney and East Suffolk Chalk and Crag		
	Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	N/A	N/A
		Physico-chemistry: General			
	Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River	N/A	N/A
		Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			
O2 Presence of permanent SSSI crossing / main site access road	Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity	Minsmere Old River Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	N/A
		Physico-chemistry: General, specific pollutants			
		Biology: Aquatic flora, benthic invertebrates, fish			
O3 Presence of marine structures	Suffolk	Hydromorphology	N/A	N/A	N/A
		Water quality – chemical and physico-chemical			
		Biology - habitats			

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
O4 Presence of flood defences	Suffolk	Hydromorphology	N/A	N/A	N/A
O5 Surface and foul water discharge via cooling water system	Suffolk	Water quality – chemical and physico-chemical Biology - Habitats	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	661 Southwold The Denes Southwold The Pier
O6 Intake of cooling water	Suffolk	Biology – phytoplankton and fish. Fish is not a compliance parameter for coastal water bodies so the potential effect is considered on the transitional water bodies only which could be impacted indirectly.	Blyth (S) Alde and Ore	N/A	N/A
O7 Discharge of trade effluent from cooling water system	Suffolk	Water quality – chemical and physico-chemical, Biology – habitats under plume. There is a possibility that existing INNS species could be encouraged by the thermal plume	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	661
O8 Discharge of polluting matter via FRR system	Suffolk	Water Quality – physico-chemical	None	N/A	661

2.5 Stage 3: Detailed assessment

a) Introduction

2.5.1. To inform the assessment, a baseline for each quality element within each water body is presented**.** This builds on the information provided in **Volume 2** of the **ES** (Doc Ref. 6.3) in the following chapters:

- **Chapter 14** – Terrestrial ecology and ornithology.
- **Chapter 18** – Geology and land quality.
- **Chapter 19** – Groundwater and surface water.
- **Chapter 20** – Coastal geomorphology and hydrodynamics**.**
- **Chapter 21** – Marine water quality and sediments**.**
- **Chapter 22** – Marine ecology**.**

2.5.2. The assessment assumes Sizewell B forms part of the baseline (given its current operational status) and, therefore, predicts impacts based on the combined influence of the Sizewell B and Sizewell C where applicable. In time, Sizewell B will no longer operate, but the combined scenario represents the worst case.

b) Baseline for the Waveney and East Suffolk Chalk and Crag groundwater body for quality elements at risk

i. Hydrogeology

2.5.3. The Waveney and East Suffolk Chalk and Crag groundwater body has an area of 1,455km^2 and underlies all of the landside component of the main development site (**Figure 2.6**). There are also a number of groundwater dependent terrestrial ecosystems (GWDTE) also shown in **Figure 2.6.**

2.5.4. The groundwater body is classified as being of poor quantitative status, attributed to impacts from groundwater and surface water abstractions for agriculture (Ref. 2.8).

2.5.5. As described in the Sizewell Site C: Conceptual Site Model of the Hydrogeological Regime – provided at **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3) – the geology underlying the main development site comprises:

- Made ground.

- Superficial Deposits comprising glacial sand and gravel and clays of the Lowestoft Formation on higher ground, with more recent Alluvium and peat along the river valleys, underlain in places by silt and mud tidal flats.
- Pliocene-Pleistocene Crag.
- Paleogene deposits comprising London Clay and Lower London Tertiary Deposits.
- Upper Chalk of Cretaceous age.

2.5.6. The Paleogene deposits, comprising approximately 15m of London Clay overlying 25m of Lower London Tertiaries are present beneath the site and surrounding area. These deposits thin to the west where they ultimately wedge-out approximately 8 to 10km inland and Crag deposits directly overlie the Chalk.

2.5.7. The Crag and the Chalk are designated as 'Principal Aquifers', which can provide a high level of water storage and support water supply and base river flows on a strategic scale.

2.5.8. The sand and gravel component of the Lowestoft Formation is designated as a 'Secondary A Aquifer'. The properties of a 'Secondary A Aquifer' are more variable and as such they may be of local rather than regional importance as a source of water supply. Secondary A Aquifers often constitute important sources of flow to rivers and associated wetlands.

2.5.9. The peat deposits within the Sizewell C area, though not classified as an aquifer can be considered as being of similar significance to a 'Secondary B Aquifer', storing and transmitting water originating from groundwater, surface water and precipitation.

2.5.10. Other natural and anthropogenic deposits act to modify, constrain or retard the movement of groundwater. Groundwater in the made ground, where present, is considered to be in partial hydraulic continuity with the underlying strata. The laterally inconsistent areas of cohesive material will act to delay recharge to the underlying aquifers, potentially resulting in locally perched water tables. The soils underlying the majority of the site are identified as having high permeability, with the exception of the peat deposits and Lowestoft Formation, which are identified as having intermediate leaching potential.

2.5.11. Available groundwater monitoring data in the vicinity of the proposed development record a maximum groundwater level in the area of 2.28m AoD which occurred during a storm surge event in December 2013. Under standard winter conditions, maximum groundwater levels typically reach 1.4m AoD.

2.5.12. The peat deposits store and transmit water originating from groundwater, surface water and precipitation and therefore are important in sustaining a number of GWDTE habitats found within the two local SSSIs. To the south and west is Sizewell Marshes SSSI (see **Figure 2.6**), a mosaic of habitats including marshy grassland, ditches, reedbed and wet woodland. Leiston Beck, located on the western boundary of the development platform, receives drainage from Sizewell Marshes and runs north, parallel with the coast, before joining the Minsmere New Cut, a large watercourse running west to east discharging to the sea approximately 2km north of the Sizewell C site (see **Figure 2.7** and **2.8**). North of the New Cut is an extensive area of reedbed forming part of the Minsmere to Walberswick SAC and Ramsar designation, whilst south of the New Cut is an area of wet grassland and ditch habitat forming part of the Minsmere to Walberswick SSSI (see **Figure 2.6**).

2.5.13. Of the habitats present, fen meadow and ditches are considered to be more likely to be sensitive to changes in the groundwater regime, as provided at **Appendix 19B**, of **Volume 2** of the **ES** (Doc Ref. 6.3). In terms of relevant WFD elements, aquatic plants, fish and invertebrates are considered sensitive to groundwater quantity. Fish are considered particularly vulnerable as they may tolerate fluctuations in water level but not complete drying out.

2.5.14. The groundwater levels in and around the main development site respond quickly to rainfall events and in response to pumping within the drainage system. In the western (upstream) part of the Sizewell Marshes, the peat groundwater level is slightly lower than the surface water levels indicating that surface water recharges the groundwater. In the eastern (downstream) part of the Sizewell Marshes, the groundwater levels appear to have a similar pattern of change in levels as the nearby surface water levels. During dry periods, the surface water level is slightly lower than the groundwater level.

2.5.15. This indicates that groundwater contributes to the surface water during dry conditions in the eastern (downstream) part of the Sizewell Marshes. This interaction between surface water and peat groundwater is also indicated by the hydrochemistry which indicates that the peat and surface water are of similar type and that the mixed water type within the peat are in locations close to Leiston Beck.

2.5.16. There is no evidence of tidal influence on the peat groundwater levels, whilst a tidal influence is observed in the Crag. This suggests that the peat and

Crag are in limited hydrostatic continuity although it is considered that, given the relative groundwater levels between the peat and the Crag, there is some upward flow from the Crag into the peat.

2.5.17. The hydrochemistry results indicate that a saline interface and therefore mixed water types are typical in the Crag beneath the Sizewell C main development site and Sizewell Marshes SSSI. However, it considered likely that a wedge of fresher calcium bicarbonate water will be present above the more chloride rich Crag water and that the chloride concentration typically increases with depth.

2.5.18. The silt and clay of the Alluvium and Lowestoft Formation (where present) are considered to present an aquitard limiting the vertical movement of groundwater between the Crag and peat aquifer. The more sandy and gravelly layers at the base of these Superficial Deposits are in some cases indistinguishable from the Crag Formation and as such are considered to be in hydraulic continuity with the Crag.

2.5.19. On a local scale, groundwater levels within the Crag aquifer will have an influence on shallower groundwater bodies within Superficial Deposits. Groundwater levels in the Crag are slightly elevated upgradient of Sizewell A and Sizewell B, and there is evidence of a greater presence of high moisture indicator species in this area. It should be noted that the water levels in both SSSIs are managed with surface water levels and therefore groundwater levels in the peat maintained using various siphons and weirs across the drainage network.

ii. Water quality

2.5.20. The Waveney and East Suffolk Chalk and Crag groundwater body is classified as being of Poor Chemical status, attributed to impacts from agriculture as evidenced by elevated nitrate concentrations in groundwater (Ref. 2.8).

2.5.21. Detailed information on groundwater quality data available as part of historic groundwater sampling and ongoing baseline monitoring is provided in **Appendix 19B** and in **Appendix 18A** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.22. In summary, groundwater and surface water samples were taken at 35 monitoring locations within the Sizewell C Site and surrounding area during October and November 2014. Surface water, accessible peat piezometers and Crag boreholes installed after 2013 were prioritised for sampling, with sampling also undertaken at additional locations to allow comparison with historical data collected in January and December 2011.

2.5.23. Groundwater samples were collected on 13 occasions between 2011 and 2012 and on nine occasions between 2014 and 2015. Water samples were tested for a range of parameters and contaminants of concern including pH, ammonia, ammonium, hardness, chloride, nitrate, cyanide, metals, polycyclic aromatic hydrocarbons (PAHs), BTEX (group of contaminants consists of benzene, ethylbenzene, toluene and three isomers of xylene), total petroleum hydrocarbons, polychlorinated biphenyls (PCBs), volatile organic carbons, semi-volatile organic compounds and phenols.

2.5.24. Elevated concentrations of inorganics including chloride, sulphate, ammonium, nitrate and sodium are widespread across the site thus indicating it is being affected by marine influences, as shown in **Appendix 18A** of **Volume 2** of the **ES**, (Doc Ref. 6.3).

2.5.25. Elevated concentrations of metals and inorganics were generally reported. Zinc, ammoniacal nitrogen, lead, boron, nitrate and chromium were reported as elevated and were widespread across the site. Elevated concentrations of BTEX, PAHs and volatile organic carbons (solvents) were generally reported within the same order of magnitude or one order of magnitude above the applied water quality standard and considered marginal with the exception of fluoranthene, benzo(a)pyrene, anthracene and hexachlorobutadiene, as shown in **Appendix 18A** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.26. **Table 2.16** summaries water quality data for the groundwater body (Ref. 2.1) relevant to the dewatering assessment presented within this WFD Compliance Assessment.

Table 2.16: Summary of water quality data for the groundwater body

Parameter	Mean dissolved concentration $\mu g l^{-1}$	95% dissolved concentration $\mu g l^{-1}$
Arsenic	3.55	11.5
Cadmium	0.10	0.18
Chromium	6.39	18.45
Copper	1.87	4.25
Lead	1.07	1.07
Zinc	7.34	17.5
Mercury	0.013	0.023
Iron	395	1500
DIN	3.55	5636
N	5557.2	-

c) Baseline for the Leiston Beck water body for quality elements at risk

i. Hydromorphology

2.5.27. The main development site is predominantly located within the Leiston Beck WFD water body (**Figure 2.7**). The main channel of Leiston Beck travels through the proposed development site between the Sizewell C platform and the temporary construction area and will flow through the proposed access road and SSSI crossing.

2.5.28. As described in the Sizewell C Main Development Site: Surface Water Conceptualisation (Ref. 2.12), the surface watercourses in the area are typical of lowland, low energy drainage systems. The low, flat valleys of this river system are naturally wet, and have been extensively modified by human activities including the enlargement and diversion of the main river channels, and the construction of a complex network of interconnecting drains throughout the floodplain on the valley floor. As a result of these modifications, the watercourses have uniform, trapezoidal channels with steep banks and very little geomorphological diversity.

2.5.29. The dominant geomorphological processes are sediment deposition and, when flows have sufficient energy, sediment transport. The channel and banks are heavily vegetated and fine sedimentation on the bed is prevalent. Flows are generally low although they increase rapidly in response to rainfall and are frequently reversed as a result of tide locking at Minsmere sluice.

2.5.30. Leiston Beck discharges to the sea at Minsmere sluice to the north. Flows in the Leiston Beck are influenced by the consented discharge of treated effluent from Leiston Waste Water Treatment Works, as shown at **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3). Details of the sluice are discussed further in **section 2.5d** of this report.

2.5.31. Water levels in the surface drainage network are controlled and regulated by the operation of control structures such as sluiced pipes, siphons, stop boards, and the tidal sluice at Minsmere. Water levels are managed so that they stay within a relatively narrow range, although there are variations between the spring-summer and autumn-winter seasons.

2.5.32. As a result of the hydrology of the peat and Crag deposits which underlie the site, the surface waters are strongly influenced by water levels and flows within the groundwater system. The surface and groundwater systems both respond rapidly to rainfall, and there is strong hydraulic connectivity between the two systems. The surface water contributes to groundwater in the upstream parts of the Sizewell Marshes SSSI, and groundwater contributes to surface waters in the downstream parts of the SSSI. This means that any activities which affect surface or groundwater hydrology have the potential to affect the entire hydrological system, which should therefore be considered as a whole.

ii. Water Quality (physico-chemistry and chemical)

2.5.33. Water quality in the Leiston Beck water body is generally good. However, parts of Leiston Beck are affected by consented discharges from the Leiston Waste Water Treatment Works (which includes Combined Sewer Overflows (CSOs) from Leiston) and display elevated concentrations of ammonia, nitrate, nitrite and phosphate, as well as elevated water temperatures. WFD classification data (see **Appendix 2A** of this document) suggests that dissolved oxygen levels are also under pressure due to the influence of sewage discharges in the water body.

2.5.34. Leiston Beck is not currently reported as having high concentrations of priority substances or priority hazardous substances and is therefore at good chemical status. However, the upstream end of Sizewell drain is affected by road runoff, displaying elevated concentrations of total petroleum hydrocarbons and several specific pollutants or WFD priority substances.

2.5.35. Analysis of surface water samples for priority substances was undertaken from 2010 to 2011 at 16 monitoring locations. These were analysed for field parameters and multiple priority substances, including metals, ammonia and total petroleum hydrocarbons. Priority substances were not detected at all of the monitoring sites and this was attributed to the substances being closely bound to sediments, as provided at **Appendix 19B** of **Volume 2** of the **ES**, (Doc Ref. 6.3). A monitoring location at the drain along the southern boundary of Sizewell A was found to have particularly poor water quality conditions, with elevated tributyl tin and PAH concentrations. The distribution and concentrations of priority substances was reported to be influenced by the presence of the treatment works upstream and the amount of road runoff in the vicinity of Sizewell A.

2.5.36. Additional surface water samples were taken in November 2014 from the six surface water monitoring locations installed in 2013. Exceedances of metals and inorganic contaminants were identified in the majority of samples and overall it was concluded that water quality within the surface watercourses on and surrounding the site is moderate to poor.

2.5.37. Water quality in the Leiston Beck is influenced by the input of saline water from Minsmere sluice, which results in elevated salinity and sulphate levels in the surface waters. The refurbished sluice is deliberately operated to allow some saline intrusion into Leiston Beck and Scott's Hall drain at high tide.

iii. Biology

2.5.38. For the purpose of this WFD Compliance Assessment, only biological elements of relevance to WFD (fish, invertebrates and aquatic flora) are outlined below.

2.5.39. The Leiston Beck water body is classified at moderate ecological potential, with invertebrates classified as good ecological potential. Fish and aquatic fauna were not assessed in the most recent classification.

2.5.40. The Leiston Beck supports important assemblages of invertebrates and rare vascular plants. The drainage system has been designated for its nature conservation value in part as a result of these features. The southern parts of the water body (including the Leiston Beck and surrounding drainage units) comprise Sizewell Marshes SSSI, and the northern parts (including the drainage units that connect to the Minsmere New Cut) form part of the Minsmere to Walberswick Heaths and Marshes SSSI, SAC, SPA and Ramsar site, as provided in the **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10).

2.5.41. The Plants and Habitats Synthesis Report, provided at **Appendix 14B1** of **Volume 2** of the **ES** (Doc Ref. 6.3), identified that wetland habitats, particularly the fen meadow communities within Sizewell Marshes SSSI, are particularly at risk. Within these habitats, "ditches and associated aquatic plant assemblage" are identified as a specific Important Ecological Feature (IEF) vulnerable to alterations in hydrology and hydrogeology. The Plants and Habitats Synthesis Report also identifies lowland ditch systems as an important habitat feature within this water body.

2.5.42. Aquatic invertebrate sampling was carried out in a total of 33 ditches and other water bodies within Sizewell Marshes SSSI in September 2009. These features were sampled with a standard pond net for a 3-minute period by passing the net along the banks and over the beds of the shallower ditches. Large freshwater invertebrates were identified and returned to the water, with the rest of the sample preserved for later examination.

2.5.43. In 2014, water bodies were subjected to an aquatic invertebrate survey. Two sampling events occurred, June and August 2014. Each aquatic invertebrate sample was collected in accordance with the Murray-Bligh 3-minute sweep method (as used by the Environment Agency).

2.5.44. Overall, the ditches and drains present within the Leiston Beck water body vary in terms of macrophyte diversity and structure. The more open ditches typically support a greater macrophyte diversity and structural range. Aquatic plants characteristic of ditch networks of higher conservation value were recorded, the presence of which provides habitat for potentially important aquatic invertebrate assemblages.

2.5.45. Two scarce aquatic plant species were recorded in the ditches sampled (the Leiston Beck and the Sizewell ditch). These were Frogbit and Soft Hornwort, a nationally scarce aquatic plant. Nevertheless, it was noted that the ditches in this area do not support as diverse aquatic communities as elsewhere within the Sizewell Marshes SSSI, due to shading from dense riparian vegetation, highlighting the importance of regular ditch management in maintaining the aquatic flora, as seen in **Appendix 14A3** of **Volume 2** of the **ES** (Doc Ref. 6.3).

d) Baseline for the Minsmere Old River water body for quality elements at risk

i. Hydromorphology

Main channel

2.5.46. The main channel of the Minsmere Old River is located approximately 500m to the north of the proposed development at its closest point. There is a small area of overlap between the Minsmere Old River WFD water body catchment and the main development site, along the north-west boundary of the temporary construction area (**Figure 2.8**). While there are no surface water drains evident in this overlap area, it is possible that runoff from the site (unless mitigated) could impact on this water body.

2.5.47. As described in the Sizewell C main development site: Surface water conceptualisation (Ref. 2.12), the surface watercourses in the area are typical of lowland, low energy drainage systems. The low, flat valleys of this river system are naturally wet, and have been extensively modified by human activities including the enlargement and diversion of the main river channels, and the construction of a complex network of interconnecting drains throughout the floodplain on the valley floor. As a result of these modifications, the watercourses have uniform, trapezoidal channels with steep banks and very little geomorphological diversity. The dominant geomorphological processes are sediment deposition and, when flows have sufficient energy, sediment transport.

2.5.48. WFD classification data (see **Appendix 2A** of this document) suggests that populations of fish and are under pressure due to the presence of barriers to ecological continuity and physical modifications for land management.

Minsmere sluice

2.5.49. Minsmere Old River discharges to the sea at Minsmere sluice. Minsmere sluice is the most important structure governing the surface water drainage systems for Minsmere Old River water body (and the Leiston Beck water body). The sluice is divided into two chambers, each with its own gravity outlet culvert. The northern chamber receives flows from the Minsmere New Cut, while the southern chamber receives flows from Leiston Beck and Scott's Hall drain. When river levels exceed sea levels, water flows from river to sea. When sea levels exceed river levels, flow will cease, and water stored upstream of the sluice. Some ingress of seawater into the freshwater system has been factored into the design with further details of the structure and function of Minsmere sluice given in Sizewell Site C: Conceptual Site Model of the Hydrogeological Regime, as provided in **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.50. Water levels in the surface drainage network are controlled and regulated by the operation of control structures such as sluiced pipes, siphons, stop boards, and the tidal sluice at Minsmere. Water levels are managed so that they stay within a relatively narrow range, although there are variations between the spring-summer and autumn-winter seasons.

ii. Water Quality (physico-chemistry and chemical)

2.5.51. Water quality in the Minsmere Old River catchment is generally good. Water quality in the drainage systems surrounding the site has been monitored over several years and is outlined in **section 2.5c)**.

2.5.52. Water quality in the surface watercourses is influenced by the input of saline water from Minsmere sluice, which results in elevated salinity and sulphate levels in the surface waters. The refurbished sluice is deliberately operated to allow some saline intrusion into Leiston Beck and Scott's Hall drain at high tide.

iii. Biology

2.5.53. For the purpose of this WFD Assessment, only biological elements of relevance to WFD (fish, invertebrates and aquatic flora) are considered.

2.5.54. The Minsmere Old River water body is classified at moderate ecological potential, with invertebrates classified as good ecological potential and fish as poor ecological potential. Aquatic fauna were not assessed at element level in the most recent classification.

2.5.55. The Minsmere Old River water body surface water system supports important assemblages of invertebrates and rare vascular plants, as provided in **Appendix 14B1** of **Volume 2** of the **ES** (Doc Ref. 6.3). The drainage system has been designated for its nature conservation value as a result of these features. The eastern parts of the water body (including lower reaches of the Minsmere Old River main channel) form part of the nationally and internationally designated Minsmere to Walberswick Heaths and Marshes SSSI, SAC, SPA and Ramsar site, as shown in the **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10). The distribution of the sensitive invertebrate and plant species is closely connected to shading and is also likely to be influenced by water quality and quantity.

2.5.56. The Environment Agency have determined that the WFD water body is "at risk" from the following species: curly water-thyme (*Lagarosiphon major*), floating pennywort (*Hydrocotyle ranunculoides*), water primrose (*Ludwigia grandiflora*), a freshwater amphipod (*Dikerogammarus villosus*), North American signal crayfish (*Pacifastacus leniusculus*) and overall INNS pressures[5].

2.5.57. Furthermore, the water body is "probably at risk" from the following species: curly water-thyme (*Lagarosiphon major*), Himalayan balsam (*Impatiens glandulifera*), a mysid crustacean (*Hemimysis anomola*), Ponto Caspian shrimp (*Dikerogammarus haemobaphes*), red swamp crayfish (*Procambarus clarkii*), topmouth gudgeon (*Pseudorasbora parva*), virile crayfish (*Orconectes virilis*), water ferns (*Azolla filiculoides* and *Azolla caroliniana*), and water primrose (*Ludwigia grandiflora*)[4].

2.5.58. The water body is "probably not at risk" from the following species: Australian swamp stonecrop (*Crassula helmsii*), Canadian pondweed and Nuttall's pondweeds (*Elodea Canadensis* and *Elodea nuttallii*), Chinese mitten crab (*Eriocheir sinensis*), common carp (*Cyprinus carpio*), giant hogweed (*Heracleum mantegazzianum*), goldfish (*Carassius auratus*), Japanese knotweed (*Fallopia japonica*), Japanese knotweed / giant knotweed hybrid (*Fallopia x bohemica*), mysid crustacean (*Hemimysis anomola*), parrot's feather (*Myriophyllum aquaticum*), Ponto Caspian shrimp (*Dikerogammarus haemobaphes*), red swamp crayfish (*Procambarus clarkii*), rhododendron (*Rhododendron ponticum*) and zebra mussel (*Dreissena polymorpha*)[4].

2.5.59. Finally, the water body is "not at risk" from the following species: American oyster drill (*Urosalpinx cinerea*), Australian swamp stonecrop (*Crassula*

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[5] This information is taken directly form the Environment Agency's Data Catchment Explorer. Several species are listed in more than one risk category which is erroneous and will be updated in the next revision of the River Basin Management Plans.

helmsii), colonial tunicate (non-native *Didemnum spp.*), common cord-grass, Townsend's grass or ricegrass (*Spartina anglica*), giant knotweed (*Fallopia sachalensis*), leathery sea squirt (*Styela clava*), a marine tubeworm (*Ficopomatus enigmaticus*), parrot's feather (*Myriophyllum aquaticum*) and slipper limpet (*Crepidula fornicata*)[4].

e) Baseline for the Suffolk coastal water body for quality elements at risk

i. Hydromorphology

Geomorphology

2.5.60. The GSB is anchored in the north by the Blyth river jetties and in the south by the subtidal erosion-resistant Coralline Crag underlying the Thorpeness headland (**Figure 2.9**). The main morphological features are:

- The shingle beach.
- Two sandy, shore-parallel longshore bars.
- The Sizewell–Dunwich Bank.
- The Coralline Crag ridges that extend to the north-east from Thorpeness.

2.5.61. The intertidal beach is primarily comprised of shingle (i.e., gravel-sized material) with a smaller sand-fraction that is either mixed with shingle or exists as surface, or sub-surface, veneers. The seaward limit of the shingle beach is an abrupt beach-step that meets a sub-tidal, low sloping, sandy bed. This boundary demarcates the seaward limit of the shingle beach and indicates that cross-shore exchange of shingle occurs almost exclusively landward of the low-tide beach step.

2.5.62. Elements of all features listed are located within the WFD water body, including a proportion of the Sizewell-Dunwich Bank.

2.5.63. The low net rates of longshore transport Sizewell power stations frontage, which are due a balanced bi-directional wave climate, give rise to very low rates of shoreline change. Net shoreline change rates are also low around the Minsmere sluice outfall, which acts like a long-groyne partially blocking longshore transport during storms. In contrast, there is persistent shoreline erosion approximately 1 to 2 km either side of the sluice.

2.5.64. Landward of the continuous shingle beach are cliffs (Dunwich – Minsmere and Sizewell – Thorpeness) or low-lying hinterlands (Walberswick Marshes

WFD water body and the Minsmere Levels). A shingle barrier / dune separates the Minsmere Levels from the sea along that frontage.

2.5.65. The subtidal beach is sandy and features an inner longshore bar 5-150m from the shore as well as a larger outer bar 200 – 400 m. The bars play an important role in dissipating wave energy (through wave breaking) and minimising wave angle at the shore / bar line (which controls longshore transport). During larger storms, when both bars are part of the surf zone, high suspended sand concentrations are transported along the bar crests and troughs forming a sand transport corridor during storms.

2.5.66. Seaward of the bars, a 1200m wide channel (up to 9m deep) separates the coast from the Sizewell – Dunwich Bank. Whilst primarily sandy, muds are found in a narrow stretch just landward of the bank. Muddy sediments dominate the area to the north of the Dunwich end of the bank, whilst the bank itself is comprised of well-sorted fine-sands.

2.5.67. The erosion resistant Coralline Crag outcrops at Thorpeness form a shallow platform and a series of descending shallow ridges that extend seaward (north-east) to Sizewell Bank. These ridges are exposed or only thinly covered in sediment. The presence of the Crag at Thorpeness fixes the location of the headland, which subsequently controls the local tidal streams that maintain the bank's stable form. The Coralline Crag outcrops between Thorpeness and the bank, and on the seaward side of the bank; its presence underneath the bank may have influenced its initial formation and its stability.

Tides

2.5.68. The tidal currents in the region are strong highly rectilinear (i.e., north – south). Typical spring tidal velocities near Sizewell are $1.2ms^{-1}$. The tidal range increases from north to south across the region with spring tides from 1.9m at Lowestoft, 2.2m at Sizewell and to 3.5m at Felixstowe. Water movement is dominated by tidal currents that flow south for most of the rising (flood) tide ($1.14ms^{-1}$ (peak) seaward of Sizewell Bank) and flow north for most of the falling (ebb) tide ($1.08ms^{-1}$).

2.5.69. The strong tides and generally shallow bathymetry combine so that the water column is thermally well mixed throughout the year. As expected, tidal currents reduce close to shore and are about $0.2ms^{-1}$ (peak) within 50m of the coast.

Waves

2.5.70. The offshore wave climate at Sizewell is monitored with a Datawell directional wave recorder buoy, which is deployed offshore (approximately 1km) from Sizewell Bank in 18m of water.

2.5.71. The main features are:

- The largest fetch is towards the north (order of 3,000km), and the largest waves propagate from this direction as would be expected.
- South-easterly waves are mostly generated by winds from the south-southeast sector and have a much shorter fetch (up to approximately 150km) and are therefore typically smaller than waves from the north;
- The offshore wave climate is bidirectional with the most frequent waves propagating from northeast (23.16%), south (20.25%) and southeast (15.13%). For wave heights more than 2m, the dominant direction is east northeast. Additionally, most waves (93%) have periods less than 8 seconds.

2.5.72. To determine the inshore wave climate, data collected for the period November to December 2013 was used. The main features of the inshore wave climate are:

- Offshore waves from the north refract toward the shoreline and frequently arrive at the coast with a north-easterly approach.
- The Sizewell-Dunwich Bank is not uniform in height, and the distance from the bank crest to the measurement points varied with the wave direction.
- Wave heights were up to 40% greater at the northern monitoring point than the southern monitoring point when waves approached from the southeast and up to 20% greater at the southern monitoring point when waves were from the northeast.

Sediment transport

2.5.73. The primary potential sources of new sediment entering the water body are the Minsmere – Dunwich cliffs (within the embayment) and the Easton – Covehithe cliffs (2.5 – 10.5km north of the embayment). These cliffs comprise unconsolidated pre-glacial (Pliocene to early / mid Pleistocene) marine sediments (Norwich and Red Crag) that are weakly bound and are predominately sandy, although some beds contain gravel and mud deposits.

2.5.74. Although severely eroding in the 19th and early 20th centuries (up until 1926), the Minsmere – Dunwich cliffs erosion rate more than halved in 1926-1970, since then they have been stable and contributed almost no new material to the coastal system.

2.5.75. In comparison, the Easton and Covehithe cliffs are actively eroding and releasing sand into the coastal system. Utilising data on cliff composition and topographic elevation the sediment volumes released under different sea level scenarios were calculated to show a rise from the measured value 178,500 m^3yr^{-1} in 1992-2008, to 270,100 m^3yr^{-1} under a 4.4 $mmyr^{-1}$ sea level rise for 2008-2050 and rising again to 299,500 m^3yr^{-1} for 6.7 $mmyr^{-1}$ sea level rise for 2050-2095 (Ref. 2.13).

2.5.76. Within the water body, modelling shows inside of the Sizewell-Dunwich Bank, there is a net southward sediment transport between the Minsmere-Dunwich cliffs and Sizewell (Ref. 2.14). On the seaward side of the Bank, the net transport is also southward, except along the south-eastern flank where sediment patterns and modelling results show localised northward transport (**Figure 2.10**). Bedload and suspended load converge at Sizewell Bank, as well as a weaker convergence around Dunwich Bank, which may provide a potential mechanism for bank maintenance.

2.5.77. The net transport rate and residence times of shingle in the Sizewell Bay area were also assessed in BEEMS Technical Report TR311 (Ref. 2.13) and to summarise, the findings indicate that shingle is, in net terms, effectively static. It is not lost to the subtidal nearshore and moves very slowly in the longshore transport system.

ii. Physico-chemistry

Temperature

2.5.78. Seawater temperature data are not specifically available for the Suffolk coastal water body on the Environment Agency's Data Catchment Explorer. As a result, BEEMS Technical Report TR306 (Ref. 2.1) uses information from the Cefas Coastal Temperature Network.

2.5.79. Seawater temperature trends at Sizewell follow a seasonal cycle with winter minimum temperatures of approximately 4ºC occurring in February. Temperatures rise throughout the spring and peak in summer with temperatures in August reaching a maximum of 20ºC in 2014.

2.5.80. Yearly average temperatures were derived from years. (1963-2013) with complete sets of monthly values at locations in the Suffolk coastal waterbody.

The 98th percentile, temperature for the five- year period from 2009 – -2013 is 19.4°C.

Dissolved oxygen

2.5.81. Monitoring of dissolved oxygen levels at Sizewell has shown levels range between 7 and 11mgl^{-1}. Minimum summer dissolved oxygen values were recorded in July 2015 (6.96–7.04mgl^{-1}) but remained well above the WFD threshold for ‘high’ (Ref. 2.1).

Nutrients

2.5.82. The availability of inorganic nutrients influences the growth of phytoplankton populations. Nitrate and phosphate are the primary limiting nutrient, silicate is also important for diatoms, which dominate the phytoplankton off Sizewell.

2.5.83. Inshore waters off Sizewell have higher nutrient concentrations than waters further offshore. The highest nitrate and silicate concentrations occur between January and March and at Sizewell, nitrate concentrations of 30µmoll^{-1} (equivalent to 420µgl^{-1} NO_3-N) have been reported. In July and August, the concentrations of nitrates were the lowest (5µmoll^{-1}). All nutrients decrease in concentration in the summer and autumn months and show peak concentrations in the winter and spring months (Ref. 2.1).

2.5.84. During the winter months, light is limited, and phytoplankton growth occurs in spring when nutrients are available, temperature increases, and light is no longer limiting.

2.5.85. At Sizewell, a Combined Phytoplankton and Macroalgae (CPM) model determined that light limitation is the primary factor limiting growth until mid-May, at which point nutrients start to become limiting. Initially phosphate is the primary limiting factor, however, this is very short-term, and the system enters a period of nitrate limitation until August when light limitation reoccurs as the primary limiting factor controlling phytoplankton growth (Ref. 2.1).

2.5.86. The WFD classifies water bodies based on the 99th percentile winter DIN concentration in relation to the turbidity of the water body. However, it should be noted that the WFD Suffolk coastal water body is classified as ‘moderate’ potential for DIN.

2.5.87. The mean phosphate concentration is 33.48µgl^{-1} (Ref. 2.1).

Suspended solids

2.5.88. Suspended sediment concentrations (SSC) from seabed mounted instrumentation deployed 500m off the coast adjacent to the proposed Sizewell C station recorded the daily minimum, mean and maximum SSCs (**Table 2.17**). High levels of SSC are driven by both high wave energy events and peak spring tidal currents. Minimum observations are observed when neap tides coincide with low wave energy. The difference between daily maximum and minimum suspended load is approximately 300mgl^{-1} at 1m above the seabed and 500mgl^{-1} at 0.3m above the seabed.

Table 2.17: Suspended solids concentrations within the WFD water body (Ref. 2.1)

Parameter	Suspended solid concentrations 0.3m above the bed (mgl^{-1})	Suspended solid concentrations 1m above the bed (mgl^{-1})
Daily minimum	24-28	16-18
Daily mean	103-161	72-105
Daily maximum	357-609	266-459

2.5.89. Background concentrations in relation to Biological Oxygen Demand (BOD) were collected during the 2010 monitoring and equate to a mean value of 2mgl^{-1} (Ref. 2.15).

iii. Chemistry

Water quality

2.5.90. Under the WFD, chemical status is assessed by compliance with environmental standards for the priority chemicals that are listed in the EC Environmental Quality Standards Directive (2008/105/EC), as amended by Directive 2013/39/EU (implemented by the WFD (Standards and Classification) Directions (England and Wales) 2015) which increased the list of priority chemicals to 45. Chemical status is recorded as 'good' or 'fail'. The chemical status classification for the water body is determined by the worst scoring chemical.

2.5.91. For the WFD, certain substances that are regarded as the most polluting were identified in 2001 as priority hazardous substances by a decision of the European Parliament and the Council of Ministers (Decision 2455/2001/EC). This first list of substances became Annex X of the WFD. This was replaced by Annex II of the Directive on Environmental Quality Standards (Directive 2008/105/EC) (EQSD), also known as the Priority Substances Directive, and this was further updated in 2013 by Directive 2013/39/EU. For these substances, Environmental Quality Standards (EQS) are determined at the European level and these apply to all Member States.

2.5.92. For other substances, standards may be derived by each Member State. This list of compounds or specific pollutants is defined as substances that can have a harmful effect on biological quality, and which may be identified by Member States as being discharged to water in “significant quantities”.

2.5.93. Relevant substances for the Sizewell C Project are as follows:

- ammonia;
- cadmium and its compounds;
- lead and its compounds;
- nickel and its compounds;
- chromium VI;
- copper;
- iron;
- zinc;
- boron; and
- chlorine.

2.5.94. In the marine environment, ammonia in both its ionised NH_4 and unionised NH_3 form may contribute to toxicity, although it is the unionised form that is the most toxic. Ammonia may be lost from water by volatilisation or under aerobic conditions may be oxidised to nitrite and then nitrate. Various water quality parameters influence the toxicity of ammonia, mainly by increasing the proportion of the most toxic, unionised NH_3 form.

2.5.95. The chemical status for the Suffolk coastal water body on the Environment Agency’s Catchment Data Explorer has not been assessed in either 2015 or 2016. Prior to this, Catchment Data Explorer lists a chemical status of good.

2.5.96. The baseline data used in BEEMS Technical Report TR306 (Ref. 2.1) to inform this WFD Compliance Assessment were derived from historic data contained in the scientific literature, water quality data from the Environment Agency and project specific monitoring collected to inform the Sizewell C

Project environmental assessments. Of the data collated by the Environment Agency, four locations are specifically monitored for WFD compliance within the Suffolk coastal WFD water body (see purple sites on **Figure 2.11**).

2.5.97. A project specific survey was undertaken at 12 stations extending approximately 12km to the north and south of the Sizewell B cooling water outfall and 3km offshore during 2010-2011 and 2014-2015. Samples were collected at the surface and at the seabed (see green sites on **Figure 2.11**) and spatial, tidal and seasonal surveys were undertaken.

2.5.98. Except for zinc, the mean measured concentrations of all the priority metals in the water samples were below their respective EQS' (see **Table 2.18**).

Table 2.18: Summary of marine water quality data for heavy metals against EQS (taken from Ref. 2.1)

Parameter	Sizewell background concentration μgl^{-1}	Marine EQS annual average μgl^{-1}	Marine EQS maximum allowable concentration μgl^{-1}
Arsenic	1.07	25	-
Cadmium	0.05	0.2	-
Chromium	0.57	0.6	32 (95 percentile)
Copper	2.15	3.76	-
Lead	-	1.3	14
Zinc	15.12	6.8	-
Mercury	0.02	-	0.07
Iron	50	1000	-

2.5.99. TRO concentrations from the surveys varied between 0.01 and 0.16mgl^{-1}. Analysis for hydrazine indicated that concentrations are below the limit of detection (0.01μl^{-1}). Bromoform was detected at station 5 (near the cooling water outfall of Sizewell B) at concentrations of 2–10μgl^{-1} and the majority of stations produced negative results for morpholine. The other conditioning product, ethanolamine, was not detected in any of the samples.

2.5.100. The EQS for un-ionised ammonia is 21μgl^{-1} as an annual mean concentration. The mean background concentration of un-ionised ammonia in Sizewell seawater was 0.2μgl^{-1} (calculated from average background salinity, temperature and pH and an NH_4-N concentration of 11.4μgl^{-1}) and is well below EQS concentrations. The 95th percentile NH_4-N concentration is 26.3μgl^{-1} (with a calculated un-ionised equivalent of 0.5μgl^{-1} NH_3-N).

