MOTT MACDONALD

Essex & Suffolk Water - Water Resources Management Plan 2024 Environmental Report

Appendix F - Habitats Regulations Assessment (HRA)

October 2023

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Acronyms List

Acronym	Definition
AESI	Adverse Effect on the Site Integrity
CEMP	Construction and Environmental Management Plan
CTMP	Construction Traffic Management Plan
DAF	Dissolved Air Floatation
DO	Deployable Output
INNS	Invasive Non-Native Species
GAC	Granular Activated Carbon
GWDTE	Ground Water Dependent Terrestrial Ecosystems
LSE	Likely Significant Effects
Ml/d	Megalitres per day
NNSS	Non-native Species Secretariat
NLSE	No Likely Significant Effects
NSN	National Site Network
POM	Programme Of Measures [WFD measures required to improve waterbody status]
PS	Pumping station
RGF	Rapid Gravity Filter
SIP	Site Improvement Plan
SNCB	Statutory Nature Conservation Body
SR	Service Reservoir
SRO	Strategic Resource Option
SSSI	Site of Special Scientific Interest
STT	Severn to Thames transfer
ToLS	Test of Likely Significance
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
WRMP19	Water Resources Management Plan 2019
WRMP24	Water Resources Management Plan 2024
WSR	Water Supply Reservoir
WRE	Water Resources East
WRC	Water Recycling Centre
WRZ	Water Resource Zone
WSW	Water Supply Works
WTW	Water Treatment Works
ZoI	Zone of Influence

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Executive summary

This report presents the results of the Habitats Regulations Assessment (HRA) Stage 2 Appropriate Assessment (AA) undertaken for ESW Resource Management Plan 2024 (WRMP 24) options. It assesses the potential effects of 16 options with likely significant effect (LSE) on sites in the UK's National Site Network (hereafter referred to as 'Habitats Sites') including Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar Sites. Mott MacDonald Ltd undertook this HRA and plan level AA following the methodology in the *Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15)*.

Water companies have a statutory obligation to produce a Water Resources Management Plan (WRMP), which sets out how a company intends to maintain the balance between supply and demand for water over a minimum 25-year period. In the development of a WRMP, companies must follow the Water Resource Planning Guideline (WRPG). WRMPs should ensure a secure and sustainable supply of water, focus on efficiently delivering the outcomes that customers want, while reflecting the value that society places on the environment.

Essex & Suffolk Water (ESW) is part of Northumbrian Water Limited (NWL) and provides water services to 1.8 million people, operating in two areas: one serving parts of Norfolk and Suffolk, and the other serving parts of Essex and Greater London.

As part of the environmental assessment process to support the development of the ESW WRMP24 Plan, a HRA screening (Stage 1) was undertaken on the constrained list of water resource options to identify options with potential LSE on Habitats Sites. Options that were identified as potentially resulting in LSE were then subject to an HRA Appropriate Assessment (AA) (Stage 2). The current WRMP24 Plan for ESW includes supply options requiring HRA.

Where an option is likely to, or has the potential to, give rise to LSE upon a Habitat Site, an assessment is made of the implications on the integrity of that site in view of that site's structure, function and conservation objectives and taking into account any site-specific supplementary advice or site improvement plan. Where mitigation measures are to be applied to eliminate or reduce any effects identified in screening, these are considered within the AA.

This HRA Stage 2 AA, undertaken at plan level, concluded that 13 proposed options may result in adverse effects. This is due to uncertainty in the results arising from the early stages in options development and lack of design detail. However, the assessment found that, provided that appropriate mitigation measures are implemented, Adverse Effect on Site Integrity (AESI) can be ruled out from all of the WRMP24 options. Further studies are required to understand residual unknowns relating to the operation of Canvey Island Desalination Terrestrial option (ID: DES-001) and specifically the effect of brine discharge on hydrological processes and the aquatic environment.at the project stage. For all options where LSE was identified during construction phases mitigation can be designed in at the project level following the approaches set out within this HRA and do not have potential to result in adverse effects. The importance of establishing robust programmes of investigation is recognised, conducting further research, and implementing effective mitigation measures to proactively address adverse effects. These actions will reinforce the plan's positive effects on biodiversity and environmental well-being. The findings indicate that the successful implementation of the WRMP24 and the achievement of its intended positive outcomes are contingent on the diligent and full adherence to the identified mitigation measures and in line with guidance.