2.5.101. Overall, the results of the water quality monitoring programme show that the concentrations are relatively uniform in the Suffolk coastal water body and the majority do not regularly exceed their EQS, the exception being zinc.

Sediment quality

2.5.102. As part of the Sizewell C 2015 geotechnical survey – provided at **Appendix 18A** of **Volume 2** of the **ES** (Doc Ref. 6.3) – samples were taken from 14 vibrocores (see **Figure 2.12**). These were analysed for chemical and heavy metal concentrations as follows:

- Heavy Metals – arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.
- Pesticides – DDT (dichlorodiphenyltrichloroethane) and dieldrin.
- Organotins – Monobutyl-tin, Dibutyl-tin, tributyltin.
- PCBs.
- PAHs.
- Total hydrocarbon content.

2.5.103. Particle size analysis was also undertaken.

2.5.104. The full data set is presented in BEEMS Technical Report TR305 (Ref. 2.16) with a summary provided here.

2.5.105. Particle size analysis showed that most of the samples are comprised mainly of sand. The exception is at several depths at VC30 where a much higher level of silt / clay was recorded.

2.5.106. Metals data indicates that some samples exceed Cefas Action Level 1, specifically in relation to arsenic, chromium and nickel. However, the majority of these exceedances are marginal (i.e. close to the Action Level 1 concentration), the exception being two arsenic concentrations at depth recording 85mgkg^{-1} (VC18 at 2m) and 92mgkg^{-1} (VC30 at 5m). Both were recorded in the area of the BLF although samples taken above in the same cores indicated much smaller concentrations. Elevated levels of arsenic are, however, typical of this region of the southern North Sea and are associated with estuarine and geological inputs and seabed rock weathering. The higher levels of silt in the core could also explain the increased concentrations. There were no exceedances of Action Level 2. In relation to organotins, all data recorded levels below the limit of detection.

2.5.107. Data for total hydrocarbon content and PAHs indicates some exceedances of Cefas Action Level 1 but again most are marginal. There are relatively elevated concentrations at depth at VC30 located in the BLF area but these levels appear to be isolated to this specific core. The highest concentration of total hydrocarbon content recorded within this core was 429mgkg^{-1} at 5m.

2.5.108. PCBs, DDT and Dieldrin all indicated very low or below the limit of detection.

iv. Biology

Benthic ecology

2.5.109. To inform the biological baseline, data were collected during a series of onshore and offshore surveys implemented between 2008 and 2018 (see Ref. 2.17 for further detail). These included the following surveys:

- eleven subtidal grab and trawl surveys carried out over a seven-year period with quarterly sampling in 2008 and 2011 / 2012, annual sampling in June for 2009 and 2010 and in September for 2014; a total of 890 grab samples, 295 2m-beam trawl samples and 64 otter trawl samples were obtained;
- one survey of the shallow sublittoral area undertaken in September 2011 (40 grab samples);
- one survey of the intertidal undertaken in August 2011 (12 quadrat samples);
- 202 collection dates on which estimates of the number of invertebrates impinged on the cooling water screens were made as part of the Comprehensive Impingement Monitoring Programme undertaken at Sizewell B between February 2009 and October 2017;
- the continuous monitoring of the salinity in a coastal lagoon in Minsmere between July 2014 and May 2015;
- three surveys carried out between 2016 and 2018 using an ARIS 3000 acoustic imaging camera to provide high resolution surface imaging in highly turbid waters to assess the presence of *Sabellaria* reef; and
- an additional multibeam echosounder survey was completed in September 2018 to provide comprehensive benthic surface data for the extent of Coralline Crag habitat.

2.5.110. To summarise, the intertidal beaches of the area are predominantly coarse sediment with ephemeral sand veneers harbouring a reasonably broad range of sediment-dwelling organisms.

2.5.111. A total of 51 benthic taxa were recorded during the study, but many taxa were found infrequently (between 9 and 21 taxa found per location). *Turbellaria*, juvenile gammarid amphipods, nemerteans and juvenile *Mytilus edulis* dominate the macrobenthic assemblages, comprising 94% of the total abundance. The total density of macrofauna organisms varied from about 100 to 8500 individuals per m^2 between the sampling locations and showed high natural variability in each sampling area.

2.5.112. Comparison with historical data (Ref. 2.18) suggested no notable change in the fauna of the beaches over time, thus, the overall picture is of moderate energy shores composed of a matrix of gravel and sand, populated by patchy, low abundance and low biomass infauna assemblages more tolerant of the dynamic physical environment. The beaches are very dynamic, and the proportions of surface sand will change with tides and weather events. Consequently, the biology can be expected to be patchy and unstable over time, particularly in the southern half of the bay, south of Thorpeness, where there is no coastal sandbank to protect the shore from wave energy.

2.5.113. The subtidal surveys indicate that there is one overall infaunal and epifaunal community spanning most of the bay, but there is some evidence that a subset of taxa, recorded in very high abundances, have spatial affinity for specific localities within the study area, i.e. samples with higher abundance value of a given taxon are found across a restricted area within the study area. The distributions of these taxa appear to be structured in part by sediments, local morphological features and dynamic coastal processes.

2.5.114. The epifauna data suggest that different environmental drivers, likely related to the water column, affect hyperbenthic organisms (living in the water column above the seabed). These taxa are ubiquitous compared to the epibenthic taxa and the infauna taxa, which show spatial affinities within the bay. Both the infauna and epifauna communities are typical in a regional context as they are part of a larger community distributed across the south of the North Sea ‘infralittoral region’, corresponding to the subtidal areas within 50m depth. The abundant taxa found in the GSB have a high reproduction rate suggesting that infaunal populations are resilient.

2.5.115. Note that benthic algae are not present to any notable degree in southern East Anglian coastal waters (Ref. 2.17).

2.5.116. In May 2019, a pre-ground investigation survey collected side scan sonar data. Interpretation of data indicated the possibility of *Sabellaria spinulosa* reef like formations and a dedicated survey of the highly turbid offshore Coralline Crag, using acoustic methods, confirmed the presence of *S. spinulosa* reefs in the area where southern intake structures would be located – see **Chapter 22** of **Volume 2** of the ES (Doc Ref 6.3).

2.5.117. The benthic infauna living in the Sizewell-Dunwich sandbank shows low species richness and low abundances, as well as a low level of variability. However, settlement events, associated with an important increase in secondary production over the spring and summer months, have been recorded in the trough and on the flanks of the sandbank, suggesting a potential important feeding area for higher trophic levels.

2.5.118. Acoustic remote sensing (swath bathymetry and backscatter data – 2008 / 2009 surveys) and grab sampling (2008 to 2012) were combined within a Geographical Information System (GIS) to derive the benthic habitat maps for the GSB (Ref. 2.17). This found that most of the seabed was covered by a layer of fine sand. More muddy sediments were found in the deeper area between the shoreline and the Sizewell-Dunwich (sand) Bank and coarse sediment (mixed with fine sand) was found inshore close to the shoreline. Bedrock was observed off Thorpeness extending in a north-easterly direction. In the southern part of the survey area exposed clay deposits and areas of coarse sediment occur.

2.5.119. The distribution of these seabed characteristics has been integrated under the Level 4 European Nature Information System habitats maps and include the following six classes (see **Figure 2.13**):

- A4.13 - Mixed faunal turf communities on circalittoral rock;
- A5.13 - Infralittoral coarse sediment;
- A5.23 - Infralittoral fine sand;
- A5.26 - Circalittoral muddy sand;
- A5.33 - Infralittoral sandy mud; and;
- A3.43 - Infralittoral mixed sediments.

2.5.120. The presence of *S. spinulosa* was assessed in BEEMS Technical Report TR473 (Ref. 2.19). This work concluded that *S. spinulosa* polychaete reef structures are likely to be present upon and around the Coralline Crag and that these formations show a degree of temporal persistence. There is insufficient evidence to say conclusively whether these reef structures meet the three criteria to be classed as Annex I Reef habitat. However, it is considered likely that biogenic reef habitats exist (Ref. 2.19).

2.5.121. Survey data were used also to compute the WFD benthic infaunal status of coastal waters using the approach developed by the United Kingdom Technical Advisory Group (UKTAG) as a status classification for benthic invertebrates is not available on the Environment Agency's Data Catchment Explorer (Ref. 2.17). The Infaunal Quality Index is a multi-metric index expressing the ecological health of benthic macroinvertebrate (infauna) assemblages. The metric encompasses a high amount of information on how macroinvertebrate assemblage changes within the marine environment as its calculation relies on selected metrics and incorporates each metric as a ratio of the observed value to that expected under reference conditions.

2.5.122. The index operates on a scale of zero to one: zero reflecting ecological quality under extreme anthropogenic disturbance and one representing ecological quality where anthropogenic disturbance is absent or negligible (Ref. 2.20). The Infaunal Quality Index is the recommended indicator to assess the ecological status of the macrobenthic invertebrate and infaunal assemblages of sediment habitats in UK coastal and transitional water bodies. According to the WFD Ecological Quality Ratio (EQR) scale, the results show that the GSB community is classified as having moderate to good status.

2.5.123. WFD baseline information on Data Catchment Explorer indicates that the Suffolk coastal water body supports the habitats shown in **Table 2.19**. Given the above biotope assessment, the habitats potentially at risk are the lower sensitivity habitat 'subtidal soft sediments' and higher sensitivity habitat, 'polychaete reef'.

Table 2.19: Summary of WFD habitats in the Suffolk coastal water body (Ref. 2.8)

Higher sensitivity habitats	Areas (ha)	Lower sensitivity habitats	Areas (ha)
Polychaete reef	11.57	Cobbles, gravel and shingle	1929.57
Saltmarsh	197.49	Intertidal soft sediment	816.46
-	-	Rocky shore	1.78
-	-	Subtidal soft sediments	10568.96

Phytoplankton

2.5.124. Information presented in BEEMS Technical Report TR385 (Ref. 2.21) outlines that there is a strong seasonal signal in phytoplankton concentration in the area; the peak of the spring bloom occurs in early May, with a period of rapid growth beforehand and rapid mortality thereafter. The seasonal cycle of phytoplankton standing stocks at Sizewell can be characterised as follows:

- Winter - nutrient availability is high but phytoplankton biomass is limited in a sediment dominated system with low light and low water temperatures.
- Spring – Sediment loading decreases, and temperature and light availability increases. Phytoplankton are then able to effectively utilise the nutrients which have accumulated during the winter. Phytoplankton biomass increases quickly until a peak is reached in late May (the "spring bloom"), at which point essential nutrients become limiting, even in the relatively nutrient-rich coastal waters. During the spring bloom, chlorophyll a can reach $10\mu g l^{-1}$ around Sizewell with mean cell abundance peaking at $2x10^6$ cells per litre. Following the peak in biomass, reductions in nutrient availability and grazing cause reductions in the standing stock.
- Summer / Autumn – Phytoplankton populations persist and grazing and nutrient recycling occurs. Late summer storms can recycle nutrients but lead to increases in turbidity. A secondary bloom may occur if sufficient light is available before biomass declines towards Winter.

2.5.125. Monthly phytoplankton monitoring data from the GSB has been collected to characterise the baseline environment and is detailed in BEEMS Technical Report TR476 (Ref. 2.22). As the nearest WFD monitoring locations are approximately 29km to the north and 12.5km to the south of Sizewell B, the new data was used to compute the WFD phytoplankton status of coastal waters at Sizewell, using the approach developed by the UKTAG as a cross check against the Environment Agency's index for the wider area. Phytoplankton measurements from two sites were used; a site located approximately 5.8km north of Sizewell B; and a site close to the Sizewell B intakes.

2.5.126. Phytoplankton status was assessed using data collected from March 2014 to December 2016. The phytoplankton tool combines metrics for chlorophyll a during the growing season (March to October, inclusive), elevated counts, and seasonal succession.

2.5.127. Averaging all three metrics gave an overall final score of 0.69 for the reference site, which equates to an assessment outcome of 'Good' status and 0.80 for the intake site which equates to high status. It is therefore concluded that the data obtained are very similar to the recent assessments carried out by the Environment Agency at sites to the north and south of

Sizewell between 2013 and 2016, which ranged between 0.71 and 0.74 with a classification of 'good' status (Ref. 2.22).

Fish

Data

2.5.128. Full details of the data collected and their analysis can be found in BEEMS Technical Report TR345 (Ref. 2.23), which provides a comprehensive study of the fish fauna of the GSB area based on data collected during impingement sampling from the Sizewell B cooling water system and from a series of coastal fishing surveys. The datasets used within the report are as follows:

- impingement sampling at Sizewell B between 2009 and 2017 (Comprehensive Impingement Monitoring Programme);
- ten demersal fishing surveys carried out over a four year period; quarterly in 2008, once each in June 2009 and June 2010, and quarterly between June 2011 and March 2012. Sampling was conducted using two different fishing gears – a 2m beam trawl and a commercial otter trawl;
- a coastal pelagic fish survey carried out in March and June 2015; and
- additional information from sources such as sampling undertaken during the operation of the Sizewell A station, characterisation studies for other marine developments in the local area, inshore fishing surveys off the Suffolk coast and international stock assessments.

2.5.129. A total of 88 fish taxa were identified in the GSB area. 40 species were identified in the 2m beam trawl catches, 25 in the commercial otter trawl catches and 71 species were identified during impingement sampling.

Demersal community

2.5.130. Of the demersal species recorded, Dover sole (*Solea solea*) and whiting were extremely frequent in the impingement dataset, occurring in over 90% and 96% of the impingement samples, respectively. Gobies, dab (*Limanda limanda*) and flounder (*Platichthys flesus*) were also generally common: all three taxa were recorded in over 90% of the impingement samples. Other demersal species occurring in more than 80% of the impingement samples were Nilsson's pipefish (*Sygnathus rostellatus*), lesser weever (*Trachinus vipera*), and bass (*Dicentrarchus labrax*).

2.5.131. In the offshore samples, Dover sole was the most commonly occurring species overall, present in 68% of beam trawls and all the otter trawl samples.

Whiting was found in a third of the beam trawls and 60% of the otter trawls. Gobies, dab and flounder were also generally common: dab were recorded in two thirds of otter trawls and 13% of beam trawls, gobies in nearly half of the beam trawls and flounder in 75% of the otter trawls. Thornback rays (*Raja clavata*), were common in the otter trawls, being found in 75%, though they were rarely captured in the beam trawls.

2.5.132. Cephalopods were not common in either the offshore or onshore samples. Only a single species (the European common squid (*Alloteuthis subulata*)) was recorded in the coastal surveys; it occurred in 17 and 7 of the beam and otter trawl samples, respectively. Four species were impinged in Sizewell B, namely the little cuttlefish (*Sepiola atlantica*), the European common squid, the cuttlefish (*Sepia officinalis*) and the common squid (*Loligo vulgaris*), but only the little cuttlefish was present in more than 30% of the samples.

2.5.133. The most abundant taxa were also generally the most common. Of the demersal species in the impingement sampling, the four most abundant species were whiting (11% by abundance), bass (9%), sand gobies (4%) and Dover sole (2%). Both bass and the thin-lipped grey mullet *(Liza ramada)* were impinged in reasonably large numbers but were not a significant feature of the coastal surveys. However, the abundance of bass is seasonal with the majority of catches in the impingement dataset being made in the winter months.

2.5.134. In the offshore surveys, Dover sole dominated overall; it accounted for 28% and 39% of all fish caught in the 2m beam trawls in the original (2008 – 2010) and expanded (2011 - 2012) survey series and 48% and 25% in the otter trawl in the original and expanded series, respectively. Gobies were also highly abundant in the beam trawls (39% and 22% by abundance of the original and expanded survey series), but were not abundant in the otter trawl surveys, due to the large mesh size of the gear and small body size of the individuals. Whiting contributed 3% and 11% respectively, to the abundance of beam trawl samples in the original and extended survey areas. In the otter trawls, flounder, dab and thornback rays were also highly abundant.

2.5.135. Statistical analysis shows that there is very little evidence of consistent spatial patterns in the demersal fish community, suggesting that the fishes of GSB form one large homogenous community. The analysis showed that there was very little spatial pattern or consistency over time and that the species mix found at each site changed over time.

Pelagic community

2.5.136. The sampling gear used to characterise the demersal fish community may catch pelagic fish, particularly during deployment and retrieval; however, the gear is not specifically designed for this purpose. During the surveys, the following species were recorded:

- Atlantic herring *Clupea harengus*;
- European sprat *Sprattus sprattus*;
- anchovy *Engraulis encrasicolus*;
- mackerel *Scomber scombrus*;
- horse mackerel (scad) *Trachurus trachurus*; and
- pilchard *Sardina pilchardus*.

2.5.137. All six species were recorded in the Sizewell B impingement monitoring; collectively, they accounted for approximately 65% of the total numbers of fish caught, suggesting pelagics are common in the GSB area. Sprat was the most abundant, at 49% of the total fish catch, then herring at 16%.

2.5.138. From the acoustic data, pelagic fish were more abundant in waters further north off Minsmere than around Sizewell itself, although good numbers were found at Sizewell throughout the year. The fish aggregate in larger schools mainly at the edge of sandbanks during the winter and during the summer were more evenly distributed across the area, although the highest densities were consistently found more offshore. Schools were denser and smaller during the summer and, although variable between surveys and subareas, more than half of the pelagic fish biomass was found in the near surface waters (2-5m depth).

2.5.139. Analysis carried out for the East Anglia ONE offshore wind farm surveys of winter 2010 / 2011 (Ref. 2.24) suggests that while the species present in the bay mirror those found in the wider offshore region, there may be differences in relative distribution, at least at certain times of year. Anchovy was much more dominant in the wider region than in the Sizewell data, comprising 29% of the total catch (including non-target species) versus less than 1% of the Sizewell impingement catch, while at 14% offshore versus 49% in the Sizewell catch, sprat was much less prevalent. Pilchard was also more prevalent in the wider region, at least in November 2010. Only two pelagic species were caught; sprat, which dominated the catch (more similarly to the Sizewell data), and anchovy. On the basis of this evidence, herring and sprat are the most prevalent pelagic fish species around Sizewell.

Definition of key taxa

2.5.140. Based on socio-economic, conservation and ecological value criterion, 24 key fish taxa in the GSB were taken for assessment (Ref. 2.25). These are listed in **Table 2.20**.

Table 2.20: List of key fish taxa included in the assessment

	Fish taxa	Latin name
1	Sprat	*Sprattus sprattus*
2	Herring	*Clupea harengus*
3	Whiting	*Merlangius merlangus*
4	European bass	*Dicentrarchus labrax*
5	Sand goby	*Pomatoschistus minutus*
6	Dover sole	*Solea solea*
7	Dab	*Limanda limanda*
8	Anchovy	*Engraulis encrasicolus*
9	Thin-lipped mullet	*Liza ramada*
10	Flounder	*Platichthys flesus*
11	Plaice	*Pleuronectes platessa*
12	Smelt	*Osmerus eperlanus*
13	Cod	*Gadus morhua*
14	Thornback ray	*Raja clavata*
15	River lamprey	*Lampetra fluviatilis*
16	European eel	*Anguilla anguilla*
17	Twaite shad	*Alosa fallax*
18	Horse mackerel	*Trachurus trachurus*
19	Mackerel	*Scomber scombrus*
20	Tope	*Galeorhinus galeus*
21	Sea trout	*Salmo trutta*
22	Allis shad	*Alosa alosa*
23	Sea lamprey	*Petromyzon marinus*
24	Salmon	*Salmo salar*

2.5.141. Several taxa fall under more than one criterion and four taxa are important with respect to all three (Dover sole, herring, cod and plaice). Additionally, in the nine year Comprehensive Impingement Monitoring Programme, catches of four conservation species were extremely rare or non-existent. These included Atlantic salmon (0 fish), allis shad (one fish in 2009), marine lamprey (one fish in 2015) and sea trout (two fish in 2010).

Data for zooplankton

2.5.142. Two methods have been used to assess the type and numbers of zooplankton organisms as follows (for details of these survey techniques refer to BEEMS Technical Report TR318 (Ref. 2.26):

2.5.143. The BEEMS Comprehensive Entrainment Monitoring Programme at Sizewell B which took samples for 24 hours on 40 occasions over a 12 month period between May 2010 and May 2011.

2.5.144. Offshore plankton surveys using plankton sampling nets and sampled at the surface and various depths to the sea bed.

2.5.145. Over the twelve-month Comprehensive Entrainment Monitoring Programme surveys, 23 fish taxa were recorded as present, as either eggs, larvae, and / or small juveniles (see **Table 2.21**). Of these 23 taxa, eight species (dab, Dover sole, anchovy, flounder, sea bass, herring, Gobiidae, and sprat) are key taxa within the GSB area.

Table 2.21: Fish taxa by life history stage entrained at Sizewell B

Fish taxa	Latin name	Present as			Key species?
		Eggs	larvae	Juveniles	
Butter fish	*Pholis gunnellus*	✗	✗	✓	✗
Dab	*Limanda limanda*	✗	✗	✓	✓
Dover sole	*Solea solea*	✓	✓	✗	✓
Dragonets	Callionymidae	✓	✗	✗	✗
European anchovy	*Engraulis encrasicolus*	✓	✗	✗	✓
European flounder	*Platichthys flesus*	✗	✓	✗	✓
European sea bass	*Dicentrarchus labrax*	✓	✗	✗	✓
Garfish	*Belone belone*	✓	✗	✗	✗
Gobies	Gobiidae	✗	✓	✓	✓
Gurnards	*Trigla* spp.	✓	✗	✗	✗
Herring	*Clupea harengus*	✗	✓	✓	✓

Fish taxa	Latin name	Present as			Key species?
		Eggs	larvae	Juveniles	
Lesser weever fish	*Trachinus vipera*	✓	✗	✗	✗
Long rough dab	*Hippoglossoides platessoides*	✓	✗	✗	✗
Pilchard	*Sardina pilchardus*	✓	✓	✗	✗
Pipe-fishes / seahorses	Syngnathidae	✗	✓	✓	✗
Right eyed flatfish	Pleuronectidae	✗	✓	✗	✗
Rocklings	*Gaidropsarus* spp. / *Onos* spp.)	✓	✗	✗	✗
Sandeel	Ammodytidae	✓	✓	✓	✗
Sea snail	*Liparis liparis*	✗	✓	✗	✗
Solenette	*Buglossidium luteum*	✗	✓	✗	✗
Soles	Soleidae	✗	✓	✗	✗
Sprat	*Sprattus sprattus*	✓	✓	✓	✓
Witch	*Glyptocephalus cynoglossus*	✗	✓	✗	✗

2.5.146. Comparison of the entrainment data with those from the offshore plankton characterisation surveys confirmed that entrainment predictions calculated from samples taken from the inshore Sizewell B intake are relevant to the proposed Sizewell C intakes sited further offshore in deeper waters. Some eggs, larvae or juveniles could not be identified to species and were recorded as 'unidentified'. To ensure that the unidentified group was included in the estimates and predictions, the numbers of eggs, larvae and juveniles were re-allocated to the known species groups using the proportion of each species group to the total (minus the unidentified portion). To account for seasonality, this apportioning process was carried out monthly.

Eggs

2.5.147. The eggs of 12 fish taxa were encountered in the water taken from the Sizewell B forebay. Of these, anchovy and Dover sole made up the overwhelming (greater than 76 %) proportion. The Sizewell B numbers are shown in **Table 2.22**.

Table 2.22: Sizewell B entrainment numbers (after re-allocation of identified eggs)

Sizewell B entrainment numbers	Species
124,143,767	Dover Sole
123,239,720	European anchovy
12,352,555	Sprat
11,294,574	Rockling
10,357,745	Pilchard
4,694,916	European seabass
1,026,768	Gurnard
1,016,354	Dragonet
352,887	Garfish
36,116	Lesser weever fish
33,511	Long rough dab
33,398	Sandeels

Fish larvae

2.5.148. The larvae of 15 fish taxa were encountered in the Sizewell B forebay. Of these, gobies and clupeids (unidentified clupeids, sprat, herring and pilchard) made up 77.0 % of the larvae entrained. The results are provided in **Table 2.23**.

Table 2.23: Sizewell B entrainment numbers (after re-allocation of identified larvae)

Sizewell B entrainment numbers	Species
52,073,218	Sand goby
17,434,255	Sprat
7,781,056	Other gobies
6,999,619	Herring
3,611,703	Pilchard
1,644,325	Unidentified clupeids
1,108,154	Dragonets
777,113	Unidentified specimen
262,523	Sandeels
217,835	Dover sole

Sizewell B entrainment numbers	Species
185,055	Solenette
128,393	Right eyed flatfish
90,581	Witch
39,804	Pipe fishes
35,845	European flounder
35,535	Soles
34,005	Sea snail

Juvenile fish

2.5.149. Juveniles of seven fish taxa were entrained in Sizewell B. Of these, gobies and sprat made up the overwhelming proportion (~79 %). As with the larval component, the 'gobies' group was separated into a 'Sand goby' group and an 'Other gobies' group in the proportions 87%:13%. The results are provided in **Table 2.24**.

Table 2.24: Sizewell B juvenile fish entrainment numbers

Sizewell B entrainment numbers	Species
7,602,995	Sand goby
7,584,699	Sprat
1,969,535	Dab
1,136,080	Other gobies
986,334	Butter fish
144,512	Pipe fishes
50,379	Sandeels
34,114	Herrings

f) Baseline for the Walberswick Marshes coastal water body for quality elements at risk

2.5.150. A monitoring programme was implemented to ascertain the potential for plume-water incursion into the lagoons nearest to Sizewell (at Minsmere) and to provide evidence of potential future exposure during the construction, commissioning and operational phases of the Sizewell C Project (BEEMS Technical Report TR354 (Ref. 2.27) (see **Figure 2.14**).

2.5.151. A small brackish pond isolated and adjacent to the coast with no direct connection to the Leiston Beck was identified for monitoring to determine if there is connectivity between the pond and the sea, either via overtopping during periods of elevated tidal levels or high wave conditions or via percolation through the dune system. This pond was selected because it was the closest pond to the sea and the only pond to lie outside of the flood protection for the Minsmere reserve. This pond, therefore, is the local water body most likely to exhibit marine connectivity with the Suffolk coastal water body and is located close to the Walberswick Marshes coastal WFD water body.

2.5.152. Automated salinity and water temperature monitoring was undertaken between 30 July 2014 and 5 May 2015. No indications of overtopping were observed. The brackish nature of the pond water indicates that there is some limited seawater input and the measured changes in salinity indicate that saline water enters the pond slowly, mostly likely via slow percolation through the dune system that lies between the pond and the coast. As a result, there is the potential for an effect to arise due to Sizewell C if the plume (either chemical or thermal) affects the waters percolating through the dunes.

g) Future baseline

2.5.153. The baseline conditions outlined in **section 2.5f)** for the water bodies included in Stage 3 of the assessment are considered appropriate for the duration of the construction phase for the main development site. This is because the construction phase is predicted to last for approximately 9-12 years. However, because the development is likely to remain operational for a long period (e.g. up to 2100), there is therefore a need to consider the potential for changes to the baseline and account for them within this assessment.

2.5.154. Detailed descriptions of the likely future baselines are provided in the relevant topic chapters within **Volume 2** of the **ES** (Doc Ref 6.3) and are summarised here for ease of reference.

i. Groundwater bodies

2.5.155. Groundwater systems are naturally highly variable, with long-term trends in groundwater levels influenced by factors, such as changes in recharge caused by changes in land-use and agriculture practices, changes in land cover, particularly urbanisation, and changes in groundwater abstraction over time. They are therefore expected to respond to external factors such as climatic variations and land use change in a complex way. Wetter winters could potentially result in increased groundwater recharge, although because water from heavy storms tends to runoff directly to rivers and other surface watercourses, any increase could be limited. However, drier and warmer periods over spring and autumn could result in a shorter recharge season and an overall reduction in recharge.

2.5.156. As part of Defra's Water Abstraction Plan (Ref. 2.28), the Environment Agency will review and amend all existing abstraction licenses by 2027. It is predicted that abstraction will decrease and approximately 90% of surface water bodies and 77% of groundwater bodies will meet the required standards for chemical and quantitative status by 2021. Pressures on groundwater levels could therefore decrease in the future. However, predicted climate changes are likely to result in a future increase in temperature and therefore potentially increased demands on water supply, which could, therefore, have a detrimental effect on groundwater resources and groundwater abstraction.

2.5.157. Any changes to groundwater levels and recharge rates could also affect surface water resources and GWDTEs. In the medium to long-term, reduced precipitation is likely to lead to a reduction in water available for the wetland habitats of Sizewell Marshes SSSI and there may be a shift from fen meadow towards grassland communities. In the short-term, in the absence of cutting and grazing management, Sizewell Marshes SSSI would see rush species (*Juncus* spp.) and common reed (*Phragmites australis*) become more dominant and a gradual successional change from fen meadow to reedbed and eventually willow (*Salix* spp.) and alder (*Alnus glutinosa*) carr (wet woodland). The overall effects of climate change on habitat types and component plant species are however, uncertain – as shown in **Chapter 14** of **Volume 2** of the **ES** (Doc Ref.6.3).

2.5.158. Long-term changes in baseline groundwater quality have been documented as being due to other environmental and societal changes not related to climate change. For example, nitrate in groundwater has increased proportionately alongside increases in agricultural application of fertiliser. The effects of these other environmental changes are thought to be far more significant in terms of their impacts on groundwater quality than any direct effects from climate change (Ref. 2.29). Furthermore, an increase in sea levels could result in increased saline intrusion and the loss of groundwater resources in coastal areas.

2.5.159. The Waveney and East Suffolk Chalk and Crag groundwater body is currently under pressure from agricultural abstractions and nutrient supply from livestock management (**Appendix 2A**). Although a reduction in abstraction and improvements in land management practices could reduce pressures on groundwater, climatic changes could counteract any improvements in water body status. The status of the groundwater body is not therefore expected to alter significantly during the construction and early operational phases of the development and the potential effects of climate change and the permanent operation of the proposed development on ground and surface water levels have been included in the development of the groundwater model.

ii. River water bodies

2.5.160. Predicted climate changes under United Kingdom Climate Projections 2018 (UKCP18) are likely to result in wetter winters, drier summers and a greater number of convectional rain storms. This means that the hydrology of the river water bodies could change, with higher winter flows, lower summer flows and a greater number of storm-related flood flows. This in turn could result in changes to the geomorphology of the river systems, with increased geomorphological activity (e.g. channel adjustment) occurring in response to larger storm events. However, the predominantly stable and extensively modified nature of the WFD water bodies identified and their tributaries mean that significant hydromorphological adjustments are unlikely to occur during the operation of Sizewell C.

2.5.161. Any future initiatives to improve geomorphology, river continuity, fish passage and in-channel habitats undertaken by the Environment Agency and partner organisations to meet WFD status objectives could deliver localised improvements to hydromorphology and biology. However, the extensively modified and low gradient, stable nature of the surface drainage network means that significant improvements are likely to be spatially constrained to areas where direct interventions have been applied.

2.5.162. Continued efforts by the Environment Agency and partner organisations to achieve Good Ecological Status and Good Chemical Status over the next River Basin Management Planning cycles are likely to deliver improvements to water quality in the future. However, it is acknowledged that pressures from increased urbanisation and greater agricultural production, coupled with the long residence times of substances such as phosphates in the environment, could potentially limit the improvements that are realised within the operational lifetime of the proposed development. This means that the primary pressures on biology in the Minsmere Old River and Leiston Beck water bodies are unlikely to change during the operation of Sizewell C.

2.5.163. The biological quality elements in the Minsmere Old River are predicted to remain poor due to the unfavourable balance of costs and benefits required to improve the status of fish within the system. This is attributed to physical modifications such as hard barriers and land drainage for agriculture and rural land management. This means that, given the HMWB designation and the fact that hydromorphology already supports good potential, significant changes are unlikely to occur. Because biology is not predicted to improve, the ecological potential of the water body it therefore predicted to remain as moderate throughout the operational phase of the proposed development.

2.5.164. The physico-chemical quality of Leiston Beck is predicted to remain moderate due the continued consented discharge from the Leiston sewage treatment works. This means that phosphate levels within the system are likely to remain elevated and dissolved oxygen is likely to remain low. Furthermore, hydromorphological quality elements already support good potential and there are therefore unlikely to be significantly improvements in hydromorphology. The ecological potential of the water body is predicted to remain as moderate throughout all phases of the proposed development.

iii. Coastal and transitional water bodies

Hydromorphology

2.5.165. The future baseline for hydromorphology in the marine WFD water bodies would include increased relative sea level which is likely to increase overtopping, breaching, beach / cliff erosion and may increase rates of longshore transport. **Appendix 20A** of **Volume 2** of the **ES** (Doc Ref. 6.3) gives detail of the latest UKCP18 projections which show sea level rise of 0.76m at Sizewell by the end of operation. This could lead to an increase in sediment supply and could affect patterns and rates of shoreline change, and potentially the form and volume of the Sizewell – Dunwich Bank. There are four broad possibilities for future sediment supply, the following two are most likely (all four are detailed fully in **Appendix 20A** of **Volume 2** of the **ES** (Doc Ref 6.3)):

- Natural increase in sediment supply. A natural increase could occur if the beaches fronting Minsmere-Dunwich cliffs were eroded and/or as a result of expected increased erosion and sediment supply from the Easton / Covehithe / Benacre cliffs.
- Unnatural increase in sediment supply. This could occur if man-made structures were removed or fell into serious dis-repair (such as Minsmere Sluice Outfall and the Blyth river mouth jetties).

2.5.166. Wave energy at Sizewell is predicted to decrease by 3.3% for the annual mean significant wave height and by 12.3% for the annual maximum significant wave height by 2100. However, due to the importance of local weather in semi-enclosed North Sea, inter-decadal variability may be large.

Storm surge changes are very small (1mm increase per year for the 1-year return interval).

iv. Water Quality

Chemistry and Physico-chemistry

2.5.167. The southern North Sea is shallower with a faster warming rate than other areas of the UK. Climate predictions assume a linear increase in temperature which will be subject to increased uncertainty further into the future. Removal of the Sizewell B station will reduce the baseline temperatures.

2.5.168. Towards the end of the 21st century, ocean acidification causing a decrease in pH will influence chemical speciation and e.g. partitioning of ionised and un ionised ammonia favouring the less toxic ionised form.

2.5.169. It is not predicted, that concentrations of other substances will increase. There is the potential with the removal of the Sizewell B station that various parameters would reduce within the coastal water body.

Biology

2.5.170. The southern North Sea has seen cold water plankton species decline. Warmer water species have replaced some of the colder water species although they remain less abundant. It is acknowledged that whilst the exact species composition is likely to change, the effects on the structure and functioning of the community remain unknown.

2.5.171. In addition to distribution shifts, there has also been a change in the phenological cycles of plankton. It is therefore feasible that the spring bloom and peaks in plankton abundance at Sizewell may advance under a warming climate. However, climate driven trends advancing phenological cycles would be limited by day length and solar elevation preventing primary production in the relatively turbid coastal waters at Sizewell in the early spring. This may however, potentially extend the duration of the year that seasonal chlorination may need to be applied.

2.5.172. Phytoplankton growth in the permanently mixed regions of the North Sea, off the East Anglian coast have been least affected by temperature rises due to natural mixing (i.e. stratification is reduced) and the overriding effects of turbidity therefore annual primary productivity has been relatively consistent. Therefore, the baseline productivity of the system is not expected to change due to warming alone. The occurrence of some harmful algal bloom species is also considered more likely in the future due to climate change, driven by projected increasing sea temperatures

2.5.173. Biodiversity loss due to temperature rise is not expected in the southern North Sea and, therefore, the key taxa used in benthic ecology assessments are expected to be present in a future, warmer climate. The higher sensitivity habitat *Sabellaria spinulosa* reef is considered to have a low sensitivity to temperature rise in the UK, as it forms reefs in much warmer climates. However, warming is predicted to induce distributional shifts, with taxa moving northward as they follow shifts in their thermal niche. This is likely to increase the species pool in the southern and coastal areas of the North Sea due to northerly range expansions of southern species, thus potentially increasing the number of benthic invertebrate species.

2.5.174. Changes to hydrodynamics associated with increased storminess can influence the composition and functioning of benthic communities by altering larval dispersal patterns, causing mortality (e.g. disturbance during storm events, possibly associated with climate change) and modifying primary and secondary production. *S. spinulosa* reef is also considered to be susceptible to storms and may therefore be more or less prevalent if storminess changes in the future. Declines in water clarity in the southern North Sea due to increases in suspended sediments could also be exacerbated by increased storminess.

2.5.175. Rising sea levels have the potential to induce coastal-squeeze effects across the UK, with beaches becoming increasingly trapped between the sea and terrestrial barriers. Currently, sea-level rise on the Suffolk coast induces shoreline retreat and the release of sediment from the soft cliffs in the area between Lowestoft and Southwold, while the beaches of the GSB alternate between trends of erosion and accretion on the shoreline associated with the circulation of the sediment on the various littoral cells. The Sizewell-Dunwich Bank is likely to protect the coastline from major changes by attenuating the impact of wave energy in the long-term.

2.5.176. The 2017 Marine Climate Change Impacts Partnership (MCCIP) review on fisheries describes the changes expected in fish and fisheries with climate change and is described in detail in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref 6.3). To summarise warm-affinity species are likely to increase in abundance and cold-affinity species to decrease in abundance, with many cold-water species moving northwards. There are exceptions to this general trend, such as sole which has shifted distribution southwards and are able to remain in shallow North Sea waters all year around. Except for sole and whiting, the southerly distribution of all species is predicted to move northwards around the UK.

v. INNS

2.5.177. The spread of INNS with preferences for warmer water may also be encouraged where introduction has already occurred.

h) Detailed Assessment – C1 Initial Site Preparation

i. Introduction

2.5.178. This activity includes construction of new access road, temporary construction areas and SSSI crossings / main site access roads, excavation of borrow pits, stockpiling of materials, installation of the surface water drainage system, rerouting of ditches, installation of temporary site utilities, site clearance, preparation of temporary site infrastructure (including surface water drainage) and archaeological mitigation.

2.5.179. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.25**.

Table 2.25: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for C1

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (not in place)	415 661
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Waveney and East Suffolk	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River	N/A	78 116

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Chalk and Crag	Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			

2.5.180. A **CoCP** (Doc Ref 8.11) has been developed to guide the proposed construction works on the main development site and the associated development sites. This document is in three parts as follows:

2.5.181. **CoCP Part A: Site Wide Controls**: sets out the purpose and scope of the **CoCP** and describes the measures and procedures that are applicable across the Sizewell C Project. Part A would be applied across all Sizewell C construction works.

2.5.182. **CoCP Part B: Main development site**: describes the specific controls that apply to the main development site, and supplement and refine the controls set out in Part A.

2.5.183. **CoCP Part C: Offsite associated development sites**: describes the specific controls that apply to all the off-site associated development sites. This part to the **CoCP** is outlined in **Part 3** of this **WFD Compliance Assessment**.

2.5.184. The **CoCP** (Doc Ref. 8.11) aims to provide a clear and consistent approach to the control of Sizewell C construction activities, and to minimise impacts on people and the environment. The measures set out in the **CoCP** document follow best practice guidance and industry standards and include activity-specific measures identified through the assessment of environmental impacts in the **ES** for each topic. **Table 2.26** details the measures detailed within **Part 2** of the **CoCP** which are relevant to Activity C1.

Table 2.26: Summary of measures detailed within the CoCP which are relevant to the WFD Compliance Assessment

Environmental Statement topic	WFD Quality elements	Measure within the CoCP	Relevant water bodies
Terrestrial Ecology	Biology	When the Sizewell drain is realigned the section to be infilled will be subject to a fish and invertebrate rescue moving stranded individuals across to the new realigned drain.	Leiston Beck
	Hydromorphology, physico-chemistry, chemistry and biology	Stockpiling of sand and shingle substrates from the existing surface layers of the Sizewell C frontage would be stockpiled in accordance with the **Outline Soils Management Strategy** (**Appendix 17C** of **Volume 2** of the **ES**) and the **Outline Landscape and Ecology Management Plan** (Doc Ref. 8.2) to preserve the seedbank of the coastal vegetation and would be incorporated into the final landscaping of the new sea defence to enable reinstatement of the coastal vegetation.	Suffolk
	Hydromorphology, physico-chemistry, chemistry and biology	During the construction phase, the management and storage of spoil and other materials to have regards to the measures outlined in the **Outline Landscape and Ecology Management Plan**.	All water bodies
	Physico-chemistry, chemistry and biology	Guidance for Pollution Prevention (GPPs) will be followed for all works.	All water bodies
Soils and Agriculture	Hydromorphology, physico-chemistry, chemistry and biology	Earthworks: Ensure soils are stripped and handled in the driest condition possible.	All water bodies
	Hydromorphology, physico-chemical, chemistry and biology	Ensure protection of stockpiles from erosion and tracking over.	All water bodies
	Hydromorphology, physico-chemistry, chemistry and biology	All soils would be stored away from watercourses (or potential pathways to watercourses) and any potentially contaminated soil would be stored on an impermeable surface and covered to reduce leachate generation and potential migration to surface waters.	All water bodies

Environmental Statement topic	WFD Quality elements	Measure within the CoCP	Relevant water bodies
Geology and Land Quality (note that there is some overlap with surface and groundwater topic – if measures are the same, only listed once)	Hydromorphology, physico-chemistry, chemistry and biology. Groundwater quality	Additional ground investigation would be undertaken to inform the final design of the proposed development and to confirm the ground conditions and contamination status of the site	All water bodies
		Remediation of soil and groundwater contamination would be undertaken prior to construction (e.g. source removal, treatment or capping) if deemed necessary	
		Recording of any pollution incidents or contamination found either on- or offsite, and the action taken to resolve the situation.	
		Storage and stockpiling of made ground and natural materials separately and where necessary on impermeable surfaces and covered depending on the level of contamination.	
		All temporary stockpiles would be managed to prevent soil erosion, windblown dust and surface water run-off by methods such as capping, sealing or covering stockpiles, fencing, hydroseeding, dampening down and avoiding over stockpiling to reduce compaction of soil and loss of integrity.	
		The area and duration of soil exposure would be minimised and timely reinstatement of vegetation or hardstanding would be undertaken to prevent soil erosion and reduce temporary effects on soil compaction.	
		Appropriate pollution incident control e.g. plant drip trays, bunding and spill kits would be implemented	
		Appropriate and safe storage of fuel, oils and equipment would be implemented in accordance with the Environment Agency's guidance and best practice.	
		Appropriate working methods would be implemented during construction to ensure that there is no surface water run-off from the works or any	

Environmental Statement topic	WFD Quality elements	Measure within the CoCP	Relevant water bodies
		stockpiles into adjacent surface watercourses or leaching into underlying groundwater in accordance with best practice.	
Groundwater and Surface Water (note that there is some overlap with Geology and Land Quality topic – if measures are the same, only listed once)	Hydromorphology, physico-chemistry, chemistry and biology. Groundwater quality and GWDTE	A piling risk assessment may be required to assess the risk from the construction of the sheet pile retaining structure.	Waveney and East Suffolk Chalk and Crag
		Realignment of Sizewell drain - Updated **Water Level Management Plan** for Sizewell Marshes SSSI	Leiston Beck Waveney and East Suffolk Chalk and Crag (GWDTE)
		Realignment of Sizewell drain - The realignment will be engineered to prevent augmentation, or derogation, of groundwater flow.	Leiston Beck
		Realignment of Sizewell drain - A control structure will be implemented at the outfall of the Sizewell drain to manage water levels.	Leiston Beck and Waveney and East Suffolk Chalk and Crag (GWDTW)
		For earthworks and construction works - The wheels of all vehicles would be washed before leaving site. It is assumed that the wheels of all vehicles delivering materials to site would be washed on departure from their point of origin.	All water bodies
		Protection of watercourses - Buffer zones will be established adjacent to watercourses prior to commencement of work within 50m of a watercourse or within flood zones 2 or 3.	Leiston Beck and Minsmere Old River
		A risk assessment for all works within surface water buffer zones shall be carried out and for any use of cementitious materials within 50m of any active watercourse or within flood zones 2 or 3.	Leiston Beck and Minsmere Old River
		Concrete and cement mixing and washing areas would be situated at least 10m away from surface water receptors. These would incorporate settlement and recirculation systems to allow water to be re-used. All washing out of equipment would be undertaken in a contained area, and all water would be collected for off-site disposal.	Leiston Beck and Minsmere Old River

Environmental Statement topic	WFD Quality elements	Measure within the CoCP	Relevant water bodies
		Adequate drainage systems will be installed prior to construction works with appropriate treatment prior to discharge. This will include sediment treatment and the inclusion of oil separators where necessary.	Leiston Beck, Minsmere Old River and Suffolk
		The drainage system will be appropriately maintained throughout the works such that it remains efficient. Sediment would go to sediment lagoons.	Leiston Beck, Minsmere Old River and Suffolk
		Sustainable drainage - incorporate sustainable drainage measures such as swales, filter drains, detention basins and soakaways to promote infiltration.	All water bodies
		Measures taken to prevent the deposition of silt or other material arising from work operations in existing watercourse or catchment areas will accord with principles set out in industry guidelines, including Guidance for Pollution Prevention.	All water bodies
		Appropriate storage and disposal of wastes would be undertaken in accordance with current guidance.	All water bodies
		Foul water management – prior to construction of the CDO, foul water would be collected and tankered away offsite for suitable disposal. Following completion of the CDO, all water collected, treated and discharged from the CDO to the Suffolk coastal water body (see Activity C4)	All water bodies

2.5.185. Where required, the appropriate ecology monitoring methodologies are set out in the relevant protected species mitigation strategies and associated protected species licenses. Additional monitoring requirements relevant to the WFD Compliance Assessment include the following:

- Monitoring the establishment of the compensatory fen meadow habitats.
- Monitoring the establishment of coastal vegetation on substrate covering the hard sea defence.
- Development of a monitoring and mitigation plan for coastal processes effects to ensure, as far as possible, the maintenance of the extent of foreshore sediments covering the SCDF and the HCDF.
- Continuation of hydrological monitoring and botanical monitoring within Sizewell Marshes SSSI.

ii. Hydromorphology

2.5.186. As outlined in **Table 2.26**, there is a suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) which would prevent significant changes to hydrological and morphological conditions. These measures focus on controlling sediment release to the water environment where earthworks are required and the construction drainage system would be designed to ensure alterations to flows in the existing water bodies and associated tributaries or ditches within the water body catchment do not occur.

2.5.187. There could be a temporary interruption to river continuity during the realignment of the Sizewell drain but following completion, the realignment will be engineered to prevent changes to surface and groundwater flows.

2.5.188. Following implementation of the measures outlined in the **CoCP** (Doc Ref. 8.11), any impacts on the hydrological and geomorphological regime during construction are predicted to be insufficient to result in a change of the status of the hydromorphological quality elements supported in either Leiston Beck or the Minsmere Old River.

iii. Physico-chemistry (surface waters) and quality (groundwater)

2.5.189. As outlined in **Table 2.26**, there are a suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) would prevent significant changes to physico-chemical parameters. These focus on best practice measures to reduce the risk of pollution at source and if released in the environment are responded to quickly and appropriately to reduce the risk to the water environment.

Additionally, specifically in relation to groundwater quality, a piling risk assessment would be undertaken before any works commence to reduce the risk of introducing pollution pathways.

2.5.190. Following implementation of the measures outlined above, any impacts on the general physico-chemistry of surface waters during construction are, therefore, predicted to be insufficient to result in a change in status of the physico-chemical quality elements supported in either Leiston Beck or the Minsmere Old River. Furthermore, any changes to groundwater quality are also predicted to be insufficient to change the status of the Waveney and East Suffolk Chalk and Crag groundwater body.

iv. Biology

2.5.191. As outlined in **Table 2.26** there are a suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) that would prevent significant changes to the hydromorphology and physico-chemistry of surface waters and the quality of groundwaters. Furthermore, during the realignment of Sizewell drain, the section to be infilled will be subject to a fish and invertebrate rescue moving stranded individuals across to the new realigned drain.

2.5.192. As a result, effects on biology of Leiston Beck and Minsmere Old River are predicted to be insufficient to result in a change in the status of these water bodies.

v. GWDTE

2.5.193. As outlined in **Table 2.26**, the control measures embedded in the **CoCP** (Doc Ref. 8.11) would prevent significant changes to the quality of groundwaters or the hydromorphology, physico-chemistry of connected surface waters. There is therefore no mechanism for this activity to adversely affect the GWDTEs that these water bodies support.

2.5.194. Specific measures designed to prevent impact on GWDTEs include producing an update of the **Water Level Management Plan** for Sizewell Marshes SSSI, realigning Sizewell drain to prevent augmentation of groundwater flow, and installing a control structure at the outfall of the realigned Sizewell drain to manage water levels. As a result, effects on GWDTEs are predicted to be insufficient to result in a change in the status of the Waveney and East Suffolk Chalk and Crag groundwater body or connected surface water bodies.

vi. RBMP mitigation measures

2.5.195. For the surface water bodies scoped in for further assessment, only the RBMP mitigation measures for ‘sediment management’ (in place for Leiston Beck and not in place for Minsmere Old River) were identified as being at risk. However, given the control measures as outlined in **Table 2.26** and the output of the assessment for hydromorphology, the implementation or ongoing application of this RBMP mitigation measure in either water body would not be at risk. As a result, a change in water body status is not predicted.

vii. Protected areas

2.5.196. The only sub-activity that could impact on NVZs is the discharge of foul water on site (as considered in detail under Activity C4, **section 2.5k)**), which could release nitrates and other nutrients if discharged untreated to the water environment. However, all foul waters generated during construction would be collected in a self-contained chemical system and tankered off site for disposal. As such there will be no nitrate loadings released to the environment and therefore no effects on NVZs are predicted. As a result, a change in status is not predicted.

viii. Adjoining water bodies

2.5.197. Given that all effects outlined above would not give rise to a change in status in which the activities will be occurring, effects on adjoining water bodies are not predicted.

i) Detailed Assessment – C2 Earthworks for platform development

i. Introduction

2.5.198. The main development site would be raised above natural ground level, with embankments along its boundaries. At the toe of the western and northern embankments, immediately adjacent to the main development site, sheet piles would extend from ground level into the underlying geology, providing structural stability to the embankments. Along the perimeter, a low permeability cut-off wall would be constructed to isolate the main development site from the surrounding groundwater regime.

2.5.199. Within the cut-off wall, dewatering would lower groundwater levels across the main development site, enabling natural materials to be excavated and backfilled with site-won granular fill, and building foundations to be laid. The completed main development site would have a predominantly hardstanding cover, with site drainage discharging surface water directly to the sea.

2.5.200. Construction would therefore require deep excavations within the main construction area for the main platform as well as the raising of land levels to achieve the permanent platform height. This would require significant quantities of material for use as backfill. An area of borrow pits within the temporary construction area would be used to generate material for use as backfill and would be reinstated with materials determined to be geotechnically 'unsuitable' for re-use. Material storage in stockpiles, excavation of borrow pits, surface water management and accidental pollution associated with all main development site construction activities are considered in Activity C1 above. The presence of the completed main development site is considered in Activity O1.

2.5.201. Activity C2 therefore includes the excavation of spoil comprising soil, made ground, peat, alluvium and Crag sand to reach the foundation depths for the buildings and other structures, pumping and discharge of groundwater during construction of the main platform and cut off wall, bulk backfill to the underside of the foundation levels of the main building and archaeological mitigation.

2.5.202. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.27**.

Table 2.27: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for C2

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (not in place) Floodplain connectivity (not in place)	415 661
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Waveney and East Suffolk	Quantity: Groundwater levels and GWDTEs, saline intrusion,	Leiston Beck	N/A	78

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Chalk and Crag	water balance, dependent surface waters	Minsmere Old River		116
	Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
	Biology - Habitats			

2.5.203. The potential effects are therefore:

- Disruption of patterns of groundwater flow which could in turn alter surface water levels (surface water is strongly influenced by water levels and flows within the groundwater system).
- Creation of pollutant pathways during piling of the cut-off wall.

ii. Hydromorphology (surface waters) and quantity (groundwater)

Introduction and method of assessment

2.5.204. Surface water contributes to groundwater in the upper areas of the Sizewell Marshes and groundwater contributes to surface waters in the lower lying (eastern) areas of the marshes. The connectivity between surface waters and groundwater means that the entire hydrological system must be considered as a whole. As a result, the potential effects on all three water bodies scoped in for assessment are considered together.

2.5.205. To inform the **ES**, modelling was undertaken to determine the potential effects of the proposed construction and operational phases of the development. Full detail is provided in **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3). The Finite Element Subsurface Flow and Transport System model was used, based on a detailed Conceptual Site Model (CSM) developed in **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3). Following consultation, the model was revisited in 2016 and several changes implemented to improve calibration and consistency with the CSM.

2.5.206. Surface water channels in the transient Finite Element Subsurface Flow and Transport System model are represented by boundary conditions. These fluid-transfer boundary conditions represent surface water-groundwater interactions by allowing the transfer of water in and out of the model as a function of the relative head differences and the conductance of the exchange surface (the river bed). However, the ability to define specific features of the surface channels and model the effect of changing groundwater levels on surface water levels using only these boundary conditions, is limited.

2.5.207. As a result, channel morphology and the impact of changing groundwater levels on surface water in the ditches and drains of the study area were modelled using MIKE11. MIKE11 is a one-dimensional channel flow model that is coupled to Finite Element Subsurface Flow and Transport System via an interface manager. This coupling means that surface water processes can be modelled with a short timestep (of the order of minutes to hours), better suited to modelling surface water processes which are naturally higher in frequency than groundwater fluctuations. Coupling in this manner means that changes in surface waters will affect groundwater levels and flows and vice versa. Further detail is provided in **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.208. The model covers an area of approximately 62km^2, extending from Minsmere Old River / Minsmere New Cut in the north to the River Alde and River Fromus in the south (see **Figure 2.15**). The three WFD water bodies scoped in for assessment are therefore accounted for within the model domain.

2.5.209. Three control structures were included in the channel network: the double-pipe culvert under Lover's Lane; the thin plate weir at G3; and the thin plate weir at G4 as shown on **Figure 2.15**. The sluice at Minsmere was not included as it lies beyond the downstream boundary condition; the sluice lies at the outflow of Leiston Beck into the sea and any upstream effects from the operation of the sluice are accounted for during the baseline period by the tidally-fluctuating boundary condition in the baseline model. Groundwater and surface water abstractions were applied to the model at the locations shown in **Figure 2.15**.

2.5.210. Additional considerations included amendments to the model to account for the creation of the Aldhurst Farm habitat compensation scheme, dredging of Leiston Beck and sea level rise.

2.5.211. The simulated behaviour of the surface and groundwater system was then carried out for three climatic scenarios wet, dry and intermediate – see **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3) for more detail.

2.5.212. Following calibration and validation, construction and operation activities were incorporated into the model – see **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3). Operational conditions were assumed to commence on 1st September 2032 and are assessed in Activity O1.

Model observations – baseline results

2.5.213. A comparison of simulated groundwater levels in the peat for all three climatic scenarios under baseline conditions was undertaken for the period 2015-2040. This covers the phases leading up to, during and immediately following construction, which is scheduled to occur from 2022-2032.

2.5.214. Annual variations appear similar in each scenario, although summer minima during the dry simulations are typically at least 5cm less than those produced by the intermediate scenario and at least 10cm less than those produced in the wet scenario.

2.5.215. To provide context to projected changes from proposed construction activities, the maximum discrepancy in groundwater levels between the wet and dry scenarios during the construction period (from 2022-2032) was calculated. The maximum discrepancy was found to occur within the model on the 17th July 2031.

2.5.216. Differences between the wet and dry baseline scenarios are minimal in the vicinity of the platform area and the low-lying ground of Sizewell Marshes and Minsmere-Walberswick Heaths and Marshes SSSIs, where topography and evapotranspiration depths moderate the impacts of climatic variations, although short-term differences of up to 20cm can be seen, due to individual recharge events. The high permeability of the Crag allows substantial recharge to occur following heavy rainfall.

2.5.217. On higher ground, in the north and west of the main development site, differences between the wet and dry scenario are more pronounced, progressively increasing to up to 50cm by 2040.

2.5.218. For differences in stream stage, flow and flow duration, periods of high flow in particular are substantially reduced in the dry scenario relative to intermediate and wet conditions.

Model observations – construction results (dry scenario)

2.5.219. Full results are provided in **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3). In summary, notwithstanding the projected differences within the proposed footprint of the development, the largest changes from construction manifest as a 11cm reduction in groundwater levels in late 2024. Following the initial phase of dewatering, the maximum projected drawdown is 7-8cm typically during summer. Maximum drawdown contours for peat are shown in **Figure 2.16** and **Figure 2.17**. Maximum drawdown is less than 10cm across most of the Sizewell Marshes, areas of greater drawdown occur within 50m of the platform and in localised parts of the wetland, away from the drainage channels.

2.5.220. Small areas exceeding 10cm are present in the far south of the Minsmere-Walberswick Heaths and Marshes SSSI but these are only predicted to occur for a limited duration towards the end of 2024 / early 2025.

2.5.221. Maximum drawdown contours for the shallower Crag show more extensive drawdown considered to be due to the high permeability of this stratum with less mitigating influence from surface water drainage.

2.5.222. The differential hydrographs for the peat and Crag indicate no overall change in groundwater storage after 2035 as a result of the proposed development.

2.5.223. For the streams, the presence of surface water discharges and infiltration basins nearby leads to higher peak flows. The presence of impermeable ground cover nearby and the associated reduction in recharge appears to contribute to localised drawdown – this is considered likely to explain the negative upstream flow simulated during the early stages of dewatering.

Model observations – construction results (wet scenario)

2.5.224. Full details are provided in **Appendix 19A** of **Volume 2** of the **ES** (Doc Ref. 6.3). To summarise, the magnitude and duration of projected drawdown in the peat are similar to those modelled for the dry scenario, with drawdown of up to 10cm in several areas during the winter of 2024 / 2025.

2.5.225. The maximum projected drawdown typically occurs in winter, reaching 11cm. These impacts are fairly short-lived, however, with projected winter drawdown exceeding 4cm for less than 20% of the time in most locations. The magnitude, duration and extent of drawdown in the shallow parts of the Crag are also comparable to those modelled for the dry scenario, suggesting that impacts are not particularly sensitive to climatic conditions.

2.5.226. The differential hydrographs for the peat and Crag indicate no overall change in groundwater storage after 2035 as a result of the proposed development.

2.5.227. A slight reduction in recharge within the Sizewell Marshes from 2015 onwards is predicted, due to land use changes at Aldhurst Farm. This discrepancy increases slightly in 2022 following the installation of the cut-off wall and the effective removal of the platform area from the Sizewell marshes water balance.

2.5.228. Following the onset of construction dewatering in 2023, reduced inflows of groundwater from the underlying Crag are apparent, along with reduced outflows to streams (both from reductions in baseflow and a reduced rate of groundwater seepages). A slight but persistent reduction in evapotranspiration can also be seen during the construction period, which can be related to a lowering of the water table.

2.5.229. Projected stream stage, flow and flow duration for the baseline and construction simulations again indicate differences are minimal, with the exception of areas lying close to proposed areas of impermeable ground, as well as infiltration basins and controlled discharges to surface water.

Model observations – construction results (intermediate scenario)

2.5.230. Drawdown within the peat and Crag and implications for surface waters for the intermediate scenario are similar to those reported for wet and dry scenarios above. Seasonal drawdown is projected to be less than 8cm for at least 80% of the construction period, although winter drawdown is projected to be substantially less, with drawdown of less than 5cm for 80% of the time. The differential hydrographs for the peat and Crag indicate no overall change in groundwater storage after 2035 as a result of the proposed development.

2.5.231. This scenario is considered to represent the most likely climatic outcome and therefore is carried forward for assessment. The maximum drawdown figures represented as contours within the peat is provided in **Figure 2.16** and for the Crag, **Figure 2.17**.

Model observations – construction results with increased permeable cut-off wall

2.5.232. A further simulation was completed to assess the potential impacts of doubling the assumed hydraulic conductivity of the cut-off wall. This indicates a substantial increase in drawdown from construction dewatering and highlight the importance of ensuring that an effective, low-permeability barrier is installed and maintained throughout the construction period.

Summary of modelling output

2.5.233. The model results indicate the following:

- Under baseline conditions (i.e. in the absence of development), groundwater storage in Sizewell Marshes is projected to increase in all three climatic scenarios between now and 2040, driven by a combination of increased recharge and rising sea levels;

- The projected maximum difference in groundwater storage within Sizewell Marshes between the wet and dry baseline scenarios is equivalent to an average difference in groundwater level of approximately 14 cm across this area.
- Discernible impacts from the proposed construction activities relate almost entirely to construction dewatering within the cut-off wall of the platform area.
- The period of impacts is confined to the period of construction dewatering itself and a subsequent period of up to three years, as groundwater levels recover to their natural levels.
- Potential impacts from dewatering are highly sensitive to the permeability of the proposed cut-off wall.
- Projected impacts on stream flow are insufficient to see any discernible change in stage or flow hydrographs in any of the scenarios.

Groundwater body tests

2.5.234. To determine whether there is the potential for deterioration within the groundwater body, the output of the modelling study is considered against the groundwater tests for quantity in **Table 2.28**.

Table 2.28: Consideration of model output against groundwater tests

Test	Comment	Potential for deterioration on a water body scale?
Could the activity change groundwater levels, affecting Groundwater Dependent Terrestrial Ecosystems (GWDTEs) or dependent surface water features?	Considered separately below.	N/A
Could the activity lead to saline intrusion?	Given the location of the station on the coast and close to the boundary of the groundwater body, there is the potential that saline intrusion could increase during dewatering activities. However, because the maximum drawdown would be experienced around the main platform and within the cut off wall, it is predicted that any increase in saline intrusion would only occur in this area. The presence of the cut off wall restricts any effects to the wider groundwater body and any water drawn into the main platform construction area would be pumped out and returned to the marine water body via the CDO (see activity C5). Once dewatering ceases, the risk of increased saline intrusion is removed. Effects are therefore predicted to be insufficient to result in a change in status.	No
Could the activity result in groundwater abstraction in excess of recharge at a water body scale?	Maximum drawdown levels are limited to the main development area and within the cut off wall. Only a very small (see **Figure 2.16** and **Figure 2.17**) area of the groundwater body (1455km^2) is impacted (1.35km^2 or 0.09% of the total water body area for the Crag and 1.05km^2 or 0.07% of the total water body for peat). Effects are therefore predicted to be insufficient to result in a change in status.	No
Could the activity lead to an additional surface water body becoming non-compliant and lead to failure of the Dependent Surface Water test?	Modelling indicates minimal responses in the surface waters associated with construction of the main platform. Effects are therefore predicted to be insufficient to result in a change in status.	No
Could the activity result in additional abstraction that will exceed any groundwater body scale headroom between the fully licensed quantity and the limit imposed by the total recharge?	Maximum drawdown levels are limited to the main development area and within the cut off wall. As a result, only a very small area of the groundwater body is impacted. Effects are therefore predicted to be insufficient to result in a change in status.	No

Test	Comment	Potential for deterioration on a water body scale?
Could the activity result in additional groundwater depletion of surface water flows that will exceed any groundwater body scale headroom between Fully Licensed depletion and the limit imposed by the total low flows resource?	Modelling indicates minimal responses in the surface waters associated with construction of the main platform. Effects are therefore predicted to be insufficient to result in a change in status.	No

iii. Quality (groundwater) and water quality (surface waters)

2.5.235. Given that water from the dewatering process will be discharged to the marine environment, water quality effects on the Leiston Back water body catchment are not predicted. This assessment therefore focusses on the potential risks to the Waveney and Crag groundwater body.

2.5.236. Sheet piling or an equivalent solution along the eastern boundary of the Sizewell Marshes SSSI would enable the diversion of the Sizewell drain and to enable the construction of the main platform to the east. This has the potential to introduce preferential pathways for potentially contaminative surface water to enter the underlying groundwater aquifer, which may cause pollution. Drainage would be designed to protect groundwater in this area. A piling risk assessment in accordance with Environment Agency guidance would be undertaken to ensure that appropriate piling techniques are implemented at the site (by identifying and managing potential risks as a result of creating pathways to groundwater).

2.5.237. The excavation of borrow pits would likely increase the potential for surface run-off to groundwater. Engineered drainage would be designed to protect groundwater in this area.

2.5.238. Remediation of soil / groundwater contamination (e.g. source removal, treatment or capping) would be undertaken if further investigation and risk assessments deem this to be necessary.

iv. GWDTEs (groundwater) and biology (surface water)

2.5.239. Any changes in hydrological conditions to both groundwater and surface water (by making conditions wetter or drier) could potentially alter the plant composition of the habitat types present, leading to a loss of individual species that require specific conditions. For example, increased inundation by surface water could smother plants preventing growth and setting of seed by species not adapted to periodic inundation. Changes in water quality could potentially alter plant species composition and distribution.

2.5.240. It is not predicted that aquatic flora within the surface waters would be impacted by the earthworks and construction of the platform given the minimal changes in levels and flows predicted for the three scenarios considered above. This assessment therefore focusses on the potential risks to the Waveney and East Suffolk Chalk and Crag groundwater body and associated GWDTEs.

Minsmere to Walberswick Heaths and Marshes SAC and SSSI

2.5.241. Modelling indicates that during construction there may potentially be groundwater drawdown of less than 10cm for a very localised part of the Minsmere to Walberswick Heaths and Marshes SAC and SSSI just to the north of the main platform and a short section either side of the Leiston Beck. Measurement indicates that less than 0.6ha would be directly affected.

2.5.242. Drawdown would be short-term and reversible once the dewatering operations have concluded. It is considered that such a minor change in groundwater levels would unlikely cause a significant change to the composition or structure of the vegetation present. Importantly, other than the small (0.6ha) localised area of groundwater drawdown within the Minsmere European Site / SSSI, modelling does not indicate any other effects on this GWDTE.

2.5.243. Considering the modelling results and evidence presented above, the extent of hydrological change (if any) is considered to be highly localised. As a result, no deterioration in this GWDTE is predicted.

Sizewell Marshes SSSI

2.5.244. Sizewell Marshes SSSI supports nationally important wetland habitats which are highly sensitivity to hydrological changes. Any changes in hydrological conditions to both groundwater and surface water (by making conditions wetter or drier) could potentially alter the plant composition of the habitat types present, leading to a loss of individual species that require specific conditions. For example, increased inundation by surface water could smother plants preventing growth and setting of seed by species not adapted to periodic inundation.

2.5.245. As detailed in **Chapter 14** of **Volume 2** of the **ES** (Doc Ref. 6.3), national guidance for the optimum mean water table for fen meadows in the summer growing season is between about 5cm and 20cm below ground level. These are likely to be broadly representative of hydrological conditions at the best fen meadow sites but will vary at individual sites.

2.5.246. There are two sensitive plant assemblages present which are reliant on groundwater influence throughout the growing season. These are groups of low-growing ground-dwelling plant species and plant species associated with low-nutrient and / or high lime content conditions.

2.5.247. Results of modelling indicate that in the absence of mitigation dewatering within the cut off wall could cause a drawdown in groundwater levels within Sizewell Marshes SSSI by up to 10cm in both the peat and crag deposits.

Note that these drawdown contours represent the worst-case scenario, the largest modelled drawdown during drought conditions and it is not envisaged that these conditions would be maintained for the entirety of the construction phase. Drawdown is most likely adjacent to the cut off wall decreasing substantially moving west.

2.5.248. The modelling also demonstrates there is a close relationship between groundwater levels in the peat and Crag deposits and that primary mitigation in the form of a control structure such as a pivot sluice on the realigned Sizewell drain would be effective in correcting any changes between the synthetic baseline and changes (drawdown) caused by construction scenarios and is likely to maintain the status quo preventing any major changes to the underlying hydrological regime. Flow data from an existing control structure on the Leiston Beck provide confidence that the proposed primary mitigation would be effective, as shown in **Chapter 19** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.249. Considering the modelling results and evidence presented above, the extent of hydrological change (if any) is considered to be highly localised. As a result, no deterioration in this GWDTE is predicted.

v. RBMP mitigation measures (surface water bodies)

2.5.250. For the surface water bodies scoped in for further assessment, only the RBMP mitigation measures 'sediment management' (in place for Leiston Beck and not in place for Minsmere Old River) and 'floodplain connectivity' (not in place for Leiston Beck) were identified as being at risk.

2.5.251. However, the construction of the cut-off wall around the platform reduces the risk of wider pollution to the environment including the release of sediment into the watercourses. The implementation or ongoing application of the RBMP 'sediment management' mitigation measure in either water body will therefore not be at risk.

2.5.252. The construction of the platform would also result in the loss of parts of the existing functional floodplain of the Leiston Beck, which could therefore result in a loss of floodplain connectivity that is contrary to the aim of the 'floodplain connectivity' mitigation measure. The fluvial modelling results presented in the **Sizewell C Main Development Site Flood Risk Assessment** (Doc Ref. 5.2) predict that the loss of functional floodplain would result in a change in the maximum water levels of 15mm for the range of considered scenarios from 1 in 5-year annual probability event up to 100-year event with 65% climate change allowance; this 15mm additional flood depth would have an insignificant impact on the floodplain and any off-site property. The Environment Agency has confirmed that flood storage compensation or flood mitigation is not usually required when the change in flood depth is less than 30mm, so no flood storage compensation or flood mitigation measures are proposed. On this basis, it is assumed that the implementation of the 'floodplain connectivity' measure would not be at risk in the Leiston Beck water body. Furthermore, the proposed activities would not prevent existing barriers to floodplain inundation elsewhere in the catchment being removed or breached in the future.

vi. Protected areas

2.5.253. The only sub-activity that could impact on NVZs is if water from the dewatering process is released to surface waters because of the elevated levels of DIN in the groundwater monitoring results. However, given that the water from the dewatering process will be discharged to the Suffolk coast water body, there will be no nitrate loadings released to freshwater surface waters therefore effects on NVZs are not predicted. As a result, a change in status is not predicted.

j) Detailed Assessment – C3 Construction of marine structures

i. Introduction

2.5.254. There are a number of marine structures that need to be built during the construction phase which could cause disturbance to sediments (i.e. lead to water quality effects both physico-chemical and chemical), including intakes and outfalls (noting that intake and outfall heads are located outside of the WFD water body boundary), the CDO, BLF, FRR system and coastal defence features. Where applicable, this assessment also includes dredging and drilling required for the installation of structures.

2.5.255. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.29**.

Table 2.29: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for C3

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Water quality - chemical and physico-chemical.	N/A	N/A	N/A
	Biology – Habitats			

2.5.256. A number of control measures detailed within the **CoCP** (Doc Ref. 8.11) are taken into account in this assessment:

- Dredging works for the emplacement of heads at the FRR, CDO and cooling water intakes and outfalls would be limited to as small an area as practicably achievable and within the worst-case assessment outlined here.
- Dredging of access channel for the BLF should be limited to the depths and footprint required to achieve the tolerance of the vessels and within the footprint assessed here. Dredging would be by plough dredge only.
- Maintenance dredge frequency at the BLF would be minimised by monitoring the infill and defining a bed level tolerance to act as a trigger.
- BLF access dredging for one-off deliveries during the operations phase should be carried out immediately prior to required access, paying due attention to the weather such that infilling is low and re-dredge is not required before the delivery is complete to limit disruption the longshore transport pathway as far as possible.

ii. Physico-chemistry

Cooling water intakes and outfall

2.5.257. To install the headworks, surficial sediment would be removed to expose the bedrock. BEEMS Technical Report TR480 (Ref. 2.30) uses estimates of 17,400m^2 for each intake head and 11,750m^2 for the outfall head and undertakes modelling (using an existing detailed three dimensional hydrodynamic model) on the basis that a cutter suction dredger would be used. It was also assumed that the dredged sediments would be disposed of locally to the working areas through a pipe approximately 500m from the dredge site. Given the results of the various sediment surveys, fine to medium sand was modelled.

2.5.258. Based on the volumes to be dredged, it is estimated that it would take approximately five hours at each intake and approximately three hours at the outfall to complete the dredging. Allowing for repositioning of the dredger, this increases to approximately nine hours for each intake structure and seven hours at the outfall. The model simulated sediment dispersion associated with the dredging of one single intake (larger sediment release) and one outfall (higher percentage of fines). Highest depth average location maximum SSCs occur for the dredging of the intake structures.

2.5.259. The resultant plume extends along the main flow axis, with values of more than 100mgl^{-1} above background from approximately 13km to the north and 22km to the south on spring tides. The northern extent of the sediment plume is slightly reduced (to around 7km) on neap tides. The neap tide plume is shown in **Figure 2.18** as an example of maximum SSCs to be expected. However, it should be noted that the maximum plume concentrations reduce rapidly in a direction perpendicular to the flow, with depth average SSC returning to background concentrations within approximately 1km to the east and 1km to the west of the disposal site. Due to the offshore location of the sediment release, the water body is not expected to be significantly affected by the plume with only low concentrations in suspension and minimal settling occurring on the bed in the inshore region (**Figure 2.18**).

2.5.260. Plots of the 95th percentile concentrations show a marked decrease in concentrations thus highlighting the short lived duration of the plume. This is further demonstrated in tables indicating the potential times over which certain concentrations are exceeded. Following cessation of the dredging, these tables indicate a return to baseline conditions within six hours.

2.5.261. Sedimentation is highest in the immediate vicinity of the disposal site, where very localised sedimentation of more than 1m occurs but this only occurs in two of the 50m x 50m model grid cells when disposal commences on neap tides. On spring tides, the maximum thickness of deposit does not exceed 1m in any model grid cell.

2.5.262. The location maximum sedimentation rapidly reduces to more typical values of 10mm at distances of approximately 1km from the disposal site. Sedimentation is highest on the neap tides, with discrete areas of maximum sedimentation of more than 10mm extending 23km to the south and 7km to the north of the disposal site. Again, to provide some indication of how long the conditions prevail, the sedimentation areas on the bed were calculated for different threshold values and durations. This indicates that when the dredge occurs on spring tides, the sedimentation is typically short lived, with re-erosion occurring within one tidal cycle. When the dredge occurs on neap tides, the time for which sediment remains on the bed is more prolonged.

2.5.263. Drilling the connecting shafts would only release a very small amount of material and modelling indicates that only a very minor increase of 5mgl^{-1} above background is predicted which is unlikely to be discernible from natural variation.

2.5.264. As a result, a non-temporary effect on the WFD water body is not predicted. Given the sandy nature of the material, substantive organic material is not predicted to be present, therefore effects on other parameters such as dissolved oxygen concentrations are not predicted. Effects are therefore predicted to be insufficient to result in a change in status.

Fish Recovery and Return System and Combined Drainage Outfall

2.5.265. For each FRR system, estimates of dredge area have been calculated at approximately 210m^2 with a total of 1850m^3 dredge volume per FRR outfall. This includes dredging for both the head placement and for scour protection. Dredge spoil will be disposed of via a pipe that transports the dredge material 500m down drift. The design of the CDO is assumed to be similar dimensions to the FRR. Therefore, the dredge volume is also approximately 1850m^3 and disposal will occur in the same manner as for the FRR system outfalls.

2.5.266. For the purposes of modelling a worse case in relation to dredge plumes, the model assumed consecutive dredging of both FRR outfalls and the CDO. The dredge would take approximately ten hours to complete the dredging of surficial sediments for each FRR and the CDO. Assuming dredging consecutively, it would take approximately two days to complete the dredge at all three structure locations.

2.5.267. Modelling indicates that that the plume extends north-south along the coast with limited offshore extent (see **Figure 2.19** for a neap tide maximum SSC expected). To provide an indication of how long the conditions prevail, BEEMS Technical Report TR480 (Ref. 2.30) calculates the plume area for different durations. The results indicate that the plume is very short lived with plume areas rapidly decreasing as the threshold duration is increased. Further, no areas are subjected to increased surface SSC of more than 50mgl^{-1} for more than six hours.

2.5.268. In terms of sedimentation, the maximum sedimentation is highest close to the disposal site, where values of more than 20mm occur. Maximum sedimentation over the wider area is typically highest on the neap tides, with maximum values of more than 2mm occurring in localised patches over an area between 7km to the north and 8km to the south of the disposal location but are short lived.

2.5.269. As a result, a non-temporary effect on the WFD water body is not predicted. Given the sandy nature of the material, significant organic material is not predicted to be present, therefore effects on other parameters such as dissolved oxygen concentrations are not predicted. Effects are therefore predicted to be insufficient to result in a change in status.

Beach Landing Facility

2.5.270. The piling process itself, regardless of the method, could give rise to increases in sediment suspension levels in the water column if fines are brought up from beneath the sea floor. This could result in a short and localised rise in amount of sediment in suspension, but the effect would be sufficiently small that it would be difficult to detect. The drill arisings per pile ($18m^3$) represent 2.4% of the volumes drilled for the intake shaft ($750m^3$) where SSC were shown to not be detectable above background conditions. Jack up barges will be at anchor to pile and assemble the BLF deck. Anchoring will displace a very small quantity of bed sediment as it is laid but again this will be very small and unlikely to be significantly above background levels.