All options have been considered with regard to potential for in-combination effects. Where a pathway has been identified, options are taken to Stage 2 AA meaning that no low effects remain. For options that required a Stage 2 AA a range of potential control and mitigation techniques that will be applied have been identified. For these reasons it is considered that at the plan level an in-combination assessment is not required.

The mitigation measures detailed within this document assume a worst-case scenario at this stage in the absence of detailed survey data or local records. As such, they are considered to be appropriate so that AESI can be avoided. The receipt of additional data may provide evidence that there will be no adverse effects on Habitats Sites even in the absence of mitigation; in this scenario this document should be revised accordingly.

This report will be sent to the relevant nature conservation authorities. If the competent authority considers that residual adverse effects cannot be ruled out, a decision will be made whether the derogations are utilised, which would include Stage 3 (Assessment of Alternative Solutions) and/or Stage 4 (Assessment Where No Alternative Solutions Exist and Where Adverse Impacts Remain). Further design iterations will require revisions to this document and may result in changes to the current conclusion.

1 Introduction

1.1 Overview

Water companies in England and Wales are required to produce a Water Resources Management Plan (WRMP) every five years. The plan sets out how the company intends to maintain the balance between supply and demand for water over the long-term planning horizon to ensure security of supply in each of the water resource zones making up its supply area.

Essex & Suffolk Water (ESW) is part of Northumbrian Water Limited (NWL) and provides water services to 1.8 million people, operating in two areas: one serving parts of Norfolk and Suffolk, and the other serving parts of Essex and Greater London.

ESW is within the Water Resources East (WRE) regional planning area. In the development of a WRMP, companies in England and Wales must follow the Environment Agency (EA) Water Resources Planning Guideline (WRPG) and consider broader government policy objectives. The guideline highlights that, where required, companies must carry out a Strategic Environmental Assessment (SEA) for their WRMP.

As part of the environmental assessment process to support the development of the WRE Regional Plan and ESW WRMP 2024 'WRMP24', a Habitats Regulations Assessment (HRA) Test of Likely Significance (ToLS) was undertaken on the constrained list of water resource options (that is those that were considered suitable for inclusion into the plan), to identify options with potential likely significant effects (LSE) on Habitats Sites. Preferred options were grouped to form a 'Best Value Plan' (BVP) and the ones identified as having potential for LSE during the ToLS were taken forward for the next stage of the HRA process, the Appropriate Assessment (AA).

The HRA process was undertaken alongside the development of the ESW WRMP24 to inform the decision-making process and integrate environmental considerations. The HRA for the draft WRMP24 (dWRMP24) was presented in an HRA Report which was issued for consultation to Defra in October and to the public in December 2022. Comments received from the consultation process were reviewed and have been addressed where appropriate within this HRA Report. The draft WRMP24 has been updated to the revised draft WRMP24 (rdWRMP24) reflecting additional modelling work undertaken to optimise the plan as well as consultation feedback. This report is the HRA Report for the ESW rdWRMP24 and forms part of the ESW rdWRMP24 documentation.

1.2 The purpose of the Habitats Regulations Assessment

This HRA has been undertaken for ESW WRMP24, to inform any likely impediments to the practicality or deliverability of the options being taken forward. It delivers the duties upon Statutory Undertakers (in this case water utilities) to ensure works comply with the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended) (the 'Habitats Regulations) by ensuring that the potential effects of the plan's options are fully considered and mitigated.

Further consultation between the relevant competent authority (NWL) and the Statutory