2.5.271. Sediment would be released during plough dredging to prepare the area for construction. Following which dredging would be required once a year for the remaining construction phase of the power station. Monthly maintenance dredging (approximately 10% of the initial dredge volume is predicted). For the purposes of undertaking the assessment the volume has been calculated to be approximately $4600m^2$ over an area of $9100m^2$.

2.5.272. Vibrocore survey data from the vicinity of the proposed BLF channel indicates surficial sediments of fine to medium sands (top metre) overlaying a metre of coarse to medium sand and a subsequent layer of silty to medium sand. This is consistent with grab samples also indicating sandy material. Given only the upper two layers will be profiled, only dispersion of sand fractions were considered.

2.5.273. To undertake the assessment, modelling using an existing detailed three-dimensional hydrodynamic model was undertaken. Plough dredging involves the mechanical agitation of the bed with the ambient flows removing the sediment in suspension away from the dredge area. The rates of dredging using this method are therefore highly variable throughout the tide, with higher rates of sediment removal expected during periods of faster tidal flows. It was assumed that dredging operations would occur around the clock and therefore the reprofiling for the capital dredge would take approximately two days to complete.

2.5.274. The modelling indicates that the highest concentrations extend directly along the coast as a result of the inshore location of the dredging. An example plot of depth averaged concentrations is shown in **Figure 2.20** for neap tides.

2.5.275. However, plots of the 95 percentile concentrations show a marked decrease thus highlighting the short-lived duration of the plume. This is further demonstrated in tables indicating the potential times over which certain concentrations are exceeded. Following cessation of the dredging, these tables indicate a return to baseline conditions within 12 hours.

2.5.276. As a result, a non-temporary effect on the WFD water body is not predicted. Given the sandy nature of the material, substantive organic material is not predicted to be present, therefore effects on other parameters such as dissolved oxygen concentrations are not predicted. Effects are therefore predicted to be insufficient to result in a change in status.

Dredging of more than one structure at the same time

2.5.277. Depending on the exact timing of the construction related activities, there is the potential for the maintenance dredge of the BLF to coincide with the dredging of sediments for the installation of the outfall structures. BEEMS Technical Report TR480 (Ref. 2.30) combines the modelling for each activity. For dredging of the BLF and the cooling water structures, modelling output indicates that the two plumes do not overlap. In terms of sedimentation, up to an 8ha increase for sedimentation area above 2mm when the dredging occurs on neap tides due to the slightly less transient nature of sediment on the bed than in suspension but much of this is outside of the WFD water body.

2.5.278. Depending on the timing, there is also the potential for maintenance dredging of the BLF and sediment removal at the CDO / FRR system to coincide. Combined modelling indicated that there is some potential for overlap between the two plumes. However, SSC do not significantly vary between the activities alone and together, the plumes will still be transient in nature and cease following completion of the activities.

Coastal defence structures

2.5.279. The SCDF would consist of beach grade sediments placed seaward of the HCDF. Construction activities for these development components generally occur above mean high water springs (MHWS) and are therefore not predicted to affect water quality.

iii. Chemistry

Cooling water intakes and outfall

2.5.280. Concentrations of contaminants at the vibrocore sites collected in the vicinity of the intake and outfall locations (VC05, VC06, VC07, VC09, VC10 and VC24) did not show significantly elevated levels of contamination. Most metal concentrations were below Action Level 1. Where exceedances were recorded, these were marginal (i.e. only just over Action Level 1). THC concentrations vary from between 10mgkg^{-1} to 321mgkg^{-1} and PAH concentrations vary from 0.00044mgkg^{-1} to 0.355mgkg^{-1}. All other parameters were below the limits of detection in the majority of samples.

2.5.281. In terms of risk to water quality, the short term nature of the activity and quick dispersion of material limits the potential for contamination to be released.

Additionally, contaminant levels in the outfall and intake areas to be dredged are relatively low. PAHs have a low water solubility and hydrophobic nature therefore they tend to be associated with inorganic and organic material within sediments and therefore remain bound. As a result, most PAHs (with the exception of some low-molecular weight compounds, such as naphthalene) will be strongly sorbed by particulate matter and biota in the aquatic environment (Ref. 2.31). It is therefore highly likely that a large percentage will remain bound to the material. Given the above findings, it is concluded that a non-temporary effect on water quality due to the suspension of chemical contaminants in the sediment due to dredging at the intakes and outfall would not occur. Effects are therefore predicted to be insufficient to result in a change in status.

Fish Recovery and Return System and Combined Drainage Outfall

2.5.282. Vibrocores were not specifically located with the areas in which the CDO and FRR system outfalls would be constructed. However, it is likely that the sediment sampled at the BLF will be similar in nature. The relevant cores are VC16, VC17, VC18, VC19, VC21, VC22, VC30 and VC31.

2.5.283. As outlined above, these vibrocores showed slightly higher levels of contaminants, specifically arsenic in VC18 at 2m (84.7mgkg^{-1}) and VC30 at 5m (91.5mgkg^{-1}). Similar concentrations were not, however, recorded in the other cores, or in shallower subsamples. As a result, it is concluded that although elevated in places, similar concentrations are not likely to be wide spread throughout the site. Additionally, none of the samples exceeded Cefas Action Level 2. As for the intake and outfall structures, total hydrocarbon content and PAHs are marginally elevated in specific subsamples but adsorption to the sediments is predicted, in addition to rapid dispersion of released sediments during dredging.

2.5.284. The short term nature of the activity further reduces the risk to water quality within the water body. Overall, therefore, it is concluded that a non-temporary effect on water quality due to the suspension of chemical contaminants in the sediment due to dredging at the CDO and FRR system outfalls would not occur. Effects are therefore predicted to be insufficient to result in a change in status.

iv. Biology

Habitats

2.5.285. Benthic invertebrates are grouped by Cefas for assessment according to their mobility – high-mobility (mobile) vs. low-mobility (sessile) – which is an important trait for determining the capacity of organisms to evade direct contact with the dredge and to recolonise a disturbed area post-dredging. *Sabellaria spinulosa* reefs are present on the Coralline Crag outcrops directly off Thorpeness (inshore Coralline Crag located with the WFD water body) and seaward of the Sizewell-Dunwich Bank (offshore Coralline Crag, not located within the WFD water body) (Ref. 2.19) and **Chapter 22** of **Volume 2** of the **ES** (Doc Ref 6.3)).

2.5.286. Mobile epifauna, including the brown crab (*Cancer pagurus)*, common lobster (*Homarus gammarus)*, brown shrimp (*Crangon crangon)* and pink shrimp (*Pandalus montagui)*, have been observed near where navigational dredging would occur for the BLF. Their high mobility provides them with some capacity to escape direct contact with the dredge; however, not all individuals would evade impact.

2.5.287. The brown crab, brown shrimp and pink shrimp are distributed throughout the GSB, whereas the common lobster was recorded sporadically in low abundances during surveys. Any aggregations of the common lobster would likely occur in areas of hard habitat, i.e. not within the footprint of dredging. Therefore, only small proportions of the populations of these species are likely to be present within the dredged area, while their high mobility would allow some individuals within the dredged area to evade impact. Moreover, as the mobile species present are widely distributed within the GSB, adult individuals (including any within the dredged area that evade impact) would be able to quickly recolonise the dredged area upon cessation of this activity.

2.5.288. While mobile epifauna would be able to avoid direct impact to some degree, most infaunal taxa have low mobility (i.e. are sessile) and are therefore more vulnerable to direct disturbance and mortality due to this pressure. While substantial reductions of sessile benthic invertebrates are likely to occur in the area directly disturbed, the widespread distribution of the affected key taxa and broader benthic invertebrate community means that only a small proportion of any sessile species population is likely to be directly exposed to navigational dredging. The higher sensitivity habitat species, *S. spinulosa* is not present in the areas within the WFD water body where dredging would occur.

2.5.289. In relation to water quality effects, changes in SSC due to dredging have the potential to affect benthic invertebrates by interfering with feeding. However, ambient SSC at the site are highly variable. Additionally, dredging would only temporarily increase the SSC during dredging activities following which the plume would dilute and disperse returning to background levels several days after dredging activity ceases. In terms of the higher sensitivity habitat species *S. spinulosa,* this species is not considered to be sensitive to changes in turbidity associated with increases in suspended sediments. This is supported by evidence that this species is often found in areas of high turbidity, as provided in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3).

2.5.290. Modelling as outlined above also included the consideration of the potential for deposition (Ref. 2.30). However, the predicted deposition depths for dredging at all structures are very small and will subsequently disperse via natural resuspension. Additionally, predicted deposition for the intakes and outfall largely occurs outside of the WFD water body.

2.5.291. Together, the combined extent of the sediment removal within the WFD water body is approximately 1.5ha. Compared to the size of the WFD water body (14,653ha) this equates to 0.01% of lower sensitivity habitat. The area associated with the BLF (capital dredge) (0.9ha) will however recover following cessation of dredging activities given the species present.

2.5.292. Overall therefore, effects are predicted to be insufficient to result in a change in WFD water body status.

Phytoplankton

2.5.293. Phytoplankton exposed to increases in SSC may be susceptible to reductions in productivity. The short duration and transitory nature of the plume suggests that a small decline in primary productivity may occur, but recovery would be rapid following cessation of the dredging activity. As a result, non-temporary effects on phytoplankton in the WFD water body are not predicted.

v. Adjoining WFD water bodies

2.5.294. For the structures located offshore (i.e. the intake and outfall structures) sediment plumes do not extend to adjoining WFD water bodies (see **Figure 2.19**). For the FRR and CDO, the sediment plume does intersect with the adjoining water bodies but at relatively low SSCs at the Minsmere sluice (i.e. 30-50mgl^{-1}). For the transitional water bodies, the plume does not reach the Blyth (S) WFD water body and only intersects with the Alde and Ore WFD water body in very low concentrations.

2.5.295. The plume predicted to result from the capital dredging for the BLF, also does not intersect with the transitional water bodies at elevated concentrations however pockets of high concentrations could potentially occur in the vicinity of the Minsmere sluice. The relatively transitory and short term nature of the plume, however, reduces the potential for the plume to coincide with the opening of the sluice.

2.5.296. Overall, given the transitory and short term nature of the activities, effects on adjoining water bodies are predicted to be minimal, and likely to be within the natural baseline range where intersection occurs. Elevated concentrations in the vicinity of the Minsmere sluice could affect water quality in the Minsmere Old River and Leiston Beck, however, rapid dilution following cessation of the construction works would reduce this risk. As a result, non-temporary effects on a water body scale are not predicted.

k) Detailed Assessment – C4 Discharge of foul, surface and any other water

i. Introduction

2.5.297. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.30**.

Table 2.30: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for C4

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs	Leiston Beck Minsmere Old River	N/A	N/A
	Quality: Diffuse pollution, GWDTEs, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River		

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Water quality – Chemical and physico-chemical Biology - Habitats	Walberswick Marshes Blyth (S) Alde and Ore	N/A	N/A

2.5.298. During construction, groundwater discharges would be made via the CDO. Exploratory boreholes across the main development site quantified the concentrations of dissolved metals within the groundwater. The worst-case construction discharges for trace metals would be during the initial 28-day dewatering of the cut-off wall around the main construction site. The dewatering phase would result in an estimated 300,000m^3 of groundwater being discharged at a rate of 124ls^{-1}.

2.5.299. After the initial dewatering phase nominal discharges of 15ls^{-1} would continue throughout the construction phase to remove rainwater and seepage through the cut-off wall. **Table 2.31** summaries the potential discharge scenarios throughout the construction phase.

2.5.300. Hydrocarbons would be removed from effluent prior to discharge by the incorporation of suitable bypass separators within temporary drainage systems. Therefore, no chemical release effects to the water and sediment quality of the local area are expected from these variable sources and they are therefore screened out of further assessment.

ii. Physico-chemistry

2.5.301. To determine the potential effect of the discharge, modelling was undertaken and the physico-chemical parameters considered were DIN, phosphorus and ammonia from groundwater dewatering. Note that impacts on DIN are considered alongside chemical impacts in the section below.

Ammonia

2.5.302. Ammoniacal nitrogen exists in both ionised and unionised form in the combined groundwater and sewage discharges from the construction site with the ratio of each determined by pH, temperature and salinity. Unionised ammonia is generally considered more toxic and has an annual average EQS of 21μgl^{-1}. Treated sewage effluent discharge during construction is a primary source of un-ionised ammonia but there is also a contribution from groundwater.

2.5.303. To calculate ammonia concentrations from the various discharges the Environment Agency calculator was used (Ref. 2.1) and the results are summarised in **Table 2.31**.

Table 2.31: Unionised ammonia concentrations for groundwater, treated sewage and combined discharge using the Environment Agency calculator (Ref. 2.1)

Discharge	Ammoniacal nitrogen (N) $\mu g l^{-1}$	Salinity	Temperature	pH	Un-ionised ammonia $\mu g l^{-1}$	Discharge (ls^{-1})
Case A (groundwater)	5,557	1	11.43	7.3	22.8	124
Case D	9,049	1	11.43	7.3	37.2	55
Case D1	11,600	1	11.43	7.3	47.6	71.7
Sewage discharge only	20,000	1	11.43	7.3	82.1	13.3

2.5.304. Mixing of the different sources contributing ammoniacal nitrogen and the ratio of unionised to ionised ammonia upon mixing with seawater was evaluated using dilution rates using CORMIX-US EPA supported mixing model. The derived values were considered in combination with the estimated dilution rates derived from the modelling. Case A, Case D1 and 'Sewage only' discharged were modelled as Case D has a lower flow rate and source input so its impact will be lower.

2.5.305. The worst-case un-ionised ammonia discharge would occur in the unlikely event of a 'sewage only' discharge. In this situation dilution modelling predicts exceedance of EQS concentrations up to 6.3m from the point of discharge. EQS exceedance is within 4m of the discharge for all other construction scenarios (Ref. 2.3). Given the limited spatial extent, effects on a water body scale are not predicted.

Nutrients

2.5.306. During construction several contributions would be made to dissolved inorganic nitrogen and phosphorous. The most consistent nutrient enriching inputs would be from treated sewage and groundwater. Nutrient discharges have the potential to enhance phytoplankton biomass, particularly if they occur during periods of nutrient limitation.

2.5.307. The peak nitrogen and phosphorus additions from the proposed development were compared to the daily exchange of water in the tidal system and the additional nutrient terms were modelled using the Combined Phytoplankton and Macroalgae (CPM) model (Ref. 2.1).

2.5.308. The CPM model predicts that construction nutrient additions (this included the commissioning inputs, see activity C5) would increase annual gross primary production within the tidal excursion by <0.13%. Such changes are orders of magnitude below the natural variation in chlorophyll a biomass – see **Chapter 22** of **Volume 2** of the **ES** (Doc Ref 6.3).

2.5.309. It is recognised that whilst the CPM produces outputs at daily intervals, nutrient inputs are simulated as an annual mean. Therefore, it is feasible that phytoplankton would be more sensitive should greatest inputs occur during periods of nutrient limitation. However, poor light penetration due to turbid conditions means the coupling between nutrient inputs and signs of eutrophication are weakened and the southern North Sea is defined as a Non Problem Area based on the OSPAR Common Procedure Assessment for Eutrophication (Ref. 2.32).

2.5.310. Construction phase nutrient inputs are therefore considered not significant relative to natural variability in modelled phytoplankton biomass.

BOD / DO

2.5.311. After discharge BOD is predicted to be below the expected background within a few meters of the discharge head and even at the point of discharge (BEEMS Technical Report TR306 (Ref. 2.1)). As a result, no effect is predicted on DO levels within the WFD water body.

iii. Chemistry

2.5.312. Chemicals present as contaminants and discharged via the CDO were assessed using a screening process using Tests 1 and 5 as referenced in Environment Agency guidance (Ref. 2.33) and summarised in **Table 2.32**.

Table 2.32: Summary of screening tests as required by the Environment Agency 2016 (non cooling water discharges)

Test reference	Description	Next step	Applicability to the CDO
1	Is the level of pollutant in the discharge more than the EQS. Test for both annual average limits and maximum allowable concentration if the pollutant has both types of EQS.	If the pollutant is more than EQS limits, carry out test 2. If it's below EQS limits no further work is required.	Yes. Potentially relevant to CDO discharges

Test reference	Description	Next step	Applicability to the CDO
2	Determine whether the discharge is to the low water channel (if the water does not flow across the estuary bed at any stage of the tide) in the upper parts of an estuary where the water is mainly fresh.	If the discharge is direct to the low water channel, do the screening tests for freshwater. If not, carry out test 3.	No. Discharge is to a coastal water
3	Determine if the discharge is to an area with restricted dilution	If the discharge is to an area with restricted dilution, Environment Agency advice is required.	No. The discharge is to a coastal water with no restricted dilution
4	Determine whether the discharge contains pollutants at concentrations above EQS and either of the following apply: • the discharge location is less than 50m offshore from where the sea bed is at chart datum • the sea bed at the discharge location is less than 1m below chart datum	If they either apply, modelling is required. If they do not, continue to test 5	No. The discharge is to the subtidal environment and beyond 50m from mean low water spring tidal level.
5	Only carry out this stage if the plume is buoyant.	If the discharge is not buoyant modelling is required. If the plume is buoyant, undertake effective volume flux calculations. If the effective volume flux is more than the allowable effective volume flux for the discharge location modelling is required. If it's less no further work is required.	Yes. Should a substance fail test 1, test 5 to be carried out

2.5.313. The above tests were applied to the predicted daily and annual discharge concentrations during the initial dewatering phase as several metal contaminants were identified within the groundwater. Test 1 requires the calculated concentration (95% dissolved concentration) for a chemical to be compared to its EQS (or suitable substitute if an EQS not available). For those chemicals that are present at concentrations in excess of EQS, the Effect Volume Flux is calculated (Test 5) (see Ref. 2.1 for more information). The results of Test 1 are provided in **Table 2.33**.

Table 2.33: Summary of output of Test 1

Parameter	Concentration of parameter in groundwater (mean µgl^{-1})	95% dissolved concentration µgl^{-1}	Marine background concentration µgl^{-1}	Marine EQS Annual average µgl^{-1}	Marine EQS Maximum allowable concentration µgl^{-1}	Summary of test results
Arsenic	3.55	11.5	1.07	25	-	Pass (mean passes annual average EQS)
Cadmium	0.10	0.18	0.05	0.2	1.5	Pass (mean passes annual average and 95% passes maximum allowable concentration)
Chromium	6.39	18.45	0.57	0.6	32	Fail (mean fails annual average EQS, test 5 required)
Copper	1.87	4.25	2.15	3.76	-	Pass (mean passes annual average EQS)
Lead	1.07	1.07	-	1.3	14	Pass (mean passes annual average and 95% passes maximum allowable concentration)
Zinc	7.34	17.5	15.12	6.8	-	Fail (mean fails annual average EQS, test 5 required)
Mercury	0.013	0.023	0.02	-	0.07	Pass (95% passes maximum allowable concentration EQS)
Iron	395	1500	50	1000	-	Pass (mean passes annual average EQS)
DIN	3.55	5636	425	980[6]	-	Fail (mean passes good status but 95% does not, test 5 required)

[6] 99% (70µmol) converted to N standard for period 1st November – 28th February for dissolved inorganic nitrogen for Good status (see BEEMS Technical Report TR306 for further information)

2.5.314. The screening assessment indicated that chromium and zinc fail Test 1.

Metals

2.5.315. For Test 5, it was calculated that chromium fails even after initial dilution. It was not possible to do Test 5 on zinc as the background concentrations already exceed the EQS. As a result, these two parameters were modelled for Case A using the US EPA CORMIX model.

2.5.316. The mean background concentration of zinc in the environment is 15.12µgl^{-1} whilst the annual average EQS is 6.8µgl^{-1}. Since the background levels are in exceedance of the EQS, zinc discharges cannot be assessed under standard procedures. Modelling predicted the point at which zinc concentrations would be indiscernible from background based on analytical detection limits of 0.4 µgl^{-1}. The threshold value for zinc was therefore set at 15.52 µgl^{-1}. Thus, the amount of change relative to baseline is approximately 2.5%.

2.5.317. Modelling demonstrated that zinc concentrations would only be discernible above background over a mean sea surface area of 0.11 ha. At the seabed, zinc concentrations are not predicted to exceed background concentrations.

2.5.318. Chromium has an annual average EQS of 0.6µgl^{-1} and a maximum allowable concentration EQS of 32µgl^{-1}. Chromium background concentration of 0.4-0.57µgl^{-1} are reported for the site. As a precautionary measure the higher background concentration was applied to give a mean EQS threshold of 0.03µgl^{-1}. Thus, the amount of change relative to baseline is approximately 5%. A sea surface area of 5.49ha exceeded the annual average EQS, at the seabed chromium did not exceed EQS concentrations. The maximum allowable concentration EQS concentration (32µgl^{-1}) was not exceeded (Ref. 2.3).

2.5.319. Given the very small mixing zone over which the EQS exceedance will occur, a deterioration in the water body is not predicted. Additionally, groundwater dewatering is only predicted to occur for a limited period of time (approximately 28 days) at the higher flow of 124ls^{-1}.

2.5.320. For priority hazardous substances, additional screening is required even if screening tests outlined above are passed. Priority hazardous substances identified as potentially being present in the CDO discharge are cadmium and mercury, also resulting from the groundwater dewatering.

2.5.321. An assessment of annual loads was undertaken to determine whether these two contaminants would exceed the annual significant load limits (see Ref. 2.1 for further detail). The annual significant load for cadmium is 5kg and for mercury is 1kg. This concluded that neither cadmium or mercury would exceed this annual load over the three year period for which groundwater will be discharged to the marine environment, after which the dewatering will cease.

Tunnelling chemicals

2.5.322. Tunnelling would be subterranean, approximately 30m below the seabed and would involve transporting spoil from the cutting face to a temporary stockpile for onward management. During the transport and processing of spoil material, groundwater and potentially residual tunnel boring machine (TBM) chemicals would be produced in wastewater that would be discharged via the CDO. Effects from discharges would be mitigated by treatment with a silt-buster or similar technology to minimise sediment inputs.

2.5.323. Ground conditioning chemicals are used at the cutter head to optimise TBM efficiency and include anti-clogging agents, anti-wear components and soil-conditioning compounds. The exact chemical constituents of the ground conditioning chemicals are dependent upon the ground conditions encountered on site and therefore cannot be precisely specified in advance of drilling trials by the tunnelling contractor. Although not parameters monitored in relation to WFD compliance, there is the potential for effect on ecological parameters which do contribute to WFD compliance classification.

2.5.324. For slurry tunnelling using bentonite, the predicted concentration of bentonite in suspension that is potentially discharged following recovery is orders of magnitude lower than baseline SSC, with 95th percentile concentrations of $10 \mu g l^{-1}$ restricted to sea surface areas of less than 11ha and mean concentrations of $10 \mu g l^{-1}$ over <1.5ha, as provided in **Chapter 21** of **Volume 2** of the **ES** (Doc Ref. 6.3). In the tidally dominated environment characterised by high resuspension rates, the potential for sedimentation of fine materials to influence water quality status in terms of overall SSC is predicted to be minimal.

2.5.325. The use of TBM chemicals at Sizewell has not been confirmed and chemical use and selection would be informed by a survey of the underlying geology prior to tunnel excavation. However, to envelope representative tunnelling approaches, compounds assessed are based on those planned for use at Hinkley Point including the anti-clogging agent BASF Rheosoil 143 and the soil conditioning additive CLB F5 M. A conservative tunnelling scenario would occur when two cooling water tunnels are being excavated (Case E).

2.5.326. Modelling predicted that the mean sea surface area in exceedance of the BASF Rheosoil 143 predicted no effect concentration (PNEC) was restricted to 1.01ha (95th percentile 5.83ha). The sea surface area exposed to CLB

F5 M in exceedance of the PNEC was restricted to 3.14ha as a mean concentration (95th percentile 25.0ha). For both compounds, the seabed is not exposed to concentrations above the PNEC.

2.5.327. Tunnelling is predicted to be a medium-term impact lasting up to two years in total. The use of TBM surfactants in the tunnelling process remains to be confirmed and assessments present a precautionary approach enveloping conservative discharge concentrations for representative chemicals and discharge levels. A small mean spatial area is predicted to exceed the PNEC at the sea surface of approximately 3.1ha (95th percentile 25.0ha). The seabed would not be exposed to concentrations above the PNEC.

2.5.328. The predicted areas in which TBM surfactants would be elevated are very limited and dilution would be rapid such that water quality effects are not predicted on a water body scale.

iv. Biology

Phytoplankton

2.5.329. A very small proportion of the plankton community within the water body would be exposed to trace metal and un-ionised ammonia concentrations in exceedance of EQS thresholds or natural background concentrations. In the tidally dominated system exposure would be limited. No discernible changes in plankton communities are predicted.

2.5.330. The combined loadings of nitrogen and phosphorus as previously described from the construction and commissioning inputs together with relevant inputs resulting from the use of conditioning chemicals and the discharge of treated sewage were assessed. For much of the year light availability limits phytoplankton growth and the addition of relatively small quantities of nutrients has no effect. In the summer, nitrate is a limiting nutrient (when light is not limiting) and is consumed rapidly. However, the exchange with the wider environment is much greater than the maximum proposed discharges, during construction, so that no change in phytoplankton growth beyond natural variability would be observed (Ref. 2.3).

2.5.331. In terms of TBM surfactants, **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3) states that literature from freshwater communities and the physico-chemical properties of the aqueous solution indicate that higher concentrations than those predicted at Sizewell are required to cause toxicity or community effects. Furthermore, biodegradation of surfactants is rapid for all chain lengths (Ref. 2.34). A very small proportion of the plankton community within the water body would be exposed to TBM surfactants and concentrations are unlikely to cause toxicological effects. As a result, non-temporary effects on phytoplankton communities are not predicted.

Habitats

2.5.332. Given the discharge location and very small areas over which EQS or PNEC exceedance will occur, there is considered to be no risk to higher sensitivity habitats. Effects on lower sensitivity habitats are also predicted to be small scale and located within the vicinity of the outfall location. Additionally, the effects will cease following completion of the power station. As a result, effects on a water body scale within or between classes for biology are not predicted.

v. Protected Areas

Bathing Waters

2.5.333. The nearest bathing waters are located 10km (Southwold the Dunes) and 35km (Felixstowe North, located in the Essex WFD coastal water body GB650503520001) away from the CDO. To assess whether concentrations of bacteria could cause non-compliance with the bathing waters directive, maximum levels of faecal indicator organisms for the raw sewage input to the treatment plant were calculated. Addition of secondary treatment allows for a 100 factor (2 log) reduction in faecal indicator microorganisms, coliforms and enterococci and if tertiary treatment is applied, a 5.4 log reduction can be assumed.

2.5.334. Following sewage treatment at a secondary level the distance from the CDO discharge point at which enough dilution occurs to be below relevant microbiological standard levels, has been estimated using CORMIX for Case D ($30ls^{-1}$) sewage discharge and Case D1 ($72ls^{-1}$).

2.5.335. CORMIX estimates show that the concentration of intestinal Enterococci cells will only exceed the bathing water standard within 66m of the discharge for the $30ls^{-1}$ case, without tertiary treatment. For the larger discharge volume ($72ls^{-1}$) the bathing water standards are exceeded for 460m.

Nitrates Directive

2.5.336. See assessment above for DIN and ammonia discharges. Effects on nutrients are therefore not predicted on a water body scale.

vi. Adjoining WFD water bodies

2.5.337. Discharges from the CDO will occur inshore of the Sizewell – Dunwich Bank at approximately 300m from the coast. The physical and chemical inputs from construction discharges are predicted to have limited and localised influence within tens of metres of the discharge point. As a result, effects on adjoining WFD water bodies are not predicted.

l) Detailed Assessment – C5 Discharge of commissioning water via the CDO

i. Introduction

2.5.338. Cold flush testing involves cleansing and flushing the various plant systems with demineralised water to remove surface deposits and residual debris from installation. Tests use demineralised water for preparing plant systems and testing of the primary and secondary circuits requires them to be filled and flushed several times each. The maximum daily discharge volume is $1500m^3d^{-1}$, equivalent to the contents of the two $750m^3$ tanks that serve this waste stream.

2.5.339. The operational cooling water system would not be available for the disposal and dilution of commissioning phase effluents as such discharge would be through the CDO. The discharge of nutrient concentrations is presented in activity C4 (a combined assessment for cold flush commissioning and construction discharges).

2.5.340. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.34**.

Table 2.34: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for C5

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Water quality – Chemical and physico-chemical Biology - Habitats	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	N/A

ii. Chemistry

2.5.341. The main parameters of concern are hydrazine, ethanolamine and unionised ammonia.

2.5.342. Prior to the release of hydrazine from the holding tanks, hydrazine would be treated to reduce the discharge concentration. The proposed treatment option has not yet been confirmed, however, it is predicted that a discharge concentration of 30µgl^{-1} is representative of the 95th percentile.

2.5.343. The two other chemical contaminants used in circuit conditioning are ethanolamine (at 4000µgl^{-1}) and ammonia, principally in the unionised form (at 12000µgl^{-1}) due to the higher pH (approximately 10) maintained in the circuits.

2.5.344. As outlined above in activity C4, Environment Agency guidance requires the consideration of the proposed contaminants in the discharge against various tests (see **Table 2.32**). The output for cold water flush testing is provided in **Table 2.35**. A maximum discharge rate of 83.3l^{-1} from a total holding volume of 1500m^{3} has been assumed.

Table 2.35: H1 Test 1 and 5 for relevant discharges for cold flush testing

Substance	Estimated discharge concentration µgl^{-1}	Saltwater annual average EQS	Background concentration	Effective Volume Flux (EVF) (based on flow 83.3 ls^{-1})	TraC Water test 5 EVF < 3.0 (Pass/Fail)
Hydrazine	30	0.4ngl^{-1}	-	N/A	Fail
Ethanolamine	4000	160 µgl^{-1}	-	2.08	Pass
Unionised ammonia	12000	21 µgl^{-1}	0.2	47.6	Fail

2.5.345. As a discharge concentration of 30µgl^{-1} exceeds the substitute EQS and fails the Test 5 dilution test, hydrazine requires additional assessment. The same applies to unionised ammonia. To do this, BEEMS used the General Estuarine Transport Model (GETM) and the salinity of the discharge was modelled as freshwater with no thermal uplift. Modelling took the precautionary position of both reactors being commissioned simultaneously but in reality, it is likely that only one reactor will require commissioning and discharge of water via the CDO.

2.5.346. For hydrazine, a release concentration of 30µgl^{-1} in daily pulses of 5.0 h starting at 12:00 was modelled. This discharge period is calculated to be enough to empty the total volume of both treatment tanks 1,500m^3. The simulation was carried out for a period of one month, to encompass a full spring neap cycle. The month of May was chosen due to having the highest phytoplankton growth which drives the marine ecosystem. Due to the pulse-like discharge, the interpretation of the short-term results (daily) is biased to the moment of the tidal cycle when hydrazine has been released. To evaluate this effect, an additional simulation was carried out with the release pulses starting at 18:00.

2.5.347. To assess the spatial extent of the hydrazine plume and compare the resulting concentrations with the PNEC values (chronic and acute), the mean and 95th percentile of the hydrazine concentrations were extracted from the 31-day model run. The model results predict the concentrations are higher at the surface than at the seabed, showing the stratification of the hydrazine plume caused by the difference in salinity. The results are presented in **Table 2.36**.

Table 2.36: Areas of PNEC exceedance for hydrazine discharges during cold water testing

Predicted no effect concentrations	Area of Suffolk coastal water body impacted	
	Surface (ha)	Seabed
Chronic 0.4 ngl-1 (as a mean concentration)	53.60 (0.366%)	11.33 (0.077%)
Acute 4 ngl-1 (as a 95th percentile)	27.25 (0.186%)	10.99 (0.075%)

2.5.348. Given the very small areas over which the exceedance will occur, the tidally dominated system and the fact that hydrazine is rapidly degraded in the marine environment, the impact predicted is very small on a water body scale.

2.5.349. The model output for unionised ammonia shows there is no area of the plume in exceedance of the EQS apart from in the direct vicinity of the outfall (less than 5m). Comparisons against previous nearfield modelling using CORMIX suggest a 49-fold dilution is achieved within approximately 25m.

2.5.350. Given the very small areas impacted, the potential for within class or between class deterioration of unionised ammonia is not predicted.

iii. Biology

Habitats

2.5.351. The PNEC applied in BEEMS Technical Report TR306 (Ref. 2.1) as a trigger for ecological investigation is highly precautionary. Assessments used in support of Canadian Federal Water Quality Guidelines for hydrazine indicate concentrations below 0.2µgl^{-1} have a 'low probability of adverse effects for marine life'. Given that the area of the hydrazine plume with a concentration greater than 0.2µgl^{-1} is limited to the immediate vicinity around the CDO, effects on habitats on a water body scale are not predicted.

2.5.352. Consideration was also given to the potential effects on the Coralline Crag, an area of which is located within the WFD water body. The model results show the chronic PNEC is only exceeded twice at the surface and once at the seabed, but only for 15 minutes at a time. At the seabed, the acute PNEC is not exceeded with all release concentrations, meaning the higher sensitivity habitat *Sabellaria* (as a benthic feature) would not be exposed to acute concentrations. As a result, effects on this higher sensitivity habitat are not predicted.

Phytoplankton

2.5.353. The concentrations observed for effects in diatoms and microflagellates, as provided in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3), and brown algae gametophytes are higher than in close proximity to the point of discharge. An area of less than 1ha exceeds 200ngl^{-1} as a 95th percentile during the highest concentration discharge scenario. This represents half the concentration observed to cause growth inhibition in the most sensitive species following six-day exposures (Ref. 2.35). Therefore, any adverse effects on the most sensitive phytoplankton species would be highly localised and a very small proportion of the population would be exposed. As a result, effects on phytoplankton communities are not predicted.

iv. Adjoining WFD water bodies

2.5.354. Effects may result from direct entry to Leiston Beck and Minsmere Old River when the Minsmere sluice is open. Alternatively, contaminants may percolate through the dune system or overtop during storm events. Concentrations of discharges of hydrazine are predicted to exceed PNEC levels (acute threshold 4 ngl^{-1} as a 95th percentile) over a sea surface area of 12.9ha and 2.92ha at the seabed, however interaction with the coastline does not occur at these levels. Thus, the potential for percolation through the dune system is negligible, particularly when the rapid degradation rate of hydrazine is considered (ca. 38-minute half-life).

2.5.355. However, as a precautionary measure a time series was modelled at the position of the Minsmere sluice to determine the potential for the maximum instantaneous plume to enter the sluice.

2.5.356. The Minsmere sluice opens for half an hour after high tide, allowing saltwater to enter the system. At Sizewell the tide floods in a southerly direction. As the proposed development is south of the Minsmere sluice, discharges are only transported northward on an ebb tide, when water levels are lowering. During the ebb tide, the hydrazine plume is transported northward towards Minsmere.

2.5.357. The month-long model run resulted in highest maximum instantaneous concentrations of $0.12ngl^{-1}$ predicted at the surface and $0.11ngl^{-1}$ at the seabed, for a $15µgl^{-1}$ discharge concentration scenario.

2.5.358. Based on available data, a threshold of $2.6µgl^{-1}$ is applicable to freshwater environments in relation to the potential for ecological effects (Ref. 2.36). As such, the highest instantaneous concentration modelled at the sluice is below the threshold for low probability of adverse effects. Rapid degradation rates would also reduce the potential for effect should any hydrazine reach the freshwater bodies. Hydrazine has a low bioconcentration factor meaning the bioaccumulation potential is low (Ref. 2.36). Therefore, direct effects on benthic assemblages within the site and food web effects are unlikely to be significant. As a result, the potential for effects on Minsmere Old River or Leiston Beck are not predicted.

2.5.359. A similar conclusion can also be reached for the Walberswick Marshes WFD water body given that the only pathway for saline water to infiltrate is via the dune percolation. The potential for percolation through the dune system is unlikely, particularly when the rapid degradation rate of hydrazine is considered (approximately 38-minute half-life). As a result, effects on this water body are also not predicted.

m) Detailed Assessment – O1 Presence of power station

i. Introduction

2.5.360. This activity assesses the permanent presence and operation of all developments on the main platform, including the surface water drainage system. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.37**.

Table 2.37: Summary of water bodies, quality elements, mitigation measures and protected areas scoped in for further assessment for O1

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	N/A
	Physico-chemistry: General			
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	N/A	N/A
	Physico-chemistry: General			
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters	Leiston Beck Minsmere Old River	N/A	N/A
	Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective			

2.5.361. As outlined in Activity C2, the Finite Element Subsurface Flow and Transport System model was used to look at the potential effects on groundwater, coupled to surface water effects via MIKE11 for both the construction and operational phases.

2.5.362. Following excavation of existing material at the main development site, it would be backfilled and raised to a level of 7.3m AoD. The site would be covered by hardstanding with minimal infiltration capacity by the end of the construction phase and surface runoff would discharge to the sea via the cooling water system. For the operational phase therefore, Crag material properties and zero recharge have been applied across the main development site.

2.5.363. Given the site is expected to operate until the year 2130, future changes in climate were considered as for the construction phase and captured a range of uncertainty in future climate; wet and dry extremes as well as intermediate projections.

ii. Hydrogeomorphology and quantity (groundwater)

2.5.364. For both the wet and dry scenarios, the differential hydrographs for the peat and Crag indicated no overall change in groundwater storage after 2035 as a result of the proposed development.

2.5.365. The operational phase would also not lead to any significant effects on the flow regime of the Sizewell Drain, Leiston Beck and other connected watercourses. This is due to the proposed water management structures which would allow for easy manipulation of the water levels and flows and thus levels / flows within Leiston Beck can be reduced as and when required to allow for the Scott's Hall drain to discharge efficiently when required.

2.5.366. This coupled with the fact that the relatively small contribution from Leiston Beck (supplies approximately 14% of the total contributing catchment of the Minsmere sluice) to the overall flow at Minsmere sluice, limited effects on the flow regime of the southern chamber of the Minsmere sluice are predicted and thus no significant effect is predicted for the Scott's Hall drain and associated drainage network.

2.5.367. From a geomorphological perspective, Leiston Beck has been artificially modified and is uniform and trapezoidal in shape with near-vertical banks and a gentle longitudinal profile. The diversion of the Sizewell drain (a tributary of Leiston Beck) would offer a similar modified geomorphological structure.

2.5.368. The control structure on Sizewell Drain along with appropriate monitoring and interventions would be expected to maintain the hydrological regime of Sizewell Marshes SSSI during the operational phase and no significant effects on Sizewell Marshes SSSI are envisaged.

2.5.369. Monitoring of the Sizewell drain water control structure would be required to ensure the water control mechanism is working effectively.

iii. Physico-chemistry

2.5.370. With respect to additional discharges to surface waters, an operational phase drainage system would be implemented, including sustainable drainage measures to intercept water, sediment and contaminants. Rainfall falling onto the power station site would be managed through an engineered drainage system. This water would be discharged to sea with the cooling water and will therefore no longer influence flow / water level of Leiston Beck. At the western perimeter of the site, a filter drain would be installed to capture surface water run-off and prevent direct discharge to Sizewell drain. The realigned Sizewell drain will remain during the operational phase as described in the construction phase.

2.5.371. Foul effluent would be discharged to the existing local foul water system located in the south east corner of the site. Treated effluent would be pumped to the cooling water outfall tunnel and disposed to sea. As a result, there will be no effects on flows to any of the surface waters.

iv. GWDTE (groundwater)

2.5.372. Any changes in hydrological conditions to both groundwater and surface water (by making conditions wetter or drier) could potentially alter the plant composition of the habitat types present, leading to a loss of individual species that require specific conditions. For example, increased inundation by surface water could smother plants preventing growth and setting of seed. However, given that there are minimal changes predicted in both the groundwater and surface waters as a result of the presence of the platform, effects on biology are not predicted.

v. Water quality (surface water) and quality (groundwater)

2.5.373. Given both surface water drainage and foul water would be treated and discharged to the marine environment (see activity O5), effects on water quality are not predicted.

vi. RBMP mitigation measures

2.5.374. For the Leiston Beck WFD water body, only the RBMP mitigation measure ‘Floodplain connectivity’ (not in place) was identified as being at risk. The presence of the platform would result in the permanent loss of parts of the existing functional floodplain of the Leiston Beck, which could therefore result in a loss of floodplain connectivity that is contrary to the aim of this RBMP mitigation measure.

2.5.375. However, when comparing the maximum water levels for the baseline and with development scheme scenarios, both losses translate as a maximum relative difference of 10mm across the floodplain. Overall therefore, the proposed activities would not prevent existing barriers to floodplain inundation being removed or breached in the future. On this basis, it is assumed that the implementation of the ‘floodplain connectivity’ would not be at risk in the Leiston Beck water body.

vii. Adjoining water bodies

2.5.376. Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.

viii. Assessment against possible future baseline

2.5.377. Predicted climate changes under UKCP18 are likely to result in wetter winters, drier summers and a greater number of convectional rain storms. This means that the hydrology of Leiston Beck could change, with higher winter flows, lower summer flows and a greater number of storm-related flood flows. This in turn could result in changes to the geomorphology of the river systems, with increased geomorphological activity (e.g. channel adjustment) occurring in response to larger storm events. However, the stable geomorphological characteristics that currently dominate Leiston beck and its tributaries, and the extensively modified nature of these channels, mean that significant hydromorphological adjustments are unlikely to occur during the operation of the proposed development.

2.5.378. Any future initiatives to improve geomorphology and in-channel habitats undertaken by the Environment Agency and partner organisations to meet WFD status objectives could deliver localised improvements to hydromorphology, physico-chemistry and biology (e.g. through measures to reduce the supply of fine sediment and nutrients from diffuse catchment sources). However, the extensively modified and low energy nature of the surface drainage network means that significant improvements are likely to be spatially constrained to areas where direct interventions have been applied. This means that the primary pressures on biology in the Leiston Beck water body are unlikely to change significantly during the operational lifetime of the proposed development. The assessments presented in the previous sections are therefore considered to be suitable for likely future baseline conditions.

2.5.379. Similarly, the status of the groundwater body is not expected to improve significantly during the early operational phases of the development, although improvements to both quantity and quality could occur in the longer term. However, because minimal changes in groundwater and quality are predicted as a result of the platform, its permanent presence is unlikely to result in a significantly greater impact on groundwater in the future.

n) Detailed Assessment – O2 Presence of permanent SSSI crossing / main site access road

i. Introduction

2.5.380. This assessment includes effects associated with the permanent presence and operational use of the main site access road (including SSSI crossing), short access roads and walkways. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.38**.

Table 2.38: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O2

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity	Minsmere Old River Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	N/A
	Physico-chemistry: General, specific pollutants			
	Biology: Aquatic flora, benthic invertebrates, fish			

2.5.381. The proposed SSSI crossing would comprise a causeway running in a north-north-west orientation, from the main development site platform across the SSSI to the permanent access road and temporary construction site at Goose Hill. Where the causeway crosses the existing Leiston Beck, the channel would be culverted.

2.5.382. The majority of below ground structures are within the cut-off wall and will therefore be isolated from the wider groundwater regime. However, this structure is located outside the cut-off wall and therefore has the potential to change the groundwater flow regime by changing the infiltration patterns and modifying recharge to the aquifer.

ii. Hydromorphology

Direct loss of natural geomorphology in the footprint of the proposed crossing

2.5.383. The design comprises a causeway with a half-round box culvert, through which Leiston Beck would flow. The width of the embankment at road level would be up to 35m and the overall width of the crossing at its base would be up to 68m.

2.5.384. The watercourse crossing would be constructed at a size appropriate to avoid restricting the current range of flows that are conveyed through the channel from Leiston Beck and Sizewell drain systems (i.e. it will have at least as much capacity as Leiston Beck channel downstream of the confluence with Sizewell drain). The structure would incorporate a portal culvert (a three sided culvert without a base) which would be offset from the river banks, thereby avoiding the direct disturbance of the river bed and banks. However, the crossing would include sheet pilling along the banks of Leiston Beck to create ledges within the culvert. The installation of sheet piling will result in the permanent loss of the existing bank geomorphology and associated habitats in Leiston Beck within the box culvert.

2.5.385. The proposed causeway would result in the loss of approximately 68m river channel along Leiston Beck. The complete loss of natural habitats cannot be directly mitigated. However, the length of channel lost and replaced with a culvert is very small in comparison to the total length of Leiston Beck (5.75km from Abbey Road to Minsmere sluice), accounting for 1.12% of the total watercourse length.

2.5.386. Any impacts that result in a non-temporary effect on hydromorphology has the potential to cause water body deterioration. However, given the spatially constrained nature of the impact (direct losses would be limited to the immediate culvert footprint) and the inbuilt control measures to prevent impacts outside the footprint of the culvert outlined above, it is considered that any changes will be small-scale and will not have the potential to affect the wider geomorphological functionality of the river, or the ecology it supports. The impact of the proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD quality element at water body level.

Changes to geomorphology upstream and downstream of the proposed crossing

2.5.387. The presence of a culvert has the potential to cause changes to the geomorphology of Leiston Beck in the water body reach upstream of the structure by restricting flows and creating impoundment (with an estimated maximum extent of approximately 180m, based on the channel bed gradient). This could reduce the energy of the river during low flow conditions and encourage increased sedimentation on the channel bed upstream of the proposed crossing location. In addition, the presence of an obstruction on the bed of the river could also prevent the downstream movement of bed sediments.

2.5.388. However, the proposed portal culvert would not include a base, leaving the natural bed undisturbed and facilitating natural sediment transport. Any culvert will need to convey the 1:100 flow in the combined Leiston Beck and Sizewell drain channel plus an additional allowance for climate change, which will ensure that there is no impoundment (up to this flood flow) and will therefore minimise the potential of any adverse impacts to the geomorphology of the upstream ditch network occurring. In addition, any culvert would ideally be sized to avoid very shallow water depths ("sheet flows") during periods of lower flow (e.g. less than Q50) to ensure that sediment transport and fish passage is not impeded. For example, a culvert that is significantly larger than the current natural channel could result in much shallower flows through the structure than in adjacent unmodified reaches.

2.5.389. The presence of a culvert could also result in changes to channel geomorphology in the area immediately downstream of the structure, for example by reducing the cross sectional area of the channel. This would increase flow velocities within the structure and could increase the erosivity of flow at the downstream outlet, potentially leading to increased erosion. However, the culvert would not include a base, thereby maintaining a natural substrate, and sized to accommodate the 1:100 flood event plus an allowance for climate change. In addition, the incorporation of suitable bed and bank protection (using sustainable green engineering solutions as far as possible) at the downstream outlet of the culvert would reduce the likelihood of increased bed and bank scour as a result of high velocity flows exiting the culvert, ensuring that potential future geomorphological change is minimised.

2.5.390. The impact of the proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD quality element at water body level.

Changes to geomorphology resulting from changes to water level and flow

2.5.391. The presence of the culvert could result in localised changes to groundwater levels, which could in turn change the volume of surface water conveyed in the channel and result in geomorphological adjustment (e.g. increased erosion as a result of increased flows and increased sedimentation as a result of decreased flows).

2.5.392. Analytical calculations from the Sizewell C SSSI Crossings: Environmental appraisal of options under consideration (Ref. 2.37) have estimated that upstream groundwater levels could increase by a maximum of 0.19m, with zero predicted change within a radius of 40m. As described further in Sizewell C SSSI Crossings (Ref. 2.37) further modelling revised the estimates of changes in groundwater elevation caused by the use of sheet piling to be of the order less than 10mm during the operation phase. The assessment identified that the predicted maximum changes in surface water level immediately adjacent to the crossing and caused by the crossing itself, are well within the baseline variation of water levels that is observed under current conditions.

2.5.393. The SEEP/W groundwater model predicts that the maximum extent of groundwater level change will be 90m from the piles in the operational phase.

Given that potential changes in surface water levels would be driven by changes in groundwater level, the maximum extent of changes to surface water level would be within this envelope.

2.5.394. The very small magnitude of the changes to groundwater levels predicted as a result of the proposed SSSI crossing mean that significant changes to surface hydrology or geomorphology outside of the usual envelope are very unlikely.

2.5.395. The impact of the proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD quality element at water body level.

iii. Physico-chemistry

Changes to surface water chemistry resulting from drainage from the permanent SSSI crossing

2.5.396. The permanent presence of the proposed SSSI crossing will result in changes in surface runoff within the Leiston Beck water body.

2.5.397. A drainage system, compliant with the requirements of the Design Manual for Roads and Bridges, would collect surface water run-off from the road where it would outfall into a swale and infiltrate to ground – see **Outline Drainage Strategy**, **Appendix 2A** of **Volume 2** of the **ES** (Doc Ref. 6.3). Runoff from the SSSI crossing infrastructure, therefore, would be diverted away from the SSSI.

2.5.398. Given that drainage from the causeway would discharge to the drainage network on the main development site before discharging to the sea, no effects on water quality in the surface waters are predicted. The proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD quality element for the Leiston Beck water body.

Changes to surface water chemistry resulting from changes to groundwater

2.5.399. 2D modelling of the impact of sheet piling (Sizewell C SSSI Crossings: Environmental appraisal of options under consideration (Ref. 2.37), provided in **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3)) suggests that these options could generate a very small localised rise in groundwater levels to the west of the crossing, and a corresponding fall to the east. This could theoretically encourage a greater exchange between groundwater and surface water. The physico-chemical quality of the groundwater and surface water are different and therefore increased exchange could lead to changes to the surface water quality.

2.5.400. For the period when data is available for the three flow gauges on Leiston Beck and Sizewell drain closest to the crossings area it can be seen that:

- The mean accretion is approximately $0.018m^3s^{-1}$ (approximately 15% of the median flow at gauge G1, located on Leiston Beck approximately 200m downstream of the confluence with Sizewell drain). However, there is a period of anomalously high accretion during April 2015, which shows much smaller variation. If this period is excluded, the mean becomes approximately $0.0022m^3s^{-1}$ (approximately 1.9% of the median flow at gauge G1).
- The accretion shows significant sub-daily variation ($+4m^3s^{-1}$ to $-4m^3s^{-1}$), as does the monitored flow at each gauge. Some of this variation may be due to the random error associated with gauging low velocity flows. However, some of this variation may be due to periodic tide-locking effects at Minsmere sluice causing water to move up Leiston Beck.
- The one day rolling average also shows significant variation (approximately $+0.58m^3s^{-1}$ to $–0.18m^3s^{-1}$).
- There are broad seasonal scale changes but the period for which data are available is insufficient to determine a pattern.

2.5.401. From the flow accretion data it can be seen that there is significant exchange with shallow groundwater in the area of the proposed SSSI crossing, and a proportionally small net gain.

2.5.402. Piezometer P10 is sited in or close to the footprint of the proposed crossing and has its response zone within the peat. Therefore, water quality observed at P10 is likely to be representative of the shallow groundwater which may be influenced by the crossings. A full description of the quality observed at P10 can be found in the hydrogeological conceptual site model – provided in **Appendix 19B** of **Volume 2** of the **ES** (Doc Ref. 6.3) – but can be summarised as being calcium chloride dominated, which is characteristic of a significant amount of exchange with surface waters and / or saline intrusion due to proximity to the sea.

2.5.403. The evidence from water quality monitoring is consistent with significant exchange between shallow groundwater and surface water in the area of the proposed SSSI crossing. There is likely to be a broad, diffuse hyporheic zone associated with both Leiston Beck and Sizewell drain. Progression from reducing, lower pH, metalliferous conditions at depth in the peat to aerobic, higher pH conditions with less dissolved metals at the interface with the drains would be gradual. Distinct sharp changes in water chemistry with depth would not be expected.

2.5.404. As described in the Sizewell C SSSI Crossings: Environmental appraisal of options under consideration (Ref. 2.37), modelling estimates that changes in groundwater elevation caused by the use of sheet piling would be of the order of less than 10mm during the operation phase. The model is 2D and does not take into account the potential for flow around the northern end of the structure and is therefore likely to be conservative. This will be incremental to the changes to the groundwater regime caused by the greater power station development, including the cut-off wall.

2.5.405. The model shows the small increase in groundwater levels to the west of the crossing would be matched by a corresponding small decrease to the east. The net change in groundwater inflow across the crossing area as a result the proposed SSSI crossing would be very small. There is likely to be a small increase in the mixing of surface water and groundwater, however these are already very well mixed and the additional mixing is unlikely to be perceptible.

2.5.406. The proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD quality element for the Leiston Beck water body.

iv. Biology

2.5.407. For the purpose of this WFD Compliance Assessment, only biological elements of relevance to WFD (fish, invertebrates and aquatic flora) are considered.

2.5.408. In line with the Sizewell C SSSI Crossings: Environmental appraisal of options under consideration (Ref. 2.37), the following potential impacts on the Leiston Beck water body are scoped out of this assessment:

- Potential impacts on biological elements in Leiston Beck in internationally protected areas (i.e. within the Minsmere to Walberswick SAC, SPA and Ramsar site approximately 100m downstream of the proposed crossing) associated with changes in water levels. These have been scoped out because the predicted changes are not only very small but would also not be experienced at all beyond 60-90m down-stream of the crossing and would not therefore affect this site.
- **Section 2.5m) ii** describes the hydrological and hydromorphological implications of groundwater upflow and the introduction of embankment materials. Given that no noticeable impacts are predicted, any potential effects of changes to hydromorphological impacts on biological receptors can be scoped out.

- **Section 2.5m) iii** describes the water quality implications of groundwater upflow and the introduction of embankment materials. Given that no noticeable impacts are predicted, any potential effects of changes to physico-chemical impacts on biological receptors can be scoped out.

Habitat loss (direct impacts)

2.5.409. The Sizewell C SSSI Crossings: Environmental appraisal of options under consideration (Ref. 2.37) identifies that the most significant direct impact of the proposed SSSI crossing is the habitat loss associated with land take within Sizewell Marshes SSSI. For the purpose of this WFD assessment, this impact is limited as most of the habitat lost is on land, and the main aquatic habitat (Leiston Beck itself) is retained through the culvert.

2.5.410. Of the key habitat types present within Leiston Beck water body near the proposed SSSI crossing, ditch habitat is of highest value with regards to WFD compliance. Whilst the area of impact may appear relatively large on the ground, the magnitude of the impact of the proposed SSSI crossing on ditch habitats is very low, as the extent of habitat to be lost is small, accounting for 1% or less of the habitat resource available within the Sizewell Marshes SSSI (a subarea of the Leiston Beck water body).

2.5.411. Direct loss of ditch habitat will also affect the aquatic plant, fish and invertebrate species using this habitat, through a loss of suitable substrate, shelter, foraging resources and / or spawning / breeding habitat.

2.5.412. For aquatic plants, the habitat loss would be confined to the particular length of ditch habitat underneath the crossing footprint. The maximum length of ditch habitat 'lost' would be 68m, which equates to 1.12% of the length of Leiston Beck, and less than 1% of the available ditch habitat within the Sizewell Marshes SSSI (a subarea of the Leiston Beck water body). Furthermore, whilst the vegetation is unlikely to persist within the culvert, the water column itself will be maintained, albeit without floating, emergent or fringing aquatic vegetation.

2.5.413. For the invertebrate assemblage, the habitat loss would relate not only to the length of ditch habitat within the footprint of the different options, but also the areas of reedbed and wet woodland. Again, though, this would represent only a small fraction of the habitat available to the aquatic invertebrate population within the Leiston Beck water body.

2.5.414. Fish species are not restricted to the crossing location, and the sensitivity of these species, specifically to habitat loss under the crossing footprint, is therefore considered to be low. The small extent of habitat loss from the wider drainage network to accommodate the proposed SSSI crossing will not have a significant effect upon the habitat resource available to fish species.

2.5.415. The loss of habitat for fish, aquatic plant and invertebrate populations across the water body would represent a very small proportion of habitat available for these species. Therefore, the magnitude of impact for these biological quality elements associated with direct habitat loss is very low.

Habitat deterioration (indirect impacts)

2.5.416. The proposed SSSI crossing could potentially alter the habitat quality of the river channel by increasing upstream water levels and encouraging increased sedimentation and increasing downstream flow velocities and increasing bed and bank scour. This has the potential to affect in-channel habitats for aquatic organisms and therefore has the potential to cause deterioration in the status of the biological quality elements supported in the Leiston Beck water body.

2.5.417. However, the culverts would be designed to minimise any impacts on the river channel by preventing upstream impoundment, retaining natural bed substrates and associated habitats, preventing geomorphological adjustment downstream and allowing the free passage of aquatic organisms (Ref. 2.37). Therefore, the magnitude of impact for these biological quality elements associated with indirect habitat loss is very low.

Changes in hydrology / hydrogeology

2.5.418. A preliminary analytical groundwater assessment (Ref. 2.37) and a more detailed numerical assessment (Ref. 2.37) were undertaken to assess the predicted changes in water levels as a result of constructing the proposed SSSI crossing. This modelling predicted only a very small, highly localised effect.

2.5.419. Following temporary reductions in water levels of 1cm during construction, in the operational phase, the water levels would stabilise, and long term changes are predicted to be less than a 1cm increase in levels to the west of the crossing (i.e. up-gradient), with a corresponding reduction to the east, with no change apparent 60m from the crossing on both sides.

2.5.420. The ecological impact arising from this minor predicted water level change would be upon those habitat types present within the zone of influence identified above (i.e. within 60m of the crossing following construction), that is, ditch habitat, wet woodland and reedbed within Sizewell Marshes SSSI.

2.5.421. Ditches are relatively robust to small-scale temporary variation in water levels, already being subject to seasonal fluctuations substantially greater than the modelled changes. It is considered that changes in levels of the magnitude indicated will not be sufficient to bring about any long-term change or degradation to the species composition of ditch habitat present.

2.5.422. Likewise, no degradation of Leiston Beck downstream of the crossing (forming part of the Minsmere to Walberswick Ramsar criterion) is predicted. The predicted changes in water levels are therefore not predicted to have a significant impact upon any aquatic invertebrates or fish using these ditch habitats.

2.5.423. In summary, changes in water levels as a result of the proposed SSSI crossing structure are not considered to have a significant impact on biological quality elements for Leiston Beck water body.

Ecological connectivity

2.5.424. Ecological connectivity for fish, invertebrates and aquatic flora in the ditch habitats of the Sizewell Marshes SSSI are not considered likely to be affected by the causeway, since these species would continue to migrate along the ditch through the culvert (Ref. 2.37).

2.5.425. The culvert design will ensure that there will be no change in level at the culvert inlet and outlet, the natural bed will be retained, water flowing through the culvert will be a suitable depth and velocity for fish and there will be no local increase in velocity.

2.5.426. Ecological connectivity for biological quality elements in Leiston Beck water body is therefore not predicted to be impacted significantly by the proposed SSSI crossing.

v. Adjoining WFD water bodies

2.5.427. Indirect effects on the Minsmere Old River water body were scoped in to this assessment due to potential pathways from the Leiston Beck water body via Minsmere sluice and via surface water / groundwater interactions. However, the assessment for Leiston Beck has identified at most minor and localised impacts on WFD elements, none of which are considered likely to impact of the hydromorphology, physico-chemistry or biology of Minsmere Old River water body.

2.5.428. The Waveney and East Suffolk Chalk and Crag water body underlies the site. However, the groundwater impact assessment presented in the (Ref. 2.37) demonstrates that any impact will be restricted to the peat aquifer, and not the underlying groundwater body. The ecological impact arising from the minor predicted water level change outlined above would be upon those habitat types present within 60m of the crossing; that is, ditch habitat, wet woodland and reedbed within Sizewell Marshes SSSI. No impacts upon fen meadow habitat are likely to occur, as this habitat type is located approximately 300m (at the nearest point) from the Sizewell Marshes SSSI crossing location. The proposed SSSI crossing is therefore not considered likely to have a significant effect on the status of this WFD water body.

vi. Assessment against possible future baseline

2.5.429. Predicted climate changes under UKCP18 are likely to result in wetter winters, drier summers and a greater number of convectional rain storms. This means that the hydrology of Leiston Beck could change, with higher winter flows, lower summer flows and a greater number of storm-related flood flows. This in turn could result in changes to the geomorphology of the river systems, with increased geomorphological activity (e.g. channel adjustment) occurring in response to larger storm events. However, the stable geomorphological characteristics that currently dominate Leiston beck and its tributaries, and the extensively modified nature of these channels, mean that significant hydromorphological adjustments are unlikely to occur during the operation of the proposed development. It is therefore unlikely that there will be significant changes in the vicinity of the permanent crossing in the future, either as a result of natural processes or the presence of the structure itself.

2.5.430. Any future initiatives to improve geomorphology and in-channel habitats undertaken by the Environment Agency and partner organisations to meet WFD status objectives could deliver localised improvements to hydromorphology, physico-chemistry and biology (e.g. through measures to reduce the supply of fine sediment and nutrients from diffuse catchment sources). However, the extensively modified and low energy nature of the surface drainage network means that significant improvements are likely to be spatially constrained to areas where direct interventions have been applied. This means that the primary pressures on biology in the Leiston Beck water body are unlikely to change significantly during the operational lifetime of the proposed development. The assessments presented in the previous sections are therefore considered to be suitable for likely future baseline conditions.

2.5.431. Similarly, the status of the groundwater body is not expected to improve significantly during the early operational phases of the development, although improvements to both quantity and quality could occur in the longer term. However, because minimal changes in groundwater and quality are predicted as a result of the watercourse crossing, its permanent presence is unlikely to result in a significantly greater impact on groundwater in the future.

o) Detailed Assessment – O3 Presence of marine structures

i. Introduction

2.5.432. This section only considers the presence of the BLF and FRR head structures given that all other structures will either be below the seabed (tunnels) or not located within the WFD water body. The intake and outfall heads are not located within a WFD water body.

2.5.433. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.39**.

Table 2.39: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O3

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Hydromorphology	N/A	N/A	N/A
	Water quality – chemical and physico-chemical			
	Biology - habitats			

ii. Beach Landing Facility

2.5.434. As outlined in C3, dredging would occur over an area of 0.91ha once per year during the construction phase (9-12 years) following the initial site clearance. Monthly maintenance dredging, considered likely to be approximately 10% of the initial dredge volume, is predicted. During the operational phase of the power station, dredging would continue at a reduced frequency; likely to be one campaign every 5-10 years.

Hydromorphology

Water depth

2.5.435. Localised changes in water depth will occur as a result of periodic maintenance dredging as well as possible scour around permanent infrastructure. As the infrastructure footprint is small, there are no predicted broadscale effects from changes in water depth due to raised seabed structures (less than 5m above the seafloor).

Seabed and intertidal structure

2.5.436. Once constructed, the seabed surrounding the BLF, fenders, and dolphin piles will scour. For estimating a conservative area of potential habitat change, scour predictions were based on the modelled peak tidal current during a storm surge event, where the bases of all piles were submerged. The total area impacted, including the footprint of the structures themselves, was predicted to be approximately 850m^2 (conservative estimate of habitat change). A change in substrate could occur where the over lying sediment has been removed and scoured down to different sedimentary material or rock, or where scour protection is used, which introduces hard substrate. Where scour protection is used there will be a change in substrate from sand to rock (concrete).

2.5.437. With respect to dredging required at the BLF, as sediment mobility in nearshore zones is high, and the navigation channel narrow, the channel is expected to infill and so the depth change for the BLF is temporary (Ref. 2.13).

Direction of dominant currents

2.5.438. The low density of piles (spacing is 11.2m cross-shore and 6.3m alongshore) means that the BLF is transmissive to water movement, and the local effect on current flow and wave energy transmission is expected to be minimal. Modelling shows that when the BLF is not in use (structure only) the two end deck piles combined with the fender piles slightly interrupts the shore parallel tidal flow, with a small decrease in the currents in the lee of the piles up to a maximum distance of 45m. Closer to shore the effects lessen, due to the lower current speeds in shallower water.

Alterations to waves

2.5.439. When the BLF is not in use, changes to waves are small, with a maximum increase of 20% and a maximum decrease of 17%, over 0.1ha. Most changes are to the north of the structure due to the ebb tidal conditions and the south-easterly waves being considered (Ref. 2.13).

2.5.440. The peak increase in wave energy when the BLF is in use is approximately 150%, although this is for a very small area of around 500m^2. The peak decrease in wave energy is 52% and is observed around the first mooring dolphin. The area of seabed where the change in wave energy is greater than or less than five percent (±5%) corresponds to about 2.25ha over a 400m frontage. These results show that dredging works have a higher impact on wave energy, both in spatial extent and magnitude however in relation to the scale of the WFD water body small.

Physico-chemical and chemistry

2.5.441. The effect of maintenance dredging required for the BLF is similar in plume shape to the capital dredge (see activity C3), but on a smaller spatial scale and results in smaller concentrations of SSC and siltation (Ref. 2.30). The same conclusion is therefore reached which states that a deterioration within class or between classes is not predicted.

Biology

Phytoplankton

2.5.442. Phytoplankton exposed to increases in SSC may be susceptible to reductions in productivity. The short duration and transitory nature of the plume indicate that small declines in primary productivity may occur, but recovery would be rapid following cessation of the dredging activity. As a result, effects on phytoplankton on a water body scale are not predicted.

Habitats

2.5.443. Benthic species with preferences for soft or hard substrates would be affected by a change in seabed type from soft sediment to a hard surface. The approximate area of seabed that would be changed from soft sediment to a hard surface for the BLF would be $2m^2$ within the intertidal area and $12m^3$ in the subtidal area. These areas are very small compared to the size of the WFD water body and lower sensitivity habitats present.

2.5.444. In relation to navigational dredging, this will be much less frequent than during the construction phase as dredge activities are expected once every 5-10 years rather than annually. It is therefore considered likely that recovery would occur in between disturbances.

2.5.445. As a result, effects on a water body scale are not predicted.

iii. FRR

Hydromorphology

2.5.446. The scour pits for the FRR heads would be broadly elliptical due to reversing tidal currents, with a 7.2m extent from each side of the structure along the tidal axis (north – south) and a 4.1m extent across the tide (east – west). Secondary or edge scour, would be likely to form around the perimeter of the scour protection, as observed at the Sizewell B intake heads, and therefore the total area influenced by the presence of the structure would be larger than if no scour protection was installed (Ref. 2.13).

Physico-chemical and chemistry

2.5.447. Given the very small areas over which effects will occur, a deterioration in the water body is not predicted.

Biology

Phytoplankton

2.5.448. Phytoplankton exposed to increases in SSC in relation to scour may be susceptible to reductions in productivity. Given the very small areas over which effects will occur, a deterioration in phytoplankton communities is not predicted.

Habitats

2.5.449. Benthic species with preferences for soft or hard substrates would be affected by a change in seabed type from soft sediment to a hard surface. The approximate area of seabed that would be changed from soft sediment to a hard surface for the FRR would be $18m^3$ in the subtidal area under the intake heads in addition to approximately $400m^2$ for scour protection. These areas are very small compared to the size of the WFD water body and lower sensitivity habitats present. As a result, effects on a water body scale are not predicted.

iv. Interaction of effects within this activity

2.5.450. The combined area of habitat alteration from soft to hard within the WFD water body would be approximately $420m^2$. Given the relatively small area compared to the size of the subtidal sediment effected within the WFD water body, effects on a water body scale are not predicted.

v. Assessment against possible future baseline

2.5.451. Potential changes in sea temperatures and associated effects on seawater parameters would not alter the outcomes of the assessments and conclusions described above for the presence of the marine structures.

2.5.452. Given the presence of the FRR system, intake and outfall structures on the seabed, the predicted increase in sea level rise and increases in storminess would also not be altered by the potential changes in the future baseline.

2.5.453. The presence of the BLF and the gradual movement of the shoreline inland as a result of sea level rise whilst could present some operational issues, is unlikely to significantly alter the potential effects over and above those predicted for the current baseline.

p) Detailed Assessment – O4 Presence of coastal defence features

i. Introduction

2.5.454. This assessment considers the presence of both the soft and hard coastal defence features.

2.5.455. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.40**.

Table 2.40: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O4

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Hydromorphology	N/A	N/A	N/A

2.5.456. The coastal defence features at Sizewell C would be built on land above MHWS and consist of a hard-engineered component and a soft (sedimentary, landscaped and vegetated) component. Neither would be constructed within the WFD water body and in particular, the HCDF would be set well back from the coast and landward of the presence dune barrier.

2.5.457. As a result, its presence would not affect the current baseline hydromorphology of the WFD water body. However, it is acknowledged that material changes to physical processes could occur if exposed during a future baseline scenario. The potential for exposure would, however, be reduced due to the SCDF, which would slow shoreline retreat at the frontage of the proposed development and because beach management would be applied to maintain a shingle beach in front of the HCDF. Further consideration of the potential effects is given below.

2.5.458. The operation of the SCDF does, however, have the potential to affect coastal processes on the present baseline (through provision of additional sediment that would not otherwise be available) and therefore the operation of this structure is considered below.

2.5.459. It should be noted that embedded mitigation is included in the design of the coastal defence features as follows:

- Sediments used to construct the SCDF would be won from the excavation of the HCDF (if suitable) or delivered to the site rather than reprofiling the beach, resulting in a volumetric increase in the back-beach area.
- The sacrificial sediments of the SCDF would be of a substantially greater volume than the present beach / dune volumes. These beach grade sediments would be used in landscaping, be vegetated and as they erode under natural storm events, they would locally slow the rate of shoreline retreat. The location, behind the active beach, would result in the gradual release of sediment when storms erode its seaward face. Mitigation would be implemented to maintain the SCDF as required.
- The HCDF would be located landward of the SCDF and have a rock armour core dressed in a shingle / sand / soil matrix to facilitate vegetation colonisation which, like the SCDF, would stabilise the sediment.
- The HCDF positioning is as far as practical away from the shore (eastern flank) to increase its duration as a terrestrial feature that would have no influence on coastal geomorphology and hydrodynamics.
- The north-eastern corner of the HCDF would be curved to minimise potential disruption to sediment transport if exposed under future sea level rise scenarios.

ii. Hydromorphology

Soft coastal defence feature

2.5.460. The placement of the SCDF would alter the beach in two ways; it would change the profile above MHWS and increase the beach volume in that area. As a result of the larger back-beach volume, the rate of shoreline retreat would be slower and relatively small volumes of extra sediment would be episodically introduced into the coastal system during storms with high water levels. The SCDF is expected to last for several decades before it would be fully depleted due to the low rates of erosion along the Sizewell frontage.

2.5.461. Material eroded from the SCDF during storm event would supply extra sediment in a fashion similar to a small-scale sand / shingle engine. However, the SCDF would have no overall effect on the natural operation of the coast.

iii. Assessment against possible future baseline

2.5.462. It is possible that beach recession could eventually lead to exposure of the HCDF, which could result in localised alternating patterns of erosion and accretion from blockage to gross transport during individual storms. That is, despite low net rates of shoreline change, the envelope of shoreline positions would be high due to localised starvation in the lee of the HCDF during storms.

2.5.463. Reversal of the storm direction would see the return of the eroded sediments (Ref. 2.38). However, with planned beach management activities (additional 'secondary' mitigation) (bypassing, beach recycling or beach nourishment) to maintain the beach, there would be no disruption to longshore sand and shingle transport. These mitigation measures would not however, be required until approximately 2053-2087 and would be informed by ongoing monitoring and storm modelling.

2.5.464. It is therefore unlikely that there will be a significant effect on the hydromorphological features of the WFD water body in the future.

q) Detailed Assessment – O5 and O7 Cooling Water Discharge (waste streams A-G)

i. Introduction

2.5.465. This assessment considers waste streams A to G which would be discharged out of the cooling water outfall and assesses the implications of the thermal and chemical properties of the discharge on WFD water bodies.

2.5.466. It is considered that hot functional testing, during commissioning, would have the same effects as running the systems under normal operating conditions and, therefore, the assessment for operational discharges also applies to hot functional testing discharges. As a result, hot functional testing is not specifically referred to in the assessment that follows, but the outputs are relevant to commissioning.

2.5.467. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.41**.

Table 2.41: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O5 and O7

Activity	Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
O5 Surface and foul water discharge via cooling water system	Suffolk	Water quality – chemical and physico-chemical Biology – Habitats	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	661 Southwold The Denes Southwold The Pier
O7 Discharge of trade effluent from cooling water system	Suffolk	Water quality – chemical and physico-chemical, Biology - Habitats under plume INNS (spread of rather than introduction)	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	661

ii. Physico-chemistry - temperature

Methodology

2.5.468. To undertake the WFD Compliance Assessment, guidance issued by UKTAG (Ref. 2.39 and Ref. 2.40) recommends that maximum temperatures at the edge of the mixing zone should not exceed 23˚C (representative of Good Status) and, that outside the mixing zone, temperature rises above ambient should be limited to 3˚C (see **Table 2.42**).

Table 2.42: Recommended interim thermal standards (Ref. 2.39 and Ref. 2.40)

Standard	High	Good	Moderate	Poor
Maximum temperatures (as an annual 98 percentile allowed at the edge of the mixing zone)	20˚C	23˚C	28˚C	30˚C
Deviation from ambient outside of mixing zone	2°C	3˚C	3˚C	3˚C

2.5.469. BEEMS Science Advisory Report SAR008 (Ref. 2.41) considered the interim thermal standards outlined above and concluded that the UKTAG WFD recommendations (Ref. 2.39 and Ref. 2.40) should be adopted, with the exception that the maximum temperature for High Status should be set at

23˚C not 20˚C due to naturally higher summer temperatures in southern parts of the United Kingdom.

2.5.470. Hydrodynamic modelling was then undertaken to calculate the area over which the values set out above would be exceeded (Ref. 2.1, Ref. 2.42 and Ref. 2.43). The water to be discharged back to the marine environment was assumed to be 11.6°C above ambient temperatures with a flow of $125m^3s^{-1}$ for the operational scenario and 23.2°C above ambient temperatures with a flow of $62.5m^3s^{-1}$ for the maintenance scenario.

2.5.471. Modelling was undertaken using the validated Sizewell GETM (Ref. 2.42) and looked at indicative locations for the outfall to determine the worst case scenario for thermal effects (see Ref. 2.42 for further detail). The modelling also assumed that Sizewell B would be operational until at least 2035 and, therefore, this is accounted for (as part of the baseline) in the results of the assessment. Four intake heads and two outfall heads were included in the model as a realistic representation of the final design.

2.5.472. Four scenarios were considered; the first with no power stations present, the second with only Sizewell B operating, the third with both Sizewell C and B operating simultaneously and the fourth with Sizewell C under maintenance. A further set of model runs considered the effects of Sizewell C alone under normal operating conditions.

2.5.473. The effect of the power stations was evaluated by calculating the difference in temperature between the station(s) operating runs and the run which had no power station discharge. The difference was calculated for each hourly snapshot and the annual mean and the 98^{th} percentile were calculated from the difference. For assessment against absolute thermal standards, it was determined that the GETM model overestimates absolute temperatures and, therefore, a more reliable prediction of the 98^{th} percentile is derived by adding the predicted mean temperature uplift due to the plume (i.e. the annual mean excess plume temperature) to the observed 98^{th} percentile seawater background temperature (19.4˚C).

Maintenance scenario

2.5.474. The proposed Sizewell C power station has two pump systems that can work independently. When one of the pump systems is under maintenance the flow of cooling water would be halved but the heat content would remain approximately the same, raising the temperature at the outfall from 11.6°C to 23.2°C. The concern with this scenario is whether the warmer water at the outfall would lead to a larger, hotter plume which caused greater environmental impacts than the normal operation of Sizewell C. This would be of particular concern during the spring bloom when biological activity is at a peak, so a maintenance scenario was run for the month of May.

2.5.475. The results of the modelling indicate that the warmer plume loses heat faster to the atmosphere, resulting in less heat being mixed down into the water column. This reduces the size of the excess temperature plume compared to that arising during normal operation with all pumps running. As a result, the maintenance scenario is not considered further as the thermal plume effects of any maintenance would be within the extent of the effects experienced during normal operation.

Operational scenario

2.5.476. The tides at Sizewell are strong (greater than $1ms^{-1}$) and interaction with the bathymetry dominates the shape of the thermal plume and determines its effect at the seabed (Ref. 2.43). The general conceptual model of heat loss from a plume in a tidal environment is that, initially, the discharge plume will be buoyant and it will be advected by the current flows and lose heat to the atmosphere. There will come a point when the heat loss is sufficient that the difference in buoyancy between the surface and bed (stratification) does not overcome the vertical mixing due to the tides. The remaining heat energy is then mixed down and raises the general background of the water body.

2.5.477. The two stations considered herein have different discharge depths, 5m and 16m for Sizewell B and Sizewell C respectively. As vertical tidal mixing is from the seabed, the Sizewell B discharge inshore in 5m water depth is mixed down more quickly than the offshore Sizewell C discharge would be in 16m water depth. As a result, much of the total thermal uplift from the scenario with both stations operational is dominated by the Sizewell B discharge and the Sizewell C discharge only produces very small thermal effects at the seabed.

2.5.478. The Sizewell C and Sizewell B plumes are separate at high plume temperatures but at lower temperatures the Sizewell C plume increases the size and temperature of the Sizewell B plume at the surface and seabed. Note that the Sizewell C plume is smaller and guidelines are only exceeded outside of the 1nm offshore limit of the WFD water body (see **Table 2.43**, **Table 2.44** and **Figure 2.21**, **Figure 2.22** and **Figure 2.23** for surface temperatures and **Figure 2.24, 2.25** and **2.26** for seabed temperatures). A differential plot of the difference in thermal uplifts between Sizewell B operating alone and the addition of Sizewell C is provided in **Figure 2.27** (seabed temperatures) and **Figure 2.28** (surface temperatures). This further demonstrates that the main effects in the coastal zone are associated with

Sizewell B and Sizewell C only increases temperatures by very small amounts in the coastal area.

Table 2.43: Areas where the WFD temperature standards are predicted to be exceeded within the Suffolk coastal water body

Model run	Position	98 percentile >23°C (area below 'Good' threshold) hectares	98 percentile >28°C (area below 'Moderate' threshold) hectares
Sizewell B alone	Surface	43.77 (0.3%)	0
	Seabed	8.63 (0.06%)	0
Sizewell C alone	Surface	0	0
	Seabed	0	0
Sizewell B and Sizewell C	Surface	87.66 (0.6%)	0.11 (<0.01%)
	Seabed	23.81 (0.16%)	0

Table 2.44: Areas where the WFD uplift temperature standards would be exceeded within the Suffolk coastal water body

Model run	Position	Excess temperature >2°C <3°C as a 98 percentile (area at 'Good') hectares	Excess temperature >3°C as a 98 percentile (area at 'Moderate') hectares
Sizewell B alone	Surface	2428 (17%)	1260 (8%)
	Seabed	2121 (15%)	665 (5%)
Sizewell C alone	Surface	0	0
	Seabed	0	0
Sizewell B and Sizewell C	Surface	4123 (28%)	1859 (13%)
	Seabed	3758 (26%)	1550 (11%)

2.5.479. Given that the thermal standards outlined above are not evidence based in relation to biological effects (Ref. 2.44), interpretation as to whether the predictions outlined above could cause a deterioration the water body (for the combined effects of Sizewell C and Sizewell B only) is undertaken for parameters that can respond to changes in seawater temperature. These are as follows:

- physico-chemical parameters (ammonia and dissolved oxygen);
- biology (habitats and fish);
- INNS (in terms of encouragement of spread); and

- phytoplankton.

2.5.480. These parameters are considered below.

iii. Physico-chemical – other parameters

Ammonia

2.5.481. Ammonia is considered as part of the chemical assessment (see **section 2.5 q) iv** below).

Dissolved oxygen

2.5.482. At a constant salinity, temperature has a direct effect on the concentration of dissolved oxygen (near linear). However, in sea water, there are several biological processes which affect oxygen concentration through either consumption (respiration) or production (primarily photosynthesis). The dominant effect on oxygen concentration in the thermal plume comes from the change in temperature and the likely saturation of the warm plume. The plume as it comes out of the power station would be warmer than the intake and would, therefore, have less capacity to carry oxygen.

2.5.483. If the original intake water was fully saturated, then the hotter water would be supersaturated (as the oxygen has nowhere to go) and escape to the atmosphere soon after discharge. Subsequent to this the plume would remain on the surface and equilibrate (in the absence of biological processes) to the atmospheric concentration and remain at approximately 100% saturation. The plume would mix and cool; as it mixes it would reduce the dissolved oxygen carrying capacity of the water it mixes with as the resultant temperature of the mixed water would be higher than that of the background. As the plume cools and whilst it is at the surface and still in contact with the atmosphere, it would be able to absorb oxygen from the atmosphere. Thus, maps of the spatial extent of the plume which incorporate both the mixing and cooling processes are reliable indicators of the maximum oxygen content when at 100% saturation. However, in some water bodies, due to biological oxygen demand, the observed oxygen values are reduced below those of saturation.

2.5.484. In Sizewell Bay there is no evidence of high biological oxygen demand and there are no apparent oxygen deficits, the minimum oxygen saturation from 83 observations was 91% and the average was 101% saturation (Ref. 2.15).

2.5.485. Calculations of the concentration of dissolved oxygen at saturation have been derived from the GETM model output using mean salinity values (33.27) taken from the annual data obtained during 2010, and the derived temperature fields from each run using the method of Benson and Krause (Ref. 2.45). A biological demand has not been applied to the results given the survey results.

2.5.486. GETM runs show the area calculated that is beneath various dissolved oxygen concentrations for the entire model domain. The spatially average dissolved oxygen concentration for both Sizewell B and Sizewell C and Sizewell B alone is greater than $7mgl^{-1}$ as a 5th percentile, which is considerably above the WFD threshold for High Status of $5.7mgl^{-1}$. As a result, a deterioration in class status is not predicted.

iv. Chemistry

Screening potential for deterioration

2.5.487. To determine the potential impacts to water quality from Sizewell C operational discharges, Environment Agency guidance (Ref. 2.33) has been used. To undertake the assessment, the guidance requires the use of EQS. For chemicals where there are no available EQS, a surrogate value has been derived. These chemicals include hydrazine, morpholine and ethanolamine, and naturally present parameters such as manganese and suspended solids for example.

2.5.488. Two main approaches have been used to develop surrogate quality standard values either based on the review of toxicity data to develop a PNEC (discussed in more detail in Ref. 2.2) or by referring to environmental backgrounds identified during recent monitoring work (Ref. 2.15).

2.5.489. For chemicals associated with sequestering agents used in the demineralisation plant, there are currently no EQS or PNEC values available. Therefore, data available in the literature have been adopted. Further information on the source of each EQS and derived alternative is provided in BEEMS Technical Report TR193 (Ref. 2.3). Baseline concentrations for other parameters are provided in **section 2.5e)**. The relevant EQS and derived alternatives are summarised in **Table 2.45**.

Table 2.45: Summary of EQS and derived surrogates where not available (taken from Ref. 2.3)

Parameter	Annual Average EQS	Maximum allowable concentration EQS	Maximum allowable concentration as 95 percentile EQS
	Units µg l^{-1} unless otherwise stated		
Cadmium and its compounds (dissolved)	0.2	-	-
Lead and its compounds (dissolved)	1.3	14	-
Mercury and its compounds (dissolved)	-	0.07	-
Nickel and its compounds (dissolved)	8.6	34	-
Chromium VI (dissolved)	0.6		32
Arsenic (dissolved)	25	-	-
Copper (dissolved)	3.76 (2.677 x ((dissolved organic carbon / 2) - 0.5)) µgl^{-1} dissolved, where (DOC) > 1 mgl^{-1}	-	-
Iron (dissolved)	1000	-	-
Zinc (dissolved plus ambient background concentration)	6.8	-	-
Boron	7000	-	-
Chlorine (total residual oxidant)	-	-	10
Unionised ammonia (NH_3)	21	-	-
DIN (winter)	-	980[7]	-

[7] EQS for nitrogen is based on WFD 99 percentile standard for Good status for an intermediate turbidity water body

Parameter	Annual Average EQS	Maximum allowable concentration EQS	Maximum allowable concentration as 95 percentile EQS
	Units µg l^{-1} unless otherwise stated		
Escherichia coli	≤500 colony forming units/100ml (from bathing waters directive)		
Intestinal enterococci	≤200 colony forming units/100ml (from bathing waters directive)		
Hydrazine	Acute PNEC 0.004 and chronic PNEC 0.0004		
Ethanolamine	Acute and chronic PNEC 160		
Morpholine	Acute PNEC 28 and chronic PNEC 17		
Amino tri-methylene phosphonic acid	Ecotoxicity testing. 74 for acute concentration (24 hour load) and 74 for chronic concentration (annual load)		
Hydroxyethane diphosphonic acid	Ecotoxicity testing. 13 for acute concentration and 13 for chronic concentration		
Acetic Acid	Ecotoxicity testing. 301 for acute concentration and 62.8 for chronic concentration		
Phosphoric acid	Ecotoxicity testing. 200 for acute concentration and 20 for chronic concentration		
Sodium Polyacrylate	Ecotoxicity testing. 180 for acute concentration and 11.2 for chronic concentration		
Acrylic Acid	Ecotoxicity testing. 1.7 for acute concentration, 0.34 for chronic concentration		
Lithium hydroxide	65 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Phosphates	33 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Suspended solids	74000 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
BOD	2000 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
COD	239000 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Aluminumn	12 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Manganese	2 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		

Parameter	Annual Average EQS	Maximum allowable concentration EQS	Maximum allowable concentration as 95 percentile EQS
	Units µg l^{-1} unless otherwise stated		
Sulphates	2778000 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Sodium	10400000 mean background (see Appendix E of BEEMS Technical Report TR193 for raw data (Ref. 2.3))		
Chlorine TRO	10 (95th percentile maximum allowable concentration - EQS)		
Chlorine bromoform	5 (95th percentile maximum allowable concentration - EQS)		

2.5.490. In line with the Environment Agency guidance described above (Ref. 2.33), the above parameters have been assessed using an initial screening process (as follows) for annual average EQS:

- average background concentration for substance multiplied by average cooling water flow (to determine background load);
- average load of substance in process stream added to above load;
- divide result by total of average cooling water discharge volume and average process stream volume combined; and
- compare result to the annual average EQS.

2.5.491. These steps are repeated for maximum allowable concentrations as follows:

- maximum background concentration for substance multiplied by minimum cooling water flow (to determine background load);
- maximum load of substance in process stream added to above load;
- divide above result by total of minimum cooling water discharge volume and average process stream volume combined; and
- compare result to the EQS maximum allowable concentration.

2.5.492. The calculations for the maximum 24 hour loadings are based on a discharge volume of $66m^3s^{-1}$ under maintenance conditions with a single operational EPR. The maximum annual discharge of $116m^3s^{-1}$ is based on a single EPR unit having a minimal operational cooling water flow of $58m^3s^{-1}$ under low tide conditions (the worst-case scenario for ‘standard operation’).

2.5.493. The results of the screening exercise are provided in **Table 2.46**.

Table 2.46: Summary of output from screening assessment (Ref. 2.3)

Substance	EQS or surrogate (μgl^{-1} unless otherwise stated) and surrogate source	24 hour loadings		Maximum annual loadings	
		Discharge concentration (μgl^{-1}) based on daily discharge of 66m3s^{-1}	Discharge /EQS <1	Discharge concentration (μgl^{-1}) on daily discharge of 116m3s^{-1}	Discharge /EQS <1
Boron (derived from boric acid discharge concentration)	7000 (Pre WFD EQS)	4656	0.67	4146	0.59
Lithium hydroxide	65 (mean background)	90.2	**1.39**	65	**1.0**
Hydrazine	0.004 (Acute PNEC for 24 hour loads) and 0.0004 (Chronic PNEC for annual loadings)	0.53	**131.5**	0.01	**16.6**
Morpholine	28 (Acute PNEC for 24 hour loads) and 17 (Chronic PNEC for annual loads)	16.18	0.58	0.46	0.03
Ethanolamine	160 (Acute PNEC)	4.34	0.03	0.25	0.001
Nitrogen as N	980 (WFD 99%)	484.3	0.49	360.12	0.37
Unionised ammonia (NH_3)	21 (annual average EQS)	7.34	0.35	0.96	0.05
Phosphates	33.5 (mean background)	127	**3.79**	33.57	**1.00**
Detergents	-	-	-	0.17	0.2
Suspended solids	74000 (mean background)	-	-	-	-
BOD	2000 (mean background)	0.67	0.00	0.38	0.00
COD	239000 (mean background)	-	-	-	-

Substance	EQS or surrogate (μgl^{-1} unless otherwise stated) and surrogate source	24 hour loadings		Maximum annual loadings	
		Discharge concentration (μgl^{-1}) based on daily discharge of 66m3s^{-1}	Discharge /EQS <1	Discharge concentration (μgl^{-1}) on daily discharge of 116m3s^{-1}	Discharge /EQS <1
Aluminium	12 (mean background)	20.19	**1.68**	12	**1.00**
Copper	3.76 (annual average EQS)	4.76	**1.27**	2.15	0.57
Chromium	32 (95 percentile maximum allowable concentration EQS for 24 hour loadings) and 0.6 (annual average EQS for annual loadings)	2.48	0.08	0.57	0.95
Iron	1000 (annual average EQS)	302	0.3	132.58	0.13
Manganese	2 (mean backgorund)	-	-	-	-
Nickel	34 (maximum allowable concentration EQS for 24 hour loadings) and 8.6 (annual average EQS for annual loadings)	1.17	0.03	0.79	0.09
Lead	14 (maximum allowable concentration EQS for 24 hour loadings) and 1.3 (annual average EQS for annual loadings)	3.94	0.28	1.0	0.76
Zinc	6.8 (annual average EQS)	46	**6.77**	14.7	**2.16**
Mercury	0.07 (maximum allowable concentration EQS)	0.02	0.29	0.02	0.29
Cadmium	1.5 (maximum allowable concentration EQS) and 0.2 (annual average concentration EQS)	0.13	0.09	0.05	0.25

Substance	EQS or surrogate (μgl^{-1} unless otherwise stated) and surrogate source	24 hour loadings		Maximum annual loadings	
		Discharge concentration ($\mu gl^{-1)}$ based on daily discharge of $66m3s^{-1}$	Discharge /EQS <1	Discharge concentration (μgl^{-1}) on daily discharge of $116m3s^{-1}$	Discharge /EQS <1
Chloride	14128000 (mean background)	78.91	0.00	23.81	-
Sulphates	2778000 (mean background)	350.7	0.00	26.90	-
Sodium	10400000 (mean background)	150	0.00	14.32	-
Amino tri-methylene phosphonic acid	74 for both 24 hour loadings and annual loadings (No observable effect concentration (NOEC))	7.89	0.11	2.49	0.03
Hydroxyethane diphosphonic acid	13 for both 24 hour loadings and annual loadings (EC_{50}[8])	0.79	0.06	0.24	0.02
Acetic acid	301 (LC_{50}[9]) for 24 hour loadings and 62.8 for annual loadings (NOEC)	0.02	0.00006	0.004	0.0001
Phosphoric acid	200 (LC_{50}) for 24 hour loadings and 20 for annual loadings (LC_{50})	0.02	0.0001	0.003	0.0002
Sodium polyacrylate	180 for 24 hour loadings (LC_{50}) and 11.2 for annual loadings (NOEC)	7.01	0.04	2.20	0.2
Acrylic acid	1.7 (EC_{50}) for 24 hour loadings and 0.34 for annual loadings (NOEC)	0.18	0.1	0.05	0.13

[8] An EC_{50} is the median effect concentration and is the concentration predicted to cause the defined effect in 50% of the population within the specified time period.
[9] An LC_{50} is the median lethal concentration and is the concentration predicted to kill 50% of the population within the specified time period.

Substance	EQS or surrogate (μgl^{-1} unless otherwise stated) and surrogate source	24 hour loadings		Maximum annual loadings	
		Discharge concentration (μgl^{-1}) based on daily discharge of 66m3s^{-1}	Discharge /EQS <1	Discharge concentration (μgl^{-1}) on daily discharge of 116m3s^{-1}	Discharge /EQS <1
Chlorine (total residual oxidant)	10 (95th percentile maximum allowable concentration EQS)	150	**15**	N/A	N/A
Chlorine bromoform	5 (95th percentile maximum allowable concentration EQS)	190	**38**	N/A	N/A

2.5.494. **Table 2.47** summarises the output of the screening assessment for 24 hour loads for those substances with a ratio of greater than 1.

Table 2.47: Summary of output for 24 hour assessment

Substance failing screening assessment	Comment	Modelling required
Hydrazine	Potential for deterioration identified	Yes
Chlorine produced TROs	Potential for deterioration identified	Yes
Bromoform	Potential for deterioration identified	Yes
Copper	Discharge concentrations are at least 30 times below relevant annual average EQS – high background concentrations are responsible for exceedance	No
Zinc		
Lithium hydroxide	Background baseline has caused the exceedance - for example lithium in the discharge is approximately 300 times below the background concentration	No
Phosphate	The phosphate input is several times above background and as phosphate can contribute to nutrient status further consideration is required	Yes
Aluminium	Again background baseline has caused exceedance – discharge only contributes a 60th of the background concentration	No

2.5.495. Although unionised ammonia was 35% of its EQS, increases in temperature could influence the relative amount of unionised ammonia. As a result, modelling has been undertaken to assess this effect.

2.5.496. **Table 2.48** summarises the output of the screening assessment for the annual loadings for those substances with a ratio of 1 or greater.

Table 2.48: Summary of the screening output for annual loading assessment

Substance failing screening assessment	Comment	Modelling required
Hydrazine	Potential for deterioration identified	Yes
Zinc	High background responsible for exceedance (source unknown) and actual discharge concentration would be below detection limits;	No

Substance failing screening assessment	Comment	Modelling required
	therefore this input would not give rise to a deterioration	
Lithium hydroxide	Discharge concentrations are below the detection limit and are several orders of magnitude below the site background, so discharge concentrations will not give rise to a deterioration	No
Aluminium		
Phosphate	Although the discharge concentration is very low the input can contribute to nutrient status – considered in phytoplankton assessment	Yes

2.5.497. Although DIN was 37% of the EQS, increases in temperature could influence the relative amount and, therefore, potentially impact on protected areas related to nutrient effects. As a result, further consideration is given to this in the protected areas section below.

Assessment of potentially significant parameters

2.5.498. Modelling was undertaken using the validated GETM model of Sizewell used for thermal plume studies. The water quality parameters described below were modelled as fully coupled GETM runs with hydrodynamical parameters:

- Chlorination of the power station cooling water system to avoid bio-fouling. The TRO resulting from the combination of chorine and organic material in the water was modelled using an empirical demand / decay formulation derived from experiments with Sizewell seawater, coupled with the GETM Sizewell model (Ref. 2.46).
- Chlorination by-products (CBPs) as a result of complex chemical reactions in seawater. Many products are formed, the number and type being dependent on the composition and physical parameters of the seawater. The dominant CBPs are, in order, bromoform, dibromochloromethane (DBCM), bromodichloromethane (BDCM), monobromaceitic acid, dibromoaceitic acid (DBAA), dibromoacetonitrile (DBAN) and 2,4,6 tribromophenol. Laboratory studies carried out with chlorinated Sizewell seawater only detected bromoform (Ref. 2.47). Bromoform is lost through volatilization to the atmosphere, with the loss rate being a function of the thermal stratification and values obtained from the literature (Ref. 2.48).
- The addition of hydrazine to control the oxygen concentration in the power station secondary circuit. Hydrazine is an oxygen scavenger that

is used in power plants to inhibit corrosion in steam generation circuits. Hydrazine is used to condition the secondary circuit and in the primary circuit during start up. During normal operation most of the hydrazine injected daily into the secondary circuit would be broken down by the high temperatures present, but trace amounts would be present in the power station effluent discharged via the cooling water system. Based on a conservative assessment of residual hydrazine concentrations, the screening assessment indicates that following discharge and initial dilution the PNEC will be exceeded in this case. Therefore, hydrazine was modelled by using an empirical decay formulation derived in the laboratory coupled with the GETM Sizewell model.

2.5.499. Although these chemicals are not listed in the WFD lists for priority and priority hazardous substances, they are assessed to determine whether they could have an indirect effect on any WFD water body by impacting on other WFD quality elements such as biology, for example.

Total residual oxidants

2.5.500. A worst-case TRO concentration of $0.15mgl^{-1}$ at the outfalls has been used for plume modelling purposes (Ref. 2.1). The TRO plume areas at the EQS ($10\mu gl^{-1}$ as a 95^{th} percentile) in the Suffolk coastal water body have been calculated and show that there is no interaction between the Sizewell C TRO plume (above the EQS) and the Suffolk coastal water body (**Figure 2.29**). As a result, deterioration within the WFD water body is not predicted.

Chlorinated by-products (bromoform)

2.5.501. The amount of bromoform that would be discharged would largely depend on the amount of chlorine to be added, but also on the amount of mixing. Like the TRO plume, the bromoform plume would be a long, narrow feature parallel to the coast. The Sizewell B plume is always within the channel inshore of the Sizewell-Dunwich Bank and does not overlap with the Sizewell C plume that is outside the Bank. The results of the modelling show that there would be no interaction between the Sizewell C TRO plume (above the EQS) and the Suffolk coastal water body (see **Figure 2.30**). As a result, deterioration within the WFD water body is not predicted.

Hydrazine

2.5.502. There is no established EQS for hydrazine and so a chronic PNEC of $0.4ngl^{-1}$ has been calculated for long term discharges (calculated as the mean of the concentration values) and an acute PNEC of $4ngl^{-1}$ for short term discharges (represented by the 95^{th} percentile). To understand the impact of different discharge rates from the treatment tanks two discharge scenarios were investigated: the first one considered a hydrazine discharge of 69ngl^{-1} in daily pulses of 2.32 hours starting at 12pm, and the second one 34.5ngl^{-1} of hydrazine discharged in daily pulses of 4.63 hours starting at 12pm.

2.5.503. The results of the modelling show that there is no interaction between the hydrazine plume and the Suffolk coastal water body (see **Figure 2.31**). As a result, deterioration within the WFD water body is not predicted.

Unionised ammonia as influenced by temperature

2.5.504. Unionised ammonia concentrations have been calculated using the Environment Agency calculator (Ref. 2.49), the GETM output for temperature elevation and observed values for background temperature, salinity, pH and background ammonia levels. The regulatory approach for ammonia considers an annual average. The model runs replicate an annual cycle. Therefore, results have been derived using an average temperature and average ammonia values.

2.5.505. Data presented in BEEMS Technical Report TR193 (Ref. 2.3) indicates that the predicted values are very low under the influence of the thermal plume, even in more extreme conditions and no areas in the model domain (and, therefore, the WFD water body) exceed the EQS of 21µgl^{-1} as an annual mean.

v. Biology

Phytoplankton

Nutrients

2.5.506. The maximum number of people on site would occur when there are refuelling outages. During this time nitrate and phosphate loads would increase above background concentrations and these contributions are represented in the modelling by the peak 24-hour loading during operation. The refuelling outages would typically last four to six weeks but could occur at any time of year.

2.5.507. During the winter period light is limiting and no effect, resulting from the additional supply of nutrients to marine waters, is predicted. It is only in summer that the discharge needs to be considered further.

2.5.508. Maximum daily nitrate discharges represent approximately 2% of the total mass exchanged within the tidal system. The daily average is 0.2% of the exchange rate. For phosphates, maximum daily loadings reach 5%, whilst average annual loadings contribute a very small proportion of the daily exchange (0.03%). Phosphate is not a limiting nutrient within the GSB system and therefore the addition of more phosphate would not be expected to influence phytoplankton growth. Maximum loadings would be short term and small relative to the daily exchange of nutrients.

2.5.509. The CPM model was used to predict the effects of nutrients on the annual gross primary production within the tidal exclusion accounting for entrainment from Sizewell B and Sizewell C during the operational phase. The model predicted annual nutrients loadings would increase production within the GSB by 0.14%. Such changes are orders of magnitude below the natural variation in chlorophyll a biomass.

Thermal effects

2.5.510. Thermal discharges may result in acute and chronic effects on phytoplankton at different positions within the discharge plume. Sensitivity of phytoplankton has been shown to be seasonal, highly site specific and depend on the interplay of local hydrodynamics and ambient temperatures.

2.5.511. At Sizewell, light limitation is the primary factor controlling photosynthesis up to mid-May. The rate of photon absorption limits photosynthesis during periods of light limitation, during which time increases in temperature are not predicted to enhance productivity (Ref. 2.50). Therefore, thermal uplifts are not predicted to enhance the onset of the spring bloom or dramatically enhance productivity at Sizewell during periods of light limitation.

2.5.512. During the growing season when light is not a limiting factor (mid-May to mid-August), thermal uplifts may influence growth rates. A statistical approach has been applied to predict the theoretical maximum growth rate of marine phytoplankton (µmax, per day) as a function of temperature. According to the equation, a 1°C uplift results in an approximate 6.5% increase in µmax, whereas a theoretical 13% increase in maximum growth rates is possible following a 2°C uplift.

2.5.513. These empirical results indicate that thermal uplifts may enhance growth rates in the mid and far-field of the plume during the growth season particularly when ambient water temperatures at Sizewell are below 18ºC. Increases in growth rates in the field would be mediated by the overriding factors of nutrient availability and the light climate. Furthermore, the hydrodynamics of the open coastal site at Sizewell means water exchange with the wider environment would reduce the potential for the formation of phytoplankton blooms.

2.5.514. As a result, effects on phytoplankton communities are considered to be within natural variation and therefore a non-temporary effect on the WFD water body is not predicted.

Habitats

2.5.515. Given that chemical parameters are unlikely to affect the Suffolk coastal water body, this section focuses on the potential effects of the thermal plume. The main species present in the lower and higher sensitivity habitats identified in the baseline are considered individually to assess the potential overall effect of the thermal plume on the habitats at risk as biological responses to increases in temperature are species specific (Ref. 2.51).

2.5.516. The potential effects of thermal discharge on benthic organisms fall under three categories (Ref. 2.41):

- chronic effect due to long term effect of increase in mean temperature on biological processes (growth, reproduction);
- acute effects where absolute temperatures approach lethal levels; and
- short-term fluctuation caused by the passage of large magnitude thermal fronts.

2.5.517. This assessment draws on experimental and observational evidence regarding the response of species to temperature uplifts, as well as documented information on the latitudinal and depth distributions of species presented in BEEMS Technical Report TR483 (Ref. 2.51). Regarding latitudinal distributions, a species has been considered to be less sensitive to mean thermal uplifts if its range extends to low latitudes (i.e. warm waters) and more sensitive if its range is restricted to high latitudes (i.e. cold waters). Regarding depth distributions, a species has been considered less sensitive to temperature fluctuations if it occupies shallow waters (intertidal and shallow subtidal zones; where temperatures fluctuate daily) and more sensitive if it only occupies deeper waters (where temperature is relatively stable).

2.5.518. As a result, the sensitivity of benthic invertebrates found within the WFD water body to thermal discharges ranged from Not Sensitive to Low sensitivity (see **Table 2.49**). However, some cold-water species, such as *Limecola balthica*, are predicted to incur chronic effects associated with reduced growth and / or reproduction over a limited spatial area, while species that prefer relatively warm water, such as *Crangon crangon*, may experience increases in physiological processes.

2.5.519. Based on this, it is concluded that differences in species responses to the thermal plume may lead to minor changes in community composition, but such changes are unlikely to alter the structure or functioning of benthic communities within the WFD water body. Consequently, a deterioration within class or between classes for benthic invertebrates is not predicted for either higher or lower sensitivity habitats.

Table 2.49: Summary of species found in Sizewell sediments and sensitivity to thermal plume (taken from Ref. 2.51)

Species	Summary of description as provided in TR483	Cefas conclusion on sensitivity to thermal plume
Baltic tellin (*Limecola balthica)*	Present along the European coast from the south of the White Sea to Portugal. Evidence to suggest that it is sensitive to warmer winter temperatures but has naturally high fecundity and there is the potential for recruitment from outside the zone of influence of the plume.	Low sensitivity
Common mussel (*Mytilus edulis)*	Widespread and common around the British Isles and it has been observed from Artic waters to the Mediterranean. A few mussel beds can be found along the Suffolk coast, but occurrence is low. Increases in temperature do not impact on scope for growth as it can adapt.	Low sensitivity
Bivalves (*Nucula nitidosa* and *N. nucleus)*	Widespread around British Isles. Naturally high fecundity and are common in Suffolk region. Temperature tolerances correlate with distribution – i.e. lower tolerances in individuals associated with less sheltered areas. Found in subtidal area at Sizewell but not in shallow areas or in the intertidal.	Low sensitivity
Common whelk (*Buccinum undatum)*	Distributed widely throughout the North Atlantic. Species adapts to temperatures above those it currently experiences in its natural environment. Recorded within thermal plume from Bradwell. Also potential for recruitment from outside the zone of influence of the plume.	Low sensitivity
Brown crab (*Cancer pagurus)*	Widespread around British Isles. Encountered across subtidal to intertidal which suggests can tolerate chronic effects of temperature fluctuation. Species highly mobile.	Not sensitive
Lobster (*Homarus gammarus)*	Widespread along British coast. Low abundance in Sizewell sediments. Increases in temperature can change behaviour as well as bringing forward its spawning period. This species is highly mobile.	Low sensitivity
Brown shrimp (*Crangon crangon)*	Part of a larger population and thought to prefer warmer conditions. Recruitment potentially higher when mean temperatures are higher. Species is adaptable to a wide range of environmental temperatures.	Not sensitive
Pink shrimp (*Pandalus montagui)*	Range extending from Greenland and Iceland to the British Isles where it is present on all coasts. Common at Sizewell but considered to be relatively close to southern limit of distribution which suggests a low tolerance to acute increases in temperature. The species is, however, highly mobile and has been observed moving to reach its preferred temperature range (Stevenson and Pierce, 1985). This would lead to a very localised reduction in population density.	Low sensitivity

Species	Summary of description as provided in TR483	Cefas conclusion on sensitivity to thermal plume
Sand digger shrimp (*Bathyporeia elegans)*	Widespread around British coast. Large geographical area coverage which suggests tolerance to increases in mean temperatures as well as temperature fluctuations. Growth rate of amphipods is regulated by temperature as moulting frequency increases in warmer water. Amphipods reach sexual maturity after a fixed number of moults so increase in temperature could bring enhance the onset of sexual maturity for the population within the area of distribution of the thermal plume.	Low sensitivity
Sand shrimp (*Gammarus insensibilis)*	Species is more commonly found on the south coast of Britain to the Mediterranean. Found in the saline lagoons and offshore. Given this geographical spread likely to be able to tolerate temperature fluctuations.	Not sensitive
Mud shrimp (*Corophium volutator)*	Wide distribution range across American and European coasts from Norway to the Mediterranean. Also found on all British coast from the intertidal areas to sublittoral fringe. Evidence to show species is tolerant to chronic temperature uplifts. Potential for reduced reproductive output for organisms within the plume footprint. One of the most abundant species on estuarine mudflats in Suffolk.	Low sensitivity
Catworm (*Nephtys hombergii)*	Present on all British coasts and has been recorded from the Barents Sea to the Mediterranean. The wide distribution of the species across the northern Atlantic suggest a tolerance to a chronic increases in temperature. Commonly found in shallow mud which suggests tolerant to temperature fluctuations. Low temperature could impact on spawning.	Low sensitivity
Bristleworm (*Notomastus sp.)*	Found all around Britain. Inhabits a variety of estuarine environments, in shallow littoral, where temperature can show large fluctuations. High fecundity and opportunistic with rapid increase in abundance during favourable periods.	Not sensitive
Polychaete worm (*Scalibregma inflatum)*	Widespread in Britain. Dominant at Sizewell with high fecundity. Wide geographical spread indicates tolerance to temperature. Can move downwards into sediment therefore could potentially avoid temperature fluctuations.	Not sensitive
Bristleworm (*Spiophanes bombyx)*	Found on most British coasts and recorded in the Mediterranean. This range of distribution suggests that the species is likely to be tolerant to a chronic increase in temperature. Opportunistic species with a short life span, high dispersal potential and high reproductive rates.	Not sensitive
Ross worm (*Sabellaria spinulosa)*	Wide geographical spread from Iceland to Indian Ocean. Given the widespread distribution of the species it is unlikely that this species would be sensitive to a chronic increase in temperature. More sensitive to extreme cold-	Not sensitive

Species	Summary of description as provided in TR483	Cefas conclusion on sensitivity to thermal plume
	water events creating mass mortality. Can respond to environmental changes by responding to suitable conditions with a high rate of reproduction.	
Brittle star (*Ophiura ophiura)*	Found across north-west Europe from Norway to south Spain and the Mediterranean as well as along all the British coast from lower shore to about 200m. Under chronic temperature changes, up-regulates its metabolism. Considered to be mobile enough to move away from disturbance	Low sensitivity

Fish

2.5.520. Given that chemical parameters are unlikely to affect the Suffolk coastal water body, this section focuses on the potential effects of the thermal plume.

2.5.521. There are no thermal standards to assess potential migration barriers for fish in coastal waters. However, if fish have to pass through a coastal plume on their migration route to or from an estuary there remains the possibility of the plume acting as a barrier to migration.

2.5.522. Fish species that could be at risk from thermal barriers to migration at Sizewell are considered to be river lamprey, sea lamprey, cucumber smelt, sea trout and European eels (glass and silver) eel (Ref. 2.43). BEEMS Technical Report TR302 (Ref.2.42) considers a migration corridor of approximately 3km wide from the coast to the Sizewell C outfall. **Plate 2.2** shows the predicted thermal occlusion of a transect drawn from the coast to the Sizewell C outfall. Applying the 2°C thermal barrier test to this transect leads to a prediction that the 25% occlusion threshold would be exceeded for 18.7% of the year. The times when this exceedance occurs have then been compared to the migratory periods of the species listed above and are shown in **Table 2.50**.

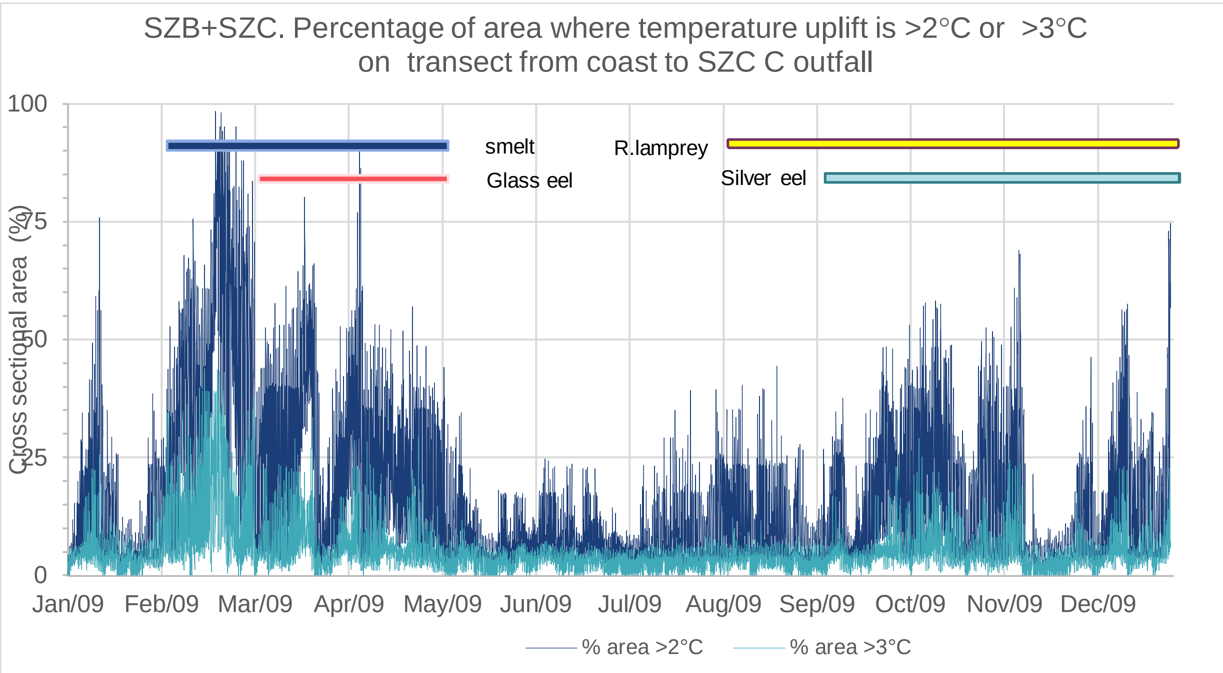

Plate 2.2 Percentage of Sizewell transect with 2°C and >3°C uplift shown against fish migration periods

Table 2.50 Potential thermal occlusion during migration periods

Species	Assumed threshold for this analysis	**Percentage** of migration period that the 25% occlusion threshold is exceeded	Migration period
Smelt	3°C (4°C actual)	4.6%	February - April
Sea trout	3°C (4°C actual)	0%	July
Glass eel	>12°C	0%	March – April
Silver eel	3°C	0.07%	September - December
River and sea lamprey	2°C (worst case)	13.2%	August - December

2.5.523. Table 2.50 shows that smelt, sea trout, glass eel and silver eel with avoidance thresholds of ≥3°C would not experience a barrier to migration in a transect from the coast to the Sizewell C outfalls. Similarly, the Sizewell thermal plumes are not predicted to present a barrier to migration for sea and river lampreys, given the high percentage of the transect that would be available for a Sizewell transit (Ref. 2.43). It is, therefore, concluded that the presence of thermal plumes would not present a barrier to migrating fish (Ref. 2.43) and there would be no deterioration in the transitional water bodies located adjacent to the Suffolk coastal water body.

vi. INNS

2.5.524. Only one INNS was recorded during the Sizewell C benthic baseline surveys, the American jacknife *Ensis leei* which was found in a single grab sample. In the North Sea, 274 INNS and cryptogenic (of uncertain origin) have been recorded. The main vector for primary introduction is vessels (ballast of hull fouling)

2.5.525. This burrowing species is thought to have been introduced to Europe at a similar latitude (German Bight) to the GSB, within the cooler part of its thermal niche. The distribution of E. leei in the North Sea (and the north-west Europe) is predicted to expand this century due to an increase in sea temperature, as shown in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3). Therefore, it is possible that the cooling water discharge would hasten its climate change-induced geographic spread. It should be noted, however, that this species has been recorded in the UK at sites north of the GSB, therefore this species has already reached areas to which the GSB could act as a steppingstone.

As a result, the effect of the thermal plume on this species is unlikely to significantly affect its spread over and above that predicted to be due to climate change.

vii. Interaction of effects within this activity

Chemical parameters as influenced by temperature

2.5.526. Increase in temperature is known to increase chemical toxicity including that of chlorine. For example, a 5°C increase in temperature more than halved the effect concentration of free chlorine and chloramine for various marine species. The main potential for synergistic effects of temperature and toxicity of the chlorinated seawater is to species experiencing entrainment. The acute effects of this exposure would be expected to diminish rapidly upon discharge of the cooling water with rapid loss of temperature and reduction in oxidant concentration as the plume mixes and reaches the sea surface. The thermal uplift in combination with the toxicological effects of chlorination is therefore not expected to change the assessment of the chlorination discharge or thermal plume alone.

Unionised ammonia as influenced by temperature

2.5.527. Unionised ammonia concentrations have been calculated using the Environment Agency calculator, the GETM output for temperature elevation and observed values for background temperature, salinity, pH and background ammonia levels. The regulatory approach for ammonia considers an annual average. The model runs replicate an annual cycle. Therefore, results have been derived using an average temperature and average ammonia values.

2.5.528. Data presented in BEEMS Technical Report TR193 (Ref. 2.3) indicates that the predicted values are very low under the influence of the thermal plume, even in more extreme conditions and no areas in the model domain (and, therefore, the WFD water body) exceed the EQS of 21µgl^{-1} as an annual mean.

Synergistic effects of chlorinated discharges and ammonia from treated sewage

2.5.529. The synergistic effects of chlorination and ammonia discharges may result in the formation of additional combined products.

2.5.530. Seawater chlorination with the ammonia present is likely to form different residual oxidants dependent on the ammonia to chlorine ratio. Dibromamine is one of the primary formation products and has a generally higher toxicity than uncombined oxidants of chlorine or bromine although it is of very low persistence. However, as total ammonia is very low and only around one third of the background ammonia, any increase in toxicity above that due to chlorination alone is expected to be very small. As a result, additional water quality effects are not predicted.

Interaction effects on biology

Habitats

2.5.531. The impact magnitude for the thermal and TRO plumes in combination depends on the area where the two pressures overlap at ecologically relevant concentrations. Benthic invertebrates could be exposed to TROs both as adults and as planktonic eggs and / or larvae, the assessment therefore considers EQS exceedance both at the seabed and sea surface. The spatial extent of the TRO plume based on EQS exceedance represents a very small area of 2.1ha at the seabed which is outside of the WFD water body. Therefore, the potential for overlap with the thermal plume at the seabed would be limited to this area and outside of the WFD water body boundary.

2.5.532. Additionally, the sessile invertebrate taxa found near the outfall are present throughout most of the GSB. Therefore, even if toxicity of TROs were substantially increased by the thermal plume, only a very small proportion of any sessile benthic invertebrate population would be affected by this pressure. In terms of egg and / or larvae, numbers produced are very high and experience a high level of natural mortality. Moreover, sharp environmental gradients would form as thermal uplifts and chemical concentrations rapidly reduce from the point of discharge. It is likely that deleterious effects of the discharges would be in a localised area of water near the outfall and would affect only a small proportion of any plankton group.

2.5.533. *S. spinulosa* reefs are not present in the area of the seabed where thermal and TRO plumes overlap. Therefore, there would be no direct effect of these combined pressures on this receptor. The planktonic eggs and larvae would, however, be exposed to the thermo-chemical plume in the water column, which could indirectly affect reef formation and development if it influences recruitment. The combined effects of the two pressures on S. spinulosa eggs and larvae are unknown, but as with other benthic invertebrates it is assumed that any potential losses would be minimal at the population level due to high levels of natural mortality (mainly through predation).

2.5.534. In terms of hydrazine, the only area over which the effect could occur is outside of the WFD water body and is very small at the seabed and the concentrations to which adult benthic invertebrates would be exposed are orders of magnitude below observed effect thresholds. Therefore, even if elevated temperature uplifts substantially increased the toxicity of the hydrazine plume, effects on benthic invertebrates are unlikely. In terms of eggs and larvae, while synergistic effects of hydrazine and temperature uplifts on the early life-stages of benthic invertebrates are unknown, the tolerance of the larvae of a sensitive species to concentrations above what would be experienced at the outfall suggests that effects on benthic invertebrate larvae within the GSB are unlikely at the population level.

2.5.535. *S. spinulosa* reefs are not present in the area of the seafloor where thermal and hydrazine plumes overlap. Therefore, there would be no direct effect of these combined pressures on this receptor.

Fish

2.5.536. TRO toxicity may increase with the near-field of the thermal plume. However, limited acute (lethal) effects are predicted to be localised and mobile species and life history stages would demonstrate avoidance behaviours reducing exposure.

viii. Protected Areas

Bathing waters

2.5.537. During normal operation, the maximum number of staff on site is estimated to be 1750. It is proposed that any sewage effluent would receive tertiary treatment. This is predicted to give rise to a 5.4 log reduction in bacterial concentrations (Ref. 2.1). Additionally, mixing of the treated sewage effluent with the cooling water would achieve a dilution of approximately 2000 (Ref. 2.1).

2.5.538. With tertiary treatment the discharge would be compliant at the point of discharge. No effects on designated bathing waters are, therefore, predicted.

Nitrates Vulnerable Zones

2.5.539. See assessment for phytoplankton above.

European Designated Sites

2.5.540. The potential for effects on the European Designated sites to arise due to water discharge activities is considered within the **Shadow Habitats Regulations Assessment Report** (Doc Ref. 5.10). As a result, no further consideration of these sites is undertaken here.

ix. Adjoining WFD water bodies

2.5.541. **Figure 2.32** shows the adjoining WFD water bodies to the Suffolk coastal WFD water body that could potentially be at risk as a result of this activity. These include:

- Leiston Beck river water body GB105035046271 – small volumes of seawater can enter many of the ponds within the Minsmere Royal Society for the Protection of Birds (RSPB) reserve by passing though Minsmere sluice and into Leiston Beck at high tide (through a slow-close flap valve), as provided in **Appendix 19E** of **Volume 2** of the **ES** (Doc Ref. 6.3).

- Minsmere Old River water body GB105035046270 - seawater can enter many of the ponds within the Minsmere RSPB reserve (and located in this water body catchment) if the penstock at the downstream end of Scott's Hall drain (part of the Minsmere sluice structure) is opened as part of the management of the reserve, as provided in **Appendix 19E** of **Volume 2** of the **ES (**Doc Ref. 6.3).

- Walberswick Marshes coastal water body GB610050076000 – this water body could be affected where water exchange occurs through or over the dunes.

- Blyth (S) GB510503503700 transitional water body – this water body is located to the north of the outfall and adjoins the Suffolk coastal water body.

- Alde and Ore GB520503503800 transitional water body – this water body is located to the south of the outfall and adjoins the Suffolk coastal water body.

Coastal water bodies

2.5.542. A monitoring programme was implemented to ascertain the potential for plume-water incursion into the lagoons nearest to Sizewell (at Minsmere) which demonstrated that saline waters enter the pond, most likely through the dune system. As a result, there is the potential for an effect if the plume (either chemical or thermal) impacts on the waters percolating through the dunes.

2.5.543. The modelling for the chemical plume has shown that the operational Sizewell C TRO, bromoform and hydrazine plumes do not intersect with the Suffolk coastal water body at concentrations above the EQS or surrogate EQS. Additionally, any chemical concentration in the marine environment is likely to be reduced after percolation through the dune system (Ref. 2.27). As a result, no effects are predicted on the Walberswick Marshes coastal water body as a result of the chemical plume.

2.5.544. In relation to the thermal plume, **Figure 2.21** indicates that Sizewell C would have an effect at the coast of between 1°C and 1.5°C. When added to the thermal influence of Sizewell B, the increase would be around 4°C.

Therefore, the adjoining marshes already experience the effect of an uplift in coastal water temperature and Sizewell C would increase this by approximately 1°C. However, given the slow percolation of coastal water through the dunes, it is likely that some or all of the excess heat would dissipate during this transfer. Additionally, the increase associated with Sizewell C would be small. As a result, within class or between class deterioration within the WFD water body Walberswick Marshes is not predicted.

Fresh water bodies

2.5.545. No effects are predicted on freshwater bodies in relation to chemical discharge from Sizewell C, as the predicted plumes associated with Sizewell C do not reach the Minsmere sluice.

2.5.546. As outlined above, **Figure 2.21** indicates a potential uplift in water temperature at the sluice of between 1°C and 1.5°C due to the Sizewell C plume on top of the baseline increases already experienced due to the operation of Sizewell B. However, for Leiston Beck, this would only occur at high tide. For Minsmere Old River this would only occur if Scott's Hall drain is open. As a result, there would not be a continuous supply of warmer water into either of these WFD water bodies, thus reducing the potential effect on biology. As a result, within class or between class deterioration in fresh water bodies is not predicted.

Transitional waters

2.5.547. It is known from laboratory thermal preference experiments that fish species can choose to avoid areas of high temperature and there is, therefore, a possibility that thermal plumes could act as barriers to migration; principally in transitional waters.

2.5.548. As a precautionary measure, existing thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25% with a temperature uplift above 2°C, for more than 5% of the time (Ref. 2.41). For Sizewell B and C, the predicted thermal plume only intersects the mouth of the Alde-Ore at excess temperatures in the 0°C to 1°C range as 98th percentiles and the standard for thermal barriers in estuarine waters, therefore, would not be exceeded.

2.5.549. The Sizewell B and Sizewell C thermal plume intersects the Blyth estuary at temperatures in the 2°C to 3°C range as 98 percentiles and there is, therefore, a potential for the estuarine thermal standard to be exceeded and an impact to arise with regard to the movement of migratory fish. Consequently, the temperatures in the cross section across the estuary mouth were extracted from the GETM Sizewell B and Sizewell C model outputs. Over the annual cycle the condition was exceeded in 307 hourly episodes or 3.50% of the time. This is below the 5% threshold included in the standard and, therefore, no barriers to fish migration in the estuary are predicted.

x. Assessment against possible future baseline

Thermal effects

2.5.550. The interaction between sea temperature warming as a result of climate change and thermal discharges is based on the assessment detailed in Appendix 21E of (Ref. 2.1). Future climate is considered relative to current thermal standards of thermal uplifts above ambient and absolute temperature.

2.5.551. To ascertain absolute temperatures in the future, the influence of climate change was added to the predicted thermal uplifts due to the proposed development. The approach considered Sizewell B and the proposed development, Sizewell C, operating together up until 2055 as a worst-case. Sizewell C operating alone in 2055 and 2085 were also considered as well as an extreme (2110) hypothetical operating scenario.

2.5.552. The results indicate that future climate change is not predicted to significantly increase the absolute areas in exceedance of 28ºC, which remain under 1ha for all scenarios tested. Following the decommissioning of Sizewell B, 28ºC as an absolute temperature is not predicted to be exceeded as a 98th percentile even under the extreme climate case of the proposed development operating in 2110. Therefore, acute thermal effects in the receiving waters are predicted to remain minimal.

2.5.553. In the likely event Sizewell B is no longer operational in 2055 there are no exceedances of the absolute 23ºC threshold within the WFD water body, either at the surface or at the seabed. The same applies to 2085 towards the end of the likely operational life-cycle of Sizewell C. In 2110, however, large areas of the WFD water body could exceed the absolute 23ºC threshold both at the surface and at the seabed. However, the influence by due to climate change is estimated to be +3.045 across the model domain, hence a station uplift of just 0.56°C is sufficient to exceed contemporary thermal standards (Appendix 21E of Ref.2.2).

Chemical

Chlorination, TRO and CBPs

2.5.554. Increases in temperature may also result in small increases in chlorination duration. The seasonal chlorination strategy for the proposed development involves chlorination during the period of the year when water temperatures exceed 10ºC. In 2030, predicted water temperatures at the intakes of the proposed development would exceed 10ºC for 219 days per annum, from the beginning of May until the start of December. Towards the end of the operational life-cycle of the proposed development in the year 2085, climate change is predicted to result in temperatures exceeding 10ºC from late April until late December, for a total of 244 days per annum. However, light limitation would limit the duration of the potential growing season and increases in the duration of annual chlorination is likely to be within the order of weeks at most.

2.5.555. TRO decay will increase at elevated temperatures, but dosing is adjusted to ensure that the target TRO of 0.2mgl^{-1} is achieved. The residual oxidant level at the point of discharge is therefore unlikely to be reduced under climate change. The relative increase in temperature background in the wider environment is also unlikely to significantly increase TRO decay and consequently a conservative assessment is that the discharge plume size and magnitude are likely to be comparable to those predicted for the current baseline.

2.5.556. A pH reduction of 0.14 units below present values by 2050 and 0.3–0.4 below present units in 2100 is predicted. The ratio of oxidant chemicals formed upon chlorination of seawater is influenced by pH: the percentage of hypochlorous acid is likely to increase relative to hypobromous acid following a pH reduction from a present baseline mean of 8.0 to around 7.8 to 7.6 for future baselines at 2055 to 2085. Although there may be some differences in the toxicity of the different oxidants this difference in relative proportions is unlikely to be significant.

2.5.557. For bromoform, increased temperatures are expected to have minimal influence on CBP decay and consequently the discharge plume magnitude and extent are conservatively assessed to be like those predicted for the current baseline.

2.5.558. Bromoform is likely to occur at similar concentrations or possibly slightly reduce following a pH reduction. For other CBPs there may be a small relative increase with lowering pH. The difference in terms of the extent and magnitude of any effects is however, predicted to be small in scale and unlikely to impact on the WFD water body.

Hydrazine

2.5.559. For hydrazine, the primary fate processes are oxygen dependent chemical breakdown and biodegradation. The former is dependent on the presence in water of appropriate catalysts e.g. copper and other factors with e.g. higher ionic strength, temperature and pH reducing the time taken for hydrazine to degrade. Biodegradation is also influenced by temperature with increasing temperature generally reducing the chemical concentration in a shorter time. Hydrazine half-life (time taken for concentration to decrease by 50% of its starting concentration) in natural seawater from Sizewell is very short (ca. 38 minutes), therefore increasing seawater temperatures is likely to reduce the discharge plume magnitude and extent, but a conservative assessment is that they remain comparable to those predicted for the current baseline.

2.5.560. Although low pH is shown to reduce hydrazine decay rate this is only demonstrated at values below 4 so projected average reductions of future baseline pH are not expected to influence hydrazine discharge plume. As a result, effects on the WFD water body are not predicted.

Biology

Phytoplankton

2.5.561. Whilst the duration of the growing season is likely to extend, temperature driven changes in phenology would be moderated by day length and solar elevation thus restricting the total growth period. High levels of turbidity in the winter and early spring also limit biological production. Increases in the duration of annual chlorination may occur but are likely to be in the order of weeks at most and would occur at the shoulders of the growth period when temperatures are lower (i.e. reduced temperature dependant effects). Effects on phytoplankton in the WFD water body are therefore not predicted.

Benthic ecology

2.5.562. While climate change would act in-combination with the proposed development to increase areas over which thermal standards are exceeded, the key benthic invertebrate taxa are generally considered to be insensitive or to have low sensitivity to temperature increases. Therefore, the increased extent of absolute temperature exceedance is unlikely to have population-level effects. It is also worth noting that benthic invertebrate taxa within the GSB in a future, warmer climate would be acclimatised to a modified thermal baseline, while any taxa not currently in the GSB but part of the future benthic ecology baseline due to climate-induced distributional shifts would likely be adapted to warm temperatures.

2.5.563. However, once Sizewell B is decommissioned the thermal footprint from the proposed development is predicted to be smaller than that of Sizewell B at present. Predictions of effects based on current baselines are therefore considered valid in light of future climate change.

Fish

2.5.564. With the combined stations operating, predicted changes in absolute seabed and sea surface temperatures, exposure of cold-water taxa to acute (lethal) effects may increase. Furthermore, the station may contribute to climate driven effects with elevated temperatures exceeding thermal preferences of sensitive species resulting in further localised chronic effects or changes in distribution.

2.5.565. However, taxa exposure would be influenced by climate-related shifts including higher background temperatures. Adaptation to elevated background temperatures and changes in geographic distribution, would occur in response to climate change. Furthermore, thermal tolerance and thermal preference in fish varies with acclimation temperature. This infers that taxa within the GSB exposed to future temperature scenarios would have differential sensitivities to absolute thermal thresholds applied in current standards. Furthermore, once Sizewell B ceases to operate the combined effects of climate change and thermal discharges from Sizewell C would be considerably smaller and further offshore than the contemporary absolute thermal exceedance of Sizewell B alone.

2.5.566. Thermal uplifts above ambient are predicted to be largely independent of the background sea temperature therefore, predicted thermal uplift areas would remain similar under future climate scenarios. Fish (including migratory species) adapted to future thermal baselines, would experience the same relative temperature differences as in the contemporary assessment. It is feasible that the elevated background temperatures may interplay with thermal uplifts to greater effect in cold-water species with potential implication for migration. However, as thermal uplifts from Sizewell C operating alone are predicted to cover a smaller spatial extent further offshore than the existing Sizewell B plumes, disruption to migratory routes is considered unlikely. Additional effects over and above those already assessed within the WFD water body are therefore not predicted.

INNS

2.5.567. The distribution of *E. leei* in the North Sea is predicted to expand this century due to an increase in sea temperature, as shown in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3). Therefore, it is possible that cooling water discharges from the proposed development would hasten its climate change-induced geographic spread. It should be noted, however, that this species has been recorded in the UK at sites north of the GSB, including other sites in East Anglia therefore this species has already reached areas to which the GSB could act as a steppingstone, and any effect on the spread of this species would likely be minimal beyond that of climate driven processes.

r) Detailed Assessment – O6 Cooling water system intake

i. Introduction

2.5.568. This assessment considers the potential effects associated with the cooling water system intakes. The potential effects of this activity that were scoped in at the end of Stage 2 are summarised in **Table 2.51**.

Table 2.51: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O6

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Biology – phytoplankton and fish. Fish is not a compliance parameter for coastal water bodies so the potential effect is considered on the transitional water bodies only which could be impacted indirectly.	Blyth (S) Alde and Ore	N/A	N/A

2.5.569. The cooling water intakes will be protected by widely spaced bars to prevent the intake of cetaceans, seals and large items of debris, however, a significant number of small organisms (small fish and crustaceans, and plankton) will inevitably enter the cooling water intake.

2.5.570. The larger organisms must be removed before the water enters the power station cooling system to prevent them blocking the condenser tubes. These organisms (fish and crustaceans greater than 25 mm in length) would be removed through impingement on rotating fine-mesh drum screens which protect the main cooling water supply to the station condensers and band screens that protect the essential and auxiliary cooling water systems. Impinged organisms will be returned to the sea via the FRR system. Not all will survive this process and therefore the impact of the loss of these organisms on fish populations is assessed.

2.5.571. The smaller organisms (mostly fish eggs and larvae and other plankton) that pass through the drum screens would be entrained and pass through the power station cooling system without causing significant blockages.

2.5.572. Note fish are not a compliance parameter for coastal water bodies (the water body in which the intake structures will be located) however there is the potential for indirect effects on fish populations moving between transitional water bodies.

ii. Biology

Phytoplankton

2.5.573. The primary effects on plankton from cooling water abstraction relate to entrainment of phytoplankton and zooplankton. Planktonic organisms that are too small to be impinged by the fine mesh drum screens would be entrained through the power station condensers (primary entrainment).

2.5.574. Effects can be mediated through loss of cell numbers, reductions in biomass, and perturbations in the diversity or the community composition due to differential tolerance (Ref. 2.52; Ref. 2.53). A range of field, laboratory and modelling studies are used in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3) to assess the potential for effects.

2.5.575. The resistance of phytoplankton to primary entrainment is dependent on a number of factors including ambient temperature, the thermal uplift, the concentration of chlorine additions, and the duration of exposure (Ref. 2.52; Ref. 2.54).

2.5.576. To determine the combined effects of thermo-chemical pressures experienced during entrainment (including hydrazine additions) the growth and recovery of samples of the phytoplankton community collected from Sizewell Bay was tested. Phytoplankton parameters; chlorophyll a, cell abundance and species diversity were analysed and experiments were repeated with Spring and Summer plankton communities. Results showed significant effects on the Spring and Summer phytoplankton communities, the greatest loss in chlorophyll a (73%) occurred following addition of chlorine and hydrazine and over 90% losses in cell numbers occurred following chlorine additions.

2.5.577. The summer community, characterised by lower biomass and dominated by smaller diatoms and dinoflagellates was more sensitive than the spring community, characterised by large diatoms and high biomass. This corresponds to previous studies which show seasonal effects and have found larger taxa to be more resistant than smaller phytoplankton.

2.5.578. Following experimental exposure to entrainment conditions phytoplankton showed signs of recovery (photosynthetic efficiency) following initial decreases indicating that the remaining cells continued to be viable.

2.5.579. The CPM model was applied to predict the net effect of entrainment on phytoplankton populations. The results estimated that the overall primary production within the GSB and tidal excursion would decrease by approximately 5% with the proposed development operating in conjunction with Sizewell B. The loss represents a reduction of 3.9% in total primary production.

2.5.580. Environment Agency data collected from the area from 1992 to 2013 indicates that the standard deviation of monthly mean chlorophyll a concentration deviates by 42% of the mean, and annual chlorophyll a values varies by 45% of the mean. Accordingly, effects from the proposed development are predicted to be much smaller than natural variation. Additionally, phytoplankton have rapid generation rates and under suitable conditions, a 5% loss in population size (commensurate with the effect of both power stations) in a parcel of water could recover after less than an hour based on the assumption that phytoplankton divide during a 12-hour light period (Ref. 2.55).

2.5.581. As a result, significant changes in phytoplankton communities is not predicted on a water body scale.

Fish

WFD assessment methods

2.5.582. To determine a WFD water body classification, the health of the quality element is assessed by comparing the measured conditions against that described for reference conditions (minimally disturbed). This is reported as an EQR. An EQR of 1 represents undisturbed conditions and a value of 0 represents a severe impact. The EQR is divided into five ecological status classes (high, good, moderate, poor and bad). To assess fish fauna in the UK, the Environment Agency uses the Transitional Fish Classification Index to represent the requirements of Annex V (Table 1.2.3 and relevant rows reproduced in **Table 2.52**) to the WFD (UKTAG, 2014). The tool is designed to be applied at the whole estuary level, not to individual WFD water bodies within that estuary.

Table 2.52: Excerpt from the WFD Annex V Table 1.2.3 regarding fish fauna

WFD Biological Quality Element	Status Classification		
	High	Good	Moderate
Fish fauna (transitional waters only)	Species composition and abundance is consistent with undisturbed conditions.	The abundance of the disturbance sensitive species shows slight signs of distortion from type-specific conditions attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements.	A moderate proportion of the type-specific disturbance sensitive species are absent as a result of anthropogenic impacts on physicochemical or hydromorphological quality elements.

2.5.583. The Transitional Fish Classification Index includes the parameters composition, abundance and the presence and / or absence of disturbance-sensitive taxa and is a multi-metric index composed of ten individual components known as metrics. These metrics are listed in **Table 2.53**.

Table 2.53: Summary of TCFI metrics

Number	Metric	Community characteristic
1	Species composition	Species diversity and composition
2	Presence of indicator species	
3	Species relative abundance	Species abundance
4	Number of taxa that make up 90% of the abundance	
5	Number of estuarine resident taxa	Nursery function
6	Number of estuarine-dependent marine taxa	
7	Functional guild composition	
8	Number of benthic invertebrate feeding taxa	Trophic integrity
9	Number of piscivorous taxa	
10	Feeding guild composition	

2.5.584. The four EQR class boundaries are High / Good = 0.81, Good / moderate = 0.58, Moderate, Moderate / Poor = 0.4 and Poor / bad = 0.2. To calculate the Transitional Fish Classification Index a representative sample of the fish community, identified to species level, is required.

2.5.585. Information for WFD water body classifications for fish is only available for the Alde and Ore transitional water body, adjoining the Suffolk coastal water body. This water body is classified for fish as good status.

Impingement survey information and calculation of impingement estimates

2.5.586. Impingement sampling at Sizewell B was initiated in 2009 to provide information that could be used to predict the losses of Sizewell C. The sampling scheme consisted of sampling for six one hour samples in daylight and one 18 hour sample that was collected overnight. In each sample, the impinged material was sorted by species where possible, weighed and the fish fauna were measured.

2.5.587. A total of 128 sampling visits was completed between February 2009 and March 2013. Following a break in sampling, a further 77 visits were completed between April 2014 and December 2017 using a revised methodology with changes to the order in which the hourly and overnight samples were collected, the use of an Electronic Data Capture system and a change from measuring fish using Standard Length, to using Total Length. All samples were raised to represent 24 hours.

2.5.588. Impingement estimates were made by fitting a statistical model to the impingement data. Each species was assessed separately, and different models used depending on the number of occasions an organism was recorded. Further details are provided in BEEMS Technical Report TR406 (Ref. 2.25).

2.5.589. The final model outputs provided (for each species) a mean daily number of individuals impinged for each month separately, along with lower and upper values that corresponded to 95% confidence intervals.

2.5.590. The predicted (unmitigated) losses that would be incurred by Sizewell C were then calculated by raising the mean, lower and upper estimates by the ratio of the two pumping capacities (i.e. 131.86m^3s^{-1} (Sizewell C) / 51.5m^3s^{-1} for Sizewell B) for each species). The resulting impingement numbers are provided in **Table 2.54**.

Table 2.54: Sizewell C predicted impingement numbers

Species	Mean Sizewell C prediction
Sprat	7,125,393
Herring	2,555,783
Whiting	1,865,492
Bass	575,367
Sand goby	381,612
Sole	250,059
Dab	148,921
Anchovy	73,865
Thin-lipped grey mullet	67,684
Flounder	38,180
Plaice	25,288
Smelt	23,863
Cod	16,845
Thornback ray	10,802
River lamprey	6,720
Eel	4,516
Twaite shad	3,601

Species	Mean Sizewell C prediction
Horse mackerel	4,077
Mackerel	628
Tope	64
Sea trout	10
Allis shad	5
Sea lamprey	5
Salmon	0

Assessing the magnitude of the potential impingement effect

2.5.591. To assess the magnitude of the impingement numbers, BEEMS Technical Report TR406 (Ref. 2.25) compares the predictions against an objective measure of the status of each population. The measures chosen includes adult spawning stock biomass (SSB) as calculated by the International Council for Exploration of the Sea (ICES) and, where SSBs are unavailable, international landings of the stock area.

2.5.592. For other species, alternative sources for catches or landings were used as follows:

- Losses of thin-lipped grey mullet and were compared against ICES' Official Nominal Catches 2006 – 2017 (Ref. 2.56), downloaded from the ICES website.
- Environment Agency data were used to source catch data for salmon, sea trout and eels.
- For river lampreys, losses were compared against a spawning run size estimate for the Humber catchment made in 2018 by the Hull International Fisheries Institute.
- Twaite shad caught at Sizewell are considered to be part of a wider North Sea population that spawns in the rivers of Europe (predominantly in the Elbe but also in the Weser and the Scheldtand). The numbers of individuals impinged have been compared with abundance estimates from monitoring surveys conducted on the Elbe and the Scheldt.
- Smelt caught at Sizewell are considered to be part of a wider North Sea population that spawns in at least the Rivers Elbe and Scheldt. Numbers of individuals impinged have been compared with adult

abundance estimates from monitoring surveys conducted in the River Elbe.

- Sand gobies are an unexploited fish stock and accordingly few abundance data are available. By comparing survey results from other studies and abundances observed in the Sizewell C specific surveys, the mean population abundance is 205.8 million individuals (see BEEMS Technical report TR406 (Ref. 2.25) for further information).

2.5.593. A summary of data used for each species is shown in **Table 2.55.**

Table 2.55: Data sources used to provide information on relevant stock unit, landings and SSB (taken from Ref. 2.25)

Species	ICES working group	Stock Unit	Assessment type	Impingement effect comparator
Sprat	HAWG[10]	Subarea 4 (North Sea)	Analytical	SSB
Herring	HAWG	Subarea 4 and Divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern Channel)	Analytical	SSB
Whiting	WGNSSK[11]	Subarea 4, Division 7.d (North Sea, Eastern Channel)	Analytical	SSB
Bass	WGCSE[12]	Divisions 4.b-c, 7.a, and 7.d-h (Central and southern N Sea, Irish Sea, English Channel, Bristol Channel and Celtic Sea)	Analytical	SSB
Sand goby	-	Not defined	Not assessed	Population abundance
Sole	WGNSSK	Subarea 4 (North Sea)	Analytical	SSB
Dab	WGNSSK	Subarea 4 and Division 3.a (North Sea, Skagerrak and Kattegat)	Trends	Landings
Anchovy	WGHANSA[13]	Given as 'Northerly anchovy'	Not assessed	Landings
Thin-lipped grey mullet	-	Not defined	Not assessed	ICES landings
Flounder	WGNSSK	Subarea 4 and Division 3.a (North Sea, Skagerrak and Kattegat)	Trends	Landings
Plaice	WGNSSK	Subarea 4 IV and Subdivision 20 (North Sea and Skagerrak)	Analytical	SSB

[10] HAWG – Herring Assessment Working Group for the Area South of 62N
[11] WGNSSK – Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
[12] WGCSE – Working Group on Celtic Seas Ecoregion
[13] WGHANSA - Working Group on Southern Horse Mackerel, Anchovy and Sardine

Species	ICES working group	Stock Unit	Assessment type	Impingement effect comparator
Cucumber smelt	-	Not defined but includes the East Anglian coast and rivers on the European coast from the Elbe to the Scheldt	Estimated adult numbers migrating up river	Elbe populations Environment Agency landings and ICES landings
Cod	WGNSSK	Subarea 4 and Division 3.a (North Sea, Skagerrak and Kattegat)	Analytical	SSB
Thornback ray	WGEF[14]	Subarea 4 and Division 3.a (North Sea, Skagerrak and Kattegat and Eastern English Channel)	Trends	Landings
River lamprey	-	Humber catchment	Estimated run numbers	Numbers converted to weight
Eel	WGEEL[15]	Anglian River Basin District	Biomass estimated	Estimated silver eel biomass
Twaite shad	-	Not defined but includes the River Elbe and Belgian river Scheldt. A separate spawning population on the river Weser has not been included in the assessment.	Estimated adult numbers migrating up river	European populations in the Elbe. ICES Landings
Horse mackerel	WGWIDE[16]	Divisions 3.a, 4.b,c and 7.d (North Sea)	Trends	Landings
Mackerel	WGWIDE	Subareas 1–8 and 14, and in Division 9.a (the Northeast Atlantic and adjacent waters)	Analytical	SSB
Tope	WGEF	North east Atlantic	Not assessed	Landings
Sea trout	-	Not defined	Assessment based on CPUE	Environment Agency catch numbers, UK

[14] WGEF - Working Group on Elasmobranch Fishes
[15] WGEEL - Joint EIFAAC/ICES/GFCM Working Group on Eels
[16] WGWIDE - Working Group on Widely Distributed Stocks

Species	ICES working group	Stock Unit	Assessment type	Impingement effect comparator
Allis shad	-	Garonne	Analytical	Adult stock in 2009, ICES Landings
Sea lamprey	-	Not defined	Not assessed	-
Salmon	WGNAS[17]	North Atlantic	North Atlantic	Environment Agency catch numbers, UK

[17] WGNAS - Working Group on North Atlantic Salmon

Variability of fish stocks

2.5.594. Fish stocks are subject to considerable annual variability due to highly variable levels of recruitment, food availability and predation pressure. Individual populations and ecosystems are resilient to such high levels of variability. This can be seen in the Hinkley Point populations via the Hinkley Point B impingement data. For example, the coefficient of variation of impingement numbers over the period 1981-2017 was in the range 69% to 180% for each of the top 13 species that constituted 95% of the local abundance and greater for the rarer species.

Impingement assessment

2.5.595. To support the environmental assessments, two scenarios were considered in BEEMS Technical Report TR406 (Ref. 2.25) as follows:

- Scenario 1 Sizewell C with no fish impingement mitigation; and
- Scenario 2 Sizewell C fitted with the Low Velocity Side Entry (LVSE) intake heads and an FRR system.

2.5.596. Given that the LVSE intake heads and FRR system are in the detailed design, this assessment considers the findings in relation to Scenario 2.

Effect of the LVSE intake heads

2.5.597. The proposed intake heads will be capped structures with the intake surfaces orthogonal to the direction of the tidal flows. This design is calculated to reduce the cross-sectional area available to intercept any fish being transported in the tidal flows. Modelling indicates that Sizewell C will abstract 0.383 per cumec of the fish abstracted by Sizewell B, because of the intake head design (Ref. 2.25).

2.5.598. The effect of the intake head design on the abstraction of organisms, is therefore assessed by first multiplying all predicted values by the factor of 0.383.

Effect of the FRR system

2.5.599. The proposed drum screen mesh size for Sizewell C is 10 mm allowing a direct comparison with the current mesh size employed at Sizewell B.

2.5.600. Located immediately before the drum and band screens, will be a series of trash racks (bar spacing at 75mm), designed to protect the screens from debris but which will also prevent the passage of large fish. These racks can be raised for cleaning and any material that cannot pass through the bars will be sent to the debris recovery building. This building has another trash rack

(200mm bar spacing) and fish that pass through this secondary trash rack will be sent to the FRR system. Any that remain (i.e. cannot pass through 200mm) will go to waste. For the purposes of the assessment BEEMS Technical Report TR406 (Ref. 2.25) assumed that all organisms that cannot pass through the primary trash rack will suffer 100% mortality.

2.5.601. Each of the 24 key species has a different body shape and maximum size, and therefore the size at which an individual will be able to pass will depend on its species. The proportion of the total number of that species that will not pass will depend on its size distribution in the cooling water system. As a result, the impingement data on lengths were used to provide an annually raised length distribution for each species, taking account of seasonal growth (see Ref. 2.25).

2.5.602. For each species, its ability to pass through the 75mm trash rack will depend on its width, which can be calculated from its length. However, Hinkley Point B already has trash racks fitted with a 75mm bar spacing and therefore this information has been used to inform the calculations in **Table 2.56**. Further information on the way in which each species was assessed is provided in Ref. 2.25.

Table 2.56: Proportion of fish that will not pass through the 75mm wide trash racks and size length used.

Species	Length of largest Sizewell B fish (mm)	Calculated width of largest Sizewell B fish (mm)	Largest Hinkley Point B fish	Calculated length at 75mm width (cm)	Proportion lost through rack
Sprat	260	53	-	-	0.000
Herring	445	94	224	-	0.715
Whiting	525	48	-	-	0.000
Seabass	850	232	657	-	0.0002
Sand goby	100	NA	74	-	0.000
Dover sole	440	124	449	-	0.000
Dab	380	160	139	-	0.419
Anchovy	230	NA	169	-	0.000
Thin-lipped mullet	425	91	524	-	0.000
Flounder	425	119	339	-	0.031
Plaice	355	150	382	-	0.000
Smelt	250	NA	-	-	0.000
Cod	895	133	709	-	0.006
Thornback Ray	765	503	952	-	0.000
River lamprey	405	25	-	-	0.000
European eel	895	56	-	-	0.000
Twaite Shad	490	103	299	-	0.883
Horse mackerel	355	71	-	-	0.000

Species	Length of largest Sizewell B fish (mm)	Calculated width of largest Sizewell B fish (mm)	Largest Hinkley Point B fish	Calculated length at 75mm width (cm)	Proportion lost through rack
Mackerel	405	69	-	-	0.000
Tope	625	63	-	-	0.000
Sea trout	530	121	-	33	1.000
Allis shad	610	128	-	36	1.000
Sea lamprey	795	50	807	-	0.000

2.5.603. FRR systems have been reported to achieve 80−100% survival rates for robust epibenthic species and moderate rates (~50−60%) for demersal species. However, survival rates for delicate pelagic species such as herring, sprat and shad (twaite shad and Allis shad) are usually low (less than 10%) (Ref. 2.57).

2.5.604. The planned FRR system has been designed to achieve high rates of survival for European eels and lamprey (river lamprey and sea lamprey), and it is expected that survival rates for other epibenthic (flatfish including rays) and demersal species will also be higher than achieved in older designs. For the purpose of this study BEEMS Technical Report TR406 (Ref. 2.25) used the FRR recovery rates given in Turnpenny and O'Keeffe (Ref. 2.57) modified to account for the improved location and station design (see **Table 2.57**).

Table 2.57: Proportion mortality by species through the Sizewell C drum and band screens

Species group	Proportion lost	
	Drum	Band
Pelagic	1.000	1.000
Demersal	0.506	1.000
Epibenthic	0.206	0.206

2.5.605. **Table 2.58** updates the impingement numbers using the above parameters for the LVSE and the FRR system.

Table 2.58: Summary of numbers following application of the LVSE intake heads and the predicted FRR mortality rates

Species	Mean Sizewell C prediction	Sizewell C prediction after intake and FRR adjustment
Sprat	7,125,393	2,729,025
Herring	2,555,783	978,865
Whiting	1,865,492	393,295
Bass	575,367	121,326
Sand goby	381,612	30,108
Sole	250,059	19,729
Dab	148,921	30,715
Anchovy	73,865	28,290
Thin-lipped grey mullet	67,684	14,273

Species	Mean Sizewell C prediction	Sizewell C prediction after intake and FRR adjustment
Flounder	38,180	3,377
Plaice	25,288	1,995
Smelt	23,863	9,139
Cod	16,845	3,884
Thornback ray	10,802	852
River lamprey	6,720	530
Eel	4,516	356
Twaite shad	3,601	1,379
Horse mackerel	4,077	1,561
Mackerel	628	241
Tope	64	5
Sea trout	10	4
Allis shad	5	2
Sea lamprey	5	0
Salmon	0	0

2.5.606. Given that the fish community is largely made up of juveniles, the effects assessment undertaken in Ref. 2.25 converts the number of juveniles taken from the Comprehensive Impingement Monitoring Programme work into the number of adults that would survive to maturity (called equivalent adults or EAV). This is to allow for processes such as natural mortality due to predation, for example, as the fish matures. The EAV values used were calculated using a method developed as part of the BEEMS programme (Ref. 2.58). The converted numbers are provided in **Table 2.59.**

Table 2.59: Impingement numbers calculated from the Comprehensive Impingement Monitoring Programme data for Sizewell C using EAVs

Species	Mean Sizewell C prediction	EAV	Sizewell C prediction after intake and FRR adjustment	Prediction after application of EAV (number)	EAV weight (t)
Sprat	7,125,393	0.751	2,729,025	2,050,190	21.53
Herring	2,555,783	0.751	978,865	700,103	132.08
Whiting	1,865,492	0.356	393,295	140,044	40.03
Bass	575,367	0.224	121,326	27,172	41.60

Species	Mean Sizewell C prediction	EAV	Sizewell C prediction after intake and FRR adjustment	Prediction after application of EAV (number)	EAV weight (t)
Sand goby	381,612	1.000	30,108	30,108	0.06
Sole	250,059	0.213	19,729	4,200	0.90
Dab	148,921	0.445	30,715	13,656	0.56
Anchovy	73,865	0.974	28,290	27,558	0.57
Thin-lipped grey mullet	67,684	0.083	14,273	1,190	0.62
Flounder	38,180	0.462	3,377	1,559	0.13
Plaice	25,288	0.345	1,995	689	0.17
Smelt	23,863	0.761	9,139	6,959	0.12
Cod	16,845	0.359	3,884	1,395	3.63
Thornback ray	10,802	0.193	852	164	0.52
River lamprey	6,720	1.000	530	530	0.04
Eel	4,516	1.000	356	356	0.12
Twaite shad	3,601	1.000	1,379	1,379	0.43
Horse mackerel	4,077	1.000	1,561	1,561	0.22
Mackerel	628	1.000	241	241	0.08
Tope	64	1.000	5	5	0.03
Sea trout	10	1.000	4	4	0.01
Allis shad	5	1.000	2	2	0.00
Sea lamprey	5	1.000	0	0	0.00
Salmon	0	1.000	0	0	0.00

2.5.607. The first stage in the WFD assessment is to consider whether there is the potential to impact on fish populations such that the classification of a WFD water body changes. Information gathered indicates that for transitional water bodies in the vicinity of the abstraction, fish fauna has been assessed as being at good status (i.e. score a Transitional Fish Classification Index between 0.58 and 0.81). Given that the UKTAG Transitional Water

Assessment Method Fish Fauna TFCI (Ref. 2.59) recommends that the index be applied at the whole transitional water level (estuary), rather than subdivisions into WFD water bodies, it is assumed that the entire area is at good status for fish.

2.5.608. In considering the metrics that contribute to this score, with the exception of metric 3 (species relative abundance), all metrics are counts of the number of species in functional, feeding or indicator species groups found in the population samples (i.e. presence / absence data). BEEMS Technical Report TR406 (Ref. 2.25) does not predict any changes to the number of species present and only negligible additional mortality on fish populations.

2.5.609. As described above, the fish community within the GSB is subject to considerable within and between-year variability as well as to long term trends such as climate change and changes in fishing pressure. Measurements of the Transitional Fish Classification Index will therefore be subject to variability and only developments that have wide scale, very large impacts on the community would be expected to have any impact on the calculated index. Given that the impingement numbers are extremely small and the number of species present would not be altered, no change in classification status is predicted.

2.5.610. To assess whether there is the potential for within classification deterioration, the 1% threshold has been considered. This assesses whether the predicted impingement is likely to be equivalent to or greater than 1% of the SSB where possible. This level is considered appropriate given that it is much lower than the measured natural variability of the populations. This is also considered to be appropriate to assessing the risk to predator-prey relationships as they are able to react to much greater natural variability. By comparison, accepted practice in fisheries management is that a level of fishing mortality of 10-20% per annum will have negligible effects on the sustainability of unexploited populations. 1% is therefore considered to be precautionary (BEEMS Technical Report TR406 (Ref. 2.25)).

2.5.611. **Table 2.60** shows the predicted impingement levels at Sizewell compared to the impingement effect comparator (see **Table 2.55**).

Table 2.60: Sizewell C impingement assessment with LVSE intake heads and FRR system in place

Species	Mean Sizewell C prediction	Sizewell C prediction after intake and FRR adjustment	Prediction after application of EAV (number)	EAV weight (t)	Impingement effect comparator	Mean SSB	Percentage of SSB	Mean landings (t)	Percentage of landings
Sprat	7,125,393	2,729,025	2,050,190	21.53	SSB	220,757	0.01	NA	NA
Herring	2,555,783	978,865	700,103	132.08	SSB	2,198,449	0.01	NA	NA
Whiting	1,865,492	393,295	140,044	40.03	SSB	151,881	0.03	NA	NA
Bass	575,367	121,326	27,172	41.60	SSB	14,897	0.28	NA	NA
Sand goby	381,612	30,108	30,108	0.06	Population abundance	205,882,353[18]	0.01	NA	NA
Sole	250,059	19,729	4,200	0.90	SSB	43,770	0.00	NA	NA
Dab	148,921	30,715	13,656	0.56	Landings	NA	NA	51,013	0.00
Anchovy	73,865	28,290	27,558	0.57	Landings	NA	NA	1,625	0.04
Thin-lipped grey mullet	67,684	14,273	1,190	0.62	ICES landings	NA	NA	120	0.52
Flounder	38,180	3,377	1,559	0.13	Landings	NA	NA	2,309	0.01
Plaice	25,288	1,995	689	0.17	SSB	690,912	0.00	NA	NA
Smelt	23,863	9,139	6,959	0.12	Environment Agency landings and ICES landings	105,733,825[18]	0.01	8	NA

[18] Estimate of population number or reported catch numbers

Species	Mean Sizewell C prediction	Sizewell C prediction after intake and FRR adjustment	Prediction after application of EAV (number)	EAV weight (t)	Impingement effect comparator	Mean SSB	Percentage of SSB	Mean landings (t)	Percentage of landings
Cod	16,845	3,884	1,395	3.63	SSB	103,025	0.00	NA	NA
Thornback ray	10,802	852	164	0.52	Landings	NA	NA	1,573	0.09
River lamprey	6,720	530	530	0.04	SSB	62	0.07	1	NA
Eel	4,516	356	356	0.12	Landings	79	0.15	41	0.79
Twaite shad	3,601	1,379	1,379	0.43	Environment Agency catch numbers, UK	7,519,986[18]	0.02	1	NA
Horse mackerel	4,077	1,561	1,561	0.22	Landings	NA	NA	21,442	0.00
Mackerel	628	241	241	0.08	SSB	3,888,854	0.00	NA	NA
Tope	64	5	5	0.03	Landings	NA	NA	498	0.01
Sea trout	10	4	4	0.01	Environment Agency catch numbers, UK	NA	NA	39,795[18]	0.01
Allis shad	5	2	2	0.00	Adult stock in 2009, ICES Landings	27,397[18]	0.01	0	NA
Sea lamprey	5	0	0	0.00	-	NA	NA	NA	NA

Species	Mean Sizewell C prediction	Sizewell C prediction after intake and FRR adjustment	Prediction after application of EAV (number)	EAV weight (t)	Impingement effect comparator	Mean SSB	Percentage of SSB	Mean landings (t)	Percentage of landings
Salmon	0	0	0	0.00	Environment Agency catch numbers, UK	NA	NA	38,456[16]	0.00

2.5.612. BEEMS Technical Report TR406 (Ref. 2.25) further assesses bass and grey mullet associated with specific conditions for these two species.

2.5.613. Approximately 20 times more bass were found inshore of the than offshore. The thermal plume generated by Sizewell C would be in the deeper water where there will be negligible warming at the seabed and limited to the top 1 m of the sea surface. The plume will have the effect of further warming the inshore waters.

2.5.614. Bass is a demersal species, but it is known to feed at the surface at night and so could be attracted to the surface plume. However, at the surface bass would be invulnerable to the impact of the abstraction at the sea bed mounted intakes. BEEMS Technical Report TR406 (Ref. 2.25) considers that it is likely that 90% of bass would remain inshore of the Bank therefore the expected bass impingement would be reduced to 0.03% SSB.

2.5.615. The landings data (120t) for grey mullet will substantially underestimate the SSB given the lack of commercial fishery. BEEMS Technical Report TR406 (Ref. 2.25) considers it is highly unlikely that the landings represent more than 20% SSB and therefore the predicted impingement is reduced to approximately 0.1% SSB.

2.5.616. Of the 24 species considered, none exceed the 1% threshold. As a result, it is predicted that Sizewell C would have a negligible effect on these species and, therefore, population trends would not be impacted. Overall, therefore, within water body class deterioration is not expected.

2.5.617. It should be noted that the above assessment is considered to be highly conservative for the following reasons:

- Impingement information has been used from Sizewell B –the deeper water depth at the Sizewell C intake location is expected to reduce impingement per m^3s^{-1} of cooling water flow compared to that experienced at Sizewell B. This has not been included in the assessments.
- The 1% of SSB value is applied as a screening threshold for negligible effects. This 1% threshold is significantly lower than mortality rates deemed sustainable in fisheries management.

Method of assessment – entrainment

2.5.618. Most fish and crustaceans that pass through the intake screens are removed through impingement on fine-mesh drum screens before the water enters the power station cooling system, to prevent them blocking the condenser tubes. Smaller planktonic organisms (fish eggs and larvae, invertebrate zooplankton and phytoplankton) are entrained, that is they pass through the power station cooling system before being discharged back into the environment. Sizewell B uses 10mm mesh for its fine filtration systems as will the proposed Sizewell C intakes. The following fish species are assessed as either the eggs, larvae or juveniles were reported during the one-year Comprehensive Entrainment Monitoring Programme:

- seabass;
- gobies;
- Dover sole;
- dab;
- flounder;
- anchovy;
- sprat; and
- Atlantic herring.

2.5.619. The assessment uses the calculated data on entrainment of species in the Sizewell B station (abstraction 51.5m^{3}s^{-1}), scaled to the level of abstraction planned for Sizewell C (i.e. 131.86m^{3}s^{-1}). The results of this scaling are shown in **Table 2.61** for eggs, **Table 2.62** for larvae and **Table 2.63** for juvenile fish.

Table 2.61: Sizewell B and Sizewell C entrainment numbers for eggs

Species	Sizewell B entrainment numbers	Sizewell C entrainment numbers
Dover Sole	124,143,767	317,856,254
European anchovy	123,239,720	315,541,543
Sprat	12,352,555	31,627,339
Rockling	11,294,574	28,918,497
Pilchard	10,357,745	26,519,849
European seabass	4,694,916	12,020,809
Gurnard	1,026,768	2,628,925
Dragonet	1,016,354	2,602,262
Garfish	352,887	903,529
Lesser weever fish	36,116	92,471
Long rough dab	33,511	85,801

Species	Sizewell B entrainment numbers	Sizewell C entrainment numbers
Sandeels	33,398	85,512

Table 2.62: Sizewell B and Sizewell C entrainment numbers for fish larvae

Species	Sizewell B entrainment numbers	Sizewell C entrainment numbers
Sand goby	52,073,218	133,327,662
Sprat	17,434,255	44,638,462
Other gobies	7,781,056	19,922,524
Herring	6,999,619	17,921,743
Pilchard	3,611,703	9,247,363
Unidentified clupeids	1,644,325	4,210,111
Dragonets	1,108,154	2,837,305
Unidentified specimen	777,113	1,989,712
Sandeels	262,523	672,162
Dover sole	217,835	557,742
Solenette	185,055	473,813
Right eyed flatfish	128,393	328,736
Witch	90,581	231,922
Pipe fishes	39,804	101,914
European flounder	35,845	91,776
Soles	35,535	90,982
Sea snail	34,005	87,066

Table 2.63: Sizewell B and Sizewell C juvenile fish entrainment numbers

Species	Sizewell B entrainment numbers	Sizewell C entrainment numbers
Sand goby	7,602,995	19,466,620
Sprat	7,584,699	19,419,776
Dab	1,969,535	5,042,775
Other gobies	1,136,080	2,908,805
Butter fish	986,334	2,525,399
Pipe fishes	144,512	370,006
Sandeels	50,379	128,990
Herrings	34,114	87,346

2.5.620. To consider the worst-case scenario of water abstraction, the combined impacts of Sizewell B and the proposed development are considered. Sizewell B abstracts $51.5m^3s^{-1}$ giving a combined abstraction rate of approximately $175m^3s^{-1}$ for both power stations. The daily volume abstracted from both power stations ($175m^3s^{-1}$ x 3600 x 24) is approximately 12.5% of the water exchanged each day and 1.25% of the total volume of the bay and tidal excursion.

2.5.621. Due to high natural mortality rates, the loss of each egg, larva or juvenile does not equate to the loss of an adult from the spawning population. Therefore, entrainment numbers were adjusted to account for this.

2.5.622. Egg losses are expressed in context of the number of eggs produced by a spawning female, based on evidence from published sources. Where a range was given then the lower, conservative estimate was used.

2.5.623. A precautionary survival rate of 0% was assumed for eggs of all species, except for Dover sole and seabass, which applied 20% and 50% survival rates, respectively based on experimental evidence.

2.5.624. Egg loss through entrainment and the impact on fish populations, has been expressed in the context of the numbers of eggs produced by an "average" or typical spawning female ("equivalent spawning females"). This information was sourced from published studies.

2.5.625. Larvae loss through entrainment and the impact on fish populations, has been expressed in the context of the numbers of larvae produced by an "average" or typical spawning female ("equivalent spawning females"). For this assessment, the estimated numbers of larvae produced was established based on the number of eggs spawned from an average female, assuming upper (97%) and lower (70%) levels of natural egg mortality. This approach provides upper and lower estimates of the impact of larval loss through entrainment (Ref. 2.25).

2.5.626. For juvenile fish, an EAV method was applied (see impingement). The estimated entrainment losses (unadjusted for entrainment survival or equivalent adults) by life history stage for Sizewell B and Sizewell C cumulatively are detailed in **Table 2.64** and **Table 2.65**.

Table 2.64: Summary of estimated entrainment losses (unadjusted for entrainment survival or equivalent adult values) by life history stage at Sizewell B.

Species	Eggs	Larvae	Juveniles	Total
Seabass	4,546,540			4,546,540
Gobies		44,698,663	8,707,566	53,406,229

Species	Eggs	Larvae	Juveniles	Total
Dover sole	98,677,999	203,189		98,881,188
Dab			1,969,535	1,969,535
Flounder		33,435		33,435
Anchovy	121,942,026			121,942,026
Sprat	5,889,729	5,644,515	6,828,612	18,362,855
Atlantic herring		19,601,091	33,788	19,634,880

Table 2.65: Summary of estimated entrainment losses (unadjusted for entrainment survival or equivalent adult values) by life history stage for Sizewell C

Species	Eggs	Larvae	Juveniles	Total
Seabass	11,640,908			11,640,908
Gobies		114,445,936	22,294,750	136,740,685
Dover sole	252,653,999	520,242		253,174,241
Dab			5,042,775	5,042,775
Flounder		85,605		85,605
Anchovy	312,218,941			312,218,941
Sprat	15,079,993	14,452,150	17,483,898	47,016,041
Atlantic herring		50,186,406	86,511	50,272,917

2.5.627. To determine losses from entrainment, the total number of equivalent adults was calculated by summing eggs, larvae and juveniles. To be precautionary, the worst-case for larvae (assumption of 70% egg mortality) was used.

Assessment

2.5.628. The estimated equivalent adult numbers were converted to weights. The weights of entrainment losses are shown as a percentage of the SSB and international landings of each species, based on its stock assessment area. For species where an estimate of the SSB is not available, comparisons with commercial catches are made. **Table 2.66** reproduces the results.

2.5.629. For the seven of the eight key taxa entrained at Sizewell the predicted entrainment losses are much less 1 % of the SSB or the international landings of that species in 2010 (year of sampling). The highest predicted loss was 0.001% of SSB for sprat or 0.01% landings for dab. Gobies are an unexploited species and the predicted entrainment loss is 1.4% of the mean population numbers which is less than the highly conservative screening threshold of 10% for that species.

2.5.630. The key fish taxa are therefore not predicted to be sensitive to entrainment losses of ichthyoplankton or juvenile life history stages, which are orders of magnitude below the 1% SSB threshold. Contextualised against high natural variability in abundance and considerable natural mortality of early life history stages, entrainment effects are **not significant** at the sea area and regional stock / population levels.

2.5.631. Given the above, non-temporary effects on fish in the WFD water body are not predicted.

Table 2.66: Predicted entrainment losses by life history stage at Sizewell C adjusted to give equivalent numbers of spawning females and equivalent numbers of adults (where species data are available to make estimates)

Species	Entrainment loss (equivalent spawning females or EAV)				Total entrainment loss (as adults)		Individual fish wt. (kg)	Total wt. (t) upper estimate	Stock landings (t)	Stock SSB (t)	% of landing	% of SSB
	Eggs	Larvae (97% egg mortality)	Larvae (70% egg mortality)	Juvenile	Lower estimate	Upper estimate						
Dab				21,810	21,810	21,810	0.040	0.872	8,279	NA	0.011	NA[19]
Dover sole	588	43	4		592	631	0.227	0.143	12,603	31,358	0.001	0.00017
European anchovy	2,869				2,869	2,869	0.021	0.060	727	NA	0.008	NA17
European seabass	36				36	36	1.365	0.049	3,365	NA	0.000	NA17
Herring		23,922	2,399	0	2,399	23,992	0.174	4.175	187,600	2,023,720	0.002	0.00017
Sprat	3,635	171,029	17,103	25,052	45,790	199,715	0.010	1.997	143,500	225,041	0.001	0.00117
Sand gobies		1,929,768	192,977	962,430	1,155,406	2,892,198				205,882,353[20]		1.4[21]

[19] Source of fisheries data is ICES
[20] Estimate of population abundance
[21] Source of fisheries data is Rogers and Millner (1996)

iii. Combined effects

Primary and secondary entrainment

2.5.632. Although there is potential for increased stress, reduced fitness and increased mortality within the discharge plume the combined effect of primary and secondary entrainment would not increase the significance of the effects beyond the effects predicted for primary alone. This is due to the fact that even if 100% mortality of entrained ichthyoplankton was assumed the volume of cooling water is sufficiently low compared to tidal exchange to reduce any effects. Effects within the water body are therefore not predicted.

Entrainment and impingement

2.5.633. Entrainment and impingement have the potential to effect fish receptors across all life history stages and the in-combination effects of the two impacts is considered.

2.5.634. Entrapment has been estimated by summing the % losses of impingement and entrainment and the results are shown in **Table 2.67**. Although not a direct comparison of SSB or landings in a given year, given the extremely low entrainment losses of key taxa (except sand goby), when compared against SSB or landings, it would require annual changes in SSBs or landings of 2 or 3 orders of magnitude to significantly affect the combined total losses.

2.5.635. Results are similar to those obtained for impingement alone. With the LVSE and FRR system in place, only sand goby exceeds 1 % of the stock comparator. However, sand goby is an unexploited short-lived stock and, in such circumstances, the appropriate comparator is determined as 10% of the SSB. Furthermore, gobies are ubiquitous in the North Sea and the species is considered highly recoverable, given its high rate of growth and reproduction. As such the entrapment of sand goby in the context of the population assessed by the Transitional Fish Classification Index tool would not lead to a deterioration in the WFD water body.

Table 2.67: Annual mean entrapment predictions (with LVSE and FRR system in place) and alterations to the grey mullet and bass assessment

Species	Impingement		Entrainment		Entrapment (impingement +entrainment)	
	Percentage of SSB	% of landings (t)	Percentage of SSB	Percentage of landings	% of SSB	% of landings
Sprat	0.01	0.01	0	0	0.01	0.01
Herring	0.01	0.03	0	0	0.01	0.03

Species	Impingement		Entrainment		Entrapment (impingement +entrainment)	
	Percentage of SSB	% of landings (t)	Percentage of SSB	Percentage of landings	% of SSB	% of landings
Whiting	0.03	0.13	-	-	0.03	0.13
Bass	0.28	1.36	0	0	0.03	0.14
Sand goby	0.01	NA	1.40	0	1.41	0.00
Sole	0.00	0.01	0	0	0.00	0.01
Dab	NA	0	NA	0	NA	0.01
Anchovy	NA	0.04	NA	0	NA	0.05
Thin-lipped grey mullet	NA	0.52	-	-	0.10	0.52
Flounder	NA	0.01	NA	0	NA	0.01
Plaice	0.00	0	-	-	0.00	0.00
Smelt	0.01	1.36	-	-	0.01	1.36
Cod	0.00	0.01	-	-	0.00	0.01
Thornback ray	NA	0.03	-	-	NA	0.03
River lamprey	0.07	3.76	-	-	0.07	3.76
Eel	0.15	0.84	-	-	0.15	0.84
Twaite shad	0.02	32.40	-	-	0.02	32.40
Horse mackerel	NA	0	-	-	NA	0.00
Mackerel	0.00	0	-	-	0.00	0.00
Tope	NA	0.01	-	-	NA	0.01
Sea trout	NA	0.01	-	-	NA	0.01
Allis shad	0.01	0.68	-	-	0.01	0.68
Sea lamprey	NA	NA	-	-	NA	NA
Salmon	NA	0	-	-	NA	0.00

iv. Adjoining WFD water bodies

2.5.636. Already considered in main assessment above.

v. Assessment against possible future baseline

2.5.637. Mortality due to temperature shock for the egg and larval life stages of many fish species increases rapidly once maximum temperatures exceed 30°C, as shown in **Chapter 22** of **Volume 2** of the **ES** (Doc Ref. 6.3). With the exception of Dover sole and seabass, egg mortality is assumed to be 100% in entrainment predictions. Therefore, only Dover sole and seabass egg entrainment mortality prediction are subject to change. However, both species entrainment losses were <0.001% of SSB. Accordingly, changes in egg mortality rates are not considered to have a significant effect.

2.5.638. High entrainment mortality rates for longer periods of time, would likely be observed under future climate change. However, thermal lethality is highly species-specific and adaptation to future climate conditions and potential species distribution shifts may influence the ability to tolerate thermal stress thus influencing entrainment mortality.

2.5.639. The assessment for the current baseline did not predict changes to WFD water body status. Whilst effects could increase slightly due to increases in entrainment temperature and prolonged seasonal chlorination, the assessment of effects would remain unchanged. Abstraction rates represent approximately 1.35% of the volume of water that passages past the station, therefore, even with 100% mortality of ichthyoplankton, there is expected to be a minimal effect at the stock / population level, especially with high natural mortality experienced in the early life stages. The effect of entrainment on the WFD water body therefore remains as that assessed for the current baseline.

s) Detailed Assessment – O8 Discharge of trade effluent from the FRR system (waste stream H)

i. Introduction

2.5.640. This assessment considers the potential effects associated with the discharge of polluting matter relating to the functioning of the FRR system (waste stream H). Stage 2 scoped in the following potential effects as summarised in **Table 2.68**.

Table 2.68: Summary of water bodies, quality elements, RBMP mitigation measures and protected areas scoped in for further assessment for O8

Water body	Quality elements	Indirect effects	RBMP mitigation measures	Protected areas
Suffolk	Water Quality – physico-chemical	None	N/A	661

2.5.641. The FRR system is designed to minimise impacts on impinged fish and invertebrate populations. However, some species are highly sensitive to mechanical damage caused during passage through the cooling water intakes, drum screens and FRR channels and incur high mortality rates.

2.5.642. The return of dead and moribund biota retains biomass within the marine system but represents a source of organic loading, with potential for increase nutrient inputs, increased un-ionised ammonia and reductions in dissolved oxygen.

2.5.643. The total biomass of moribund biota that potentially would be discharged from the FRR has been estimated based on the level of abstraction (pump rates) for the planned Sizewell C intakes and the information on seasonal distribution of species and length weight distribution of the species impinged for the existing Sizewell B (see O6). Biomass numbers are summarised in **Table 2.69**. They do not account for headwork designs and should be considered as precautionary.

Table 2.69: Summary of biomass calculations for FRR system assessment (see O6)

Time period	Kg per day wet weight (mean daily discharges from both FRR systems directly extrapolated from Sizewell B)	Comment
April to September	406	Considered to be the time most likely to give rise to effects on phytoplankton give that light is not limiting during this period
March	3442	Highest daily discharge value in the year
Daily average	1066	The highest biomass of moribund fish occurs in December to April when clupeids are most abundant.

i. Physico-chemistry

Nutrients

2.5.644. Nitrogen and phosphorous loadings based on the biomass figures as outlined in Table **2.69** are shown in Table **2.70**.

Table 2.70: Loadings of nitrogen and phosphorous

Time period	Kg per day (wet weight)	N (kg)	P (kg)
April to September	406	14	2
Daily average	1066	37.3	5.3

2.5.645. The discharge of nitrogen associated with the operational development has been calculated at 32kg which equates to 0.2% of the daily exchange for the bay. The additional inputs of nitrogen from decaying biomass based on the daily average biomass represent an increase to a value of 0.4% of the daily exchange.

2.5.646. With respect to phosphorous, the daily average operational phosphorous load is low at 0.71kg or 0.03% of the daily exchange. The addition of phosphorous from decaying biomass represents a relatively high addition to this at 0.3% of the daily exchange.

2.5.647. This basic assessment is considered to be conservative as it assumes that the fish are not consumed by other species and that the tissue nutrient content makes a direct contribution to nutrient levels when, in fact, it would take several days for the tissue to decay and to release nutrients (Ref. 2.3). The input loading of phosphorus and nitrogen from biomass discharged from the FRR is, therefore, not predicted to cause a deterioration in water quality within the WFD water body but further consideration is given with the section considering the potential effects on phytoplankton given that these parameters can contribute to blooms.

Ammonia

2.5.648. Unionised ammonia contribution from decaying biomass was calculated using the unionised ammonia calculator and ammonia contributions from tissues based on values in literature along with relevant site background conditions for pH, temperature and salinity to indicate the potential unionised ammonia contribution from decaying biomass at Sizewell.

2.5.649. Based on the daily average biomass of fish discharged during the period April to September (and average pH, salinity and temperature) the estimated NH_3 loading is predicted to be at or above the EQS over an area of 1.2ha around the FRR (including natural background and maximum predicted background from Sizewell C operation with thermal elevation). If the calculator input values are adjusted to consider 95th percentile temperature and pH, which may occur during the summer period, the area of exceedance increases to 3.8ha. Considering maximum predicted daily biomass from the FRR during

March (3442kg) adjusted for an average March temperature (Ref. 2.60) an area of 6.7ha would exceed the EQS within the WFD water body.

Biological Oxygen Demand

2.5.650. The decaying fish biomass discharged from the FRR is also likely to contribute to the biological oxygen demand. Based on the oxygen demand of organic matter inputs from fish cages coupled to the annual average daily biomass loading an estimate of biochemical oxygen demand was made.

2.5.651. The average daily BOD contributed by decaying fish tissue is estimated to be 1342kg per day which is calculated to result in an oxygen draw down of 447kg per day. This potential oxygen requirement is equivalent to 0.2% of the daily exchange and deficits would also be met by daily reaeration at the sea surface. Given that the water body is well mixed and the reaeration rate is high, effects on water quality of the water body are not predicted on a water body scale.

ii. Biology

Habitats

2.5.652. Modelling indicates that dead and moribund biota discharged from the FRR would primarily settle onto the seabed in the vicinity of the two FRR outfalls. Therefore, the higher sensitivity habitat *S. spinulosa* would not be affected by this discharge. This assessment therefore focuses on scavengers, predators and surface deposit feeders, as these taxa are the most likely to respond to discharges of dead and dying organisms from the FRR outfalls.

2.5.653. Few benthic invertebrates within the WFD water body obtain their nutrition from scavenging, with less than 5% of infaunal and epifaunal individuals exhibiting this feeding mode (Ref. 2.17). 16 of the 20 key taxa exhibit one or more of these feeding modes (Ref. 2.17), which includes all taxa except for *Ensis spp*., *Mytilus edulis*, *Notomastus spp*. and *Sabellaria spinulosa*.

2.5.654. It is possible that these taxa, along with other benthic invertebrates with the same feeding modes, would benefit from increased food availability due to discharges of dead and moribund biota from the FRR. Their population densities may increase and their spatial distributions may shift to reflect increased concentrations of food resources around FRR outfalls. Such effects on benthic invertebrates are likely to be most pronounced from December to April, when mean daily discharges are expected to be relatively high.

2.5.655. The response of scavengers, predators and surface deposit feeders, to this pressure is expected to be positive, but any population-level effects would likely be small at the scale of the water body. As a result, effects on a water body scale are not predicted.

2.5.656. In terms of water quality effects, the spatial scale of the EQS failures for the water quality parameters assessed is small and differs seasonally. Additionally, the wide distributions of benthic invertebrate species with the WFD water body mean that a very small fraction of any population would be exposed to any concentrations above EQS. As a result, effects on a water body scale are not predicted.

Phytoplankton

2.5.657. The CPM predicted that annual nutrients loadings due to operational nutrient discharges from Sizewell B and the proposed development would increase annual gross production within the GSB by less than 0.3% increase. Environment Agency data collected from the area from 1992 to 2013 indicates annual chlorophyll a values vary by 45% of the mean (Ref. 2.23).

2.5.658. As a result, a non-temporary effect on the WFD water body is not predicted. The assessment is highly precautionary as it assumes that the fish are not predated upon by other species and that the tissue nutrient content makes an immediate contribution to nutrient levels when nutrients would be released over longer periods of time following tissue to decay.

iii. Assessment against possible future baseline

2.5.659. Given that there are no changes associated with impingement in the future, the parameters assessed for the FRR system are unlikely to change from those presented for the current baseline.

2.6 Summary of outcome of Stage 3 Detailed Assessment

2.6.1. A summary of the output of the Stage 3 assessment is presented in **Table 2.71** for construction and **Table 2.72** for operation.

2.6.2. These tables demonstrate that the Stage 3 assessment did not indicate any parameters at risk of deterioration such that class status for any of the parameters would decrease. As a result, the proposed activities alone, as detailed in **section 2.2,** are considered compliant with the requirements of the WFD.

2.6.3. The potential impacts of the associated development sites are assessed separately in **Part 3** of the **WFD Compliance Assessment**. The potential for cumulative effects on water body status resulting from the proposed activities at the main development site, those at the associated development sites, and activities associated with other unrelated developments are assessed in **Part 4**.

Table 2.71: Summary of Stage 3 assessment for the construction phase

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
C1 Initial site preparation					
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (not in place)	415 661	Following implementation of the suite of control measures embedded in the **CoCP** (Doc Ref. 8.11), any changes to the surface waters and groundwater are predicted to be insufficient to result in a change in the status of these or adjoining water bodies.
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415	Following implementation of the suite of control measures embedded in the **CoCP**, any changes to the surface waters and groundwater are predicted to be insufficient to result in a change in the status of these or adjoining water bodies.
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River	N/A	78 116	Following implementation of the suite of control measures embedded in the **CoCP**, any changes to the surface waters and groundwater are predicted to be insufficient to result in a change in the status of these or adjoining water bodies.

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
C2 Earthworks for platform development					
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (not in place) Floodplain connectivity (not in place)	415 661	Disruption of patterns of groundwater flow and surface water levels, and creation of pollutant pathways during piling of the cut-off wall, were predicted to be the main effects. Based on surface water and groundwater modelling, effects are not predicted on surface water hydromorphological parameters. Discernible impacts from the proposed construction activities relate almost entirely to construction dewatering within the cut-off wall of the platform area. As water from the dewatering process will be discharged to the marine environment therefore impacts on the Leiston Beck water body catchment are not predicted. Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Sediment management (in place)	661 415	Disruption of patterns of groundwater flow and surface water levels, and creation of pollutant pathways during piling of the cut-off wall, were predicted to be the main effects. Based on surface water and groundwater modelling, effects are not predicted on surface water hydromorphological parameters. Discernible impacts from the proposed construction activities relate almost entirely to construction dewatering within the cut-off wall of the platform area. As water from the dewatering process will be discharged to the marine environment therefore impacts on the Minsmere Old River water body catchment are not predicted.

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
					Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River	N/A	78 116	Disruption of patterns of groundwater flow and surface water levels, and creation of pollutant pathways during piling of the cut-off wall, were predicted to be the main effects. The output of the modelling study was considered against the groundwater tests for quantity and determined that there is no potential for deterioration within the groundwater body associated with this activity. Based on surface water and groundwater modelling, discernible impacts from the proposed construction activities relate almost entirely to construction dewatering within the cut-off wall of the platform area. Changes to groundwater levels in this water body are less than those attributable to different climate change projections in the absence of development and the period of impacts is confined to the period of construction dewatering itself and a subsequent period of up to three years, as groundwater levels recover to their natural levels. Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
C3 Construction of marine structures					
Suffolk	Water quality - chemical and physico-chemical. Biology – Habitats	N/A	N/A	N/A	Release of sediments and any contamination within them were predicted to be the main effects. No deterioration predicted due to short term and localised nature of effects

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
C4 Discharge of waste water					
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661	Only small areas localised to the CDO (located within the Suffolk coastal water body) will exceed the various EQS / substitute EQS and therefore no deterioration in the water body is predicted or in adjoining water bodies.
	Physico-chemistry: General, specific pollutants				
	Biology: Aquatic flora, benthic invertebrates, fish				
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	Align and attenuate flows (not in place)	415 661	Only small areas localised to the CDO (located within the Suffolk coastal water body) will exceed the various EQS / substitute EQS and therefore no deterioration in the water body is predicted or in adjoining water bodies.
	Physico-chemistry: General, specific pollutants				
	Biology: Aquatic flora, benthic invertebrates, fish				
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs	Leiston Beck Minsmere Old River	N/A	N/A	Only small areas localised to the CDO (located within the Suffolk coastal water body) will exceed the various EQS / substitute EQS and therefore no deterioration in the water body is predicted or in adjoining water bodies (including groundwater).
	Quality: Diffuse pollution, GWDTEs, quality of drinking waters, pollutant trends, 'prevent or limit' objective	Leiston Beck Minsmere Old River			
Suffolk	Water quality – chemical and physico-chemical	Walberswick Marshes	N/A	N/A	Only small areas localised to the CDO (located within the Suffolk coastal water body) will exceed the various EQS /

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
	Biology - habitats	Blyth (S) Alde and Ore			substitute EQS and therefore no deterioration in the water body is predicted or in adjoining water bodies.
C5 Discharge of cold test commissioning water					
Suffolk	Water quality – chemical and physico-chemical	Leiston Beck Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore	N/A	N/A	The impact of discharges from cold flush testing through the CDO was predicted to be the main effect. Discharge concentrations of ethanolamine are sufficiently low so as not to significantly impact on this water body. Additional assessment for hydrazine and unionised ammonia identified that a very small area of the water body would be impacted, and therefore the potential for within class or between class deterioration due to water quality is not predicted. Given that the area of the discharge plume with significant concentrations of harmful chemicals is limited to the immediate vicinity around the CDO, and is only released intermittently, effects on habitats on a water body scale are not predicted. The potential effects on adjacent water bodies are not predicted, as elevated concentrations of harmful chemicals would not coincide with sluice opening and would in any case be likely to degrade rapidly prior to reaching water bodies not immediately adjacent to the CDO.

Table 2.72: Summary of Stage 3 assessment for the operational phase

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
O1 Presence of power station platform and cut-off wall					
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General	Minsmere Old River Suffolk Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	N/A	The operational phase would not lead to any significant effects on the flow regime or changes in groundwater storage as a result of the proposed development. The artificially modified geomorphological structure of the drains would be retained. Surface water runoff and foul effluent will be captured and discharged to sea so no physico-chemical impacts are predicted. Given that there are minimal changes predicted in both the groundwater and surface waters as a result of the presence of the platform, effects on biology are not predicted. Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
Minsmere Old River	Hydromorphology: Hydrological regime, morphological conditions Physico-chemistry: General	Leiston Beck Suffolk Waveney and East Suffolk Chalk and Crag	N/A	N/A	The operational phase would not lead to any significant effects on the flow regime or changes in groundwater storage as a result of the proposed development. The artificially modified geomorphological structure of the drains would be retained. Surface water runoff and foul effluent will be captured and discharged to sea so no physico-chemical impacts are predicted. Given that there are minimal changes predicted in both the groundwater and surface waters as a result of the presence of the platform, effects on biology are not predicted.

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
					Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
Waveney and East Suffolk Chalk and Crag	Quantity: Groundwater levels and GWDTEs, saline intrusion, water balance, dependent surface waters Quality: Diffuse pollution, GWDTEs, saline intrusion, quality of drinking waters, pollutant trends, ‘prevent or limit’ objective	Leiston Beck Minsmere Old River	N/A	N/A	The operational phase would not lead to any significant effects on the flow regime or changes in groundwater storage as a result of the proposed development. Surface water runoff and foul effluent will be captured and discharged to sea so no water quality impacts are predicted. Given that there are minimal changes predicted in both the groundwater and surface waters as a result of the presence of the platform, effects on dependent ecosystems are not predicted. Given the effects above are not predicted to lead to a deterioration in status, no effects on adjoining water bodies are predicted.
O2 Presence of permanent access road					
Leiston Beck	Hydromorphology: Hydrological regime, morphological conditions, river continuity Physico-chemistry: General, specific pollutants Biology: Aquatic flora, benthic invertebrates, fish	Minsmere Old River Waveney and East Suffolk Chalk and Crag	Floodplain connectivity (not in place)	N/A	Direct loss of river habitat, upstream and downstream changes in hydromorphological processes and changes in groundwater / surface water interactions were predicted to be the main effects. No deterioration predicted in this water body or adjoining water bodies due to the minor and localised nature of effects.

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
O3 Presence of marine structures					
Suffolk	Hydromorphology Water quality – chemical and physico-chemical Biology - habitats	N/A	N/A	N/A	Given most of these structures will be below the sea surface and only relatively small head structures would be present above the sea bed, only very localised effects are predicted. Note that the intakes and outfall are located outside of the water body boundaries. The BLF requires dredging during the operational phase but volumes are relatively small and sediment would remain within the system. As a reuslt, effects on hydromorphology are not anticipdated. Effects on water quality are not predicted given that sediment contamination is low. Given no effects on water quality and hydromorphology are predicted, effects on habitats are not predicted.
O4 Presence of flood defences					
Suffolk	Hydromorphology	N/A	N/A	N/A	The hard coastal defence structure in the imediate future would not be located within the WFD water body. The soft coastal defence would add additional amterail to the sediment transport processes but would not alter them, additionally effects would only occur during storm conditions. In the future, sea level rise might be such that the hard coastal defence could impact on hydromorphological parameters.
O5 Surface and foul water discharge via cooling water system					
Suffolk	Water quality – chemical and physico-chemical	Leiston Beck	N/A	661	Modelling predicted potential changes to thermal properties of the WFD water body. However additional modelling to

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
	Biology - Habitats	Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore		Southwold The Denes Southwold The Peir	consider the potential effects of the increased temperature on physico-chemical parameters did not indicate any effects. Additionally, the species located within the thermal plume were not considered sensitive to the predicted changes to termperature. In terms of chemistry, a screening assessment identified the chemicals that could potentially exceed either the EQS or subsitute EQS. However further modelling did not indicate signifcant mixing zones, most of which were located outside of the WFD water body boundary. In terms of protected areas, bacteria concentrations with the proposed treatement levels were predicted to be compliant with bathing water standards on discharge to the water environment. As a result a deterioration in the water body is not predicted. The potential for effects on adjoining water bodies were also considered.
O6 Intake of cooling water					
Suffolk	Biology – phytoplankton and fish. Fish is not a compliance parameter for coastal water bodies so the potential effect is considered on the transitional water bodies only which could be impacted indirectly.	Blyth (S) Alde and Ore	N/A	N/A	Assessment of both impingement and entrainment did not identify any significant risks to key taxa against the thresholds identified. As a result, a deterioration in the WFD water body is not predicted.
O7 Discharge of trade effluent from cooling water system					
Suffolk	Water quality – chemical and physico-chemical, Biology -	Leiston Beck	N/A	661	See O5

Water body	Quality elements	Indirect effects	Mitigation measures	Protected areas	Summary of assessment
	Habitats under plume. INNS (spread not introduction)	Minsmere Old River Walberswick Marshes Blyth (S) Alde and Ore			
O8 Discharge of polluting matter via the FRR					
Suffolk	Water Quality – physico-chemical	None	N/A	661	Modelling undertaken to look at the potenital effects of the dead fish on water quality indicated very localised effects to the FRR structures. As a result, a deterioration in the WFD water body is not predicted.

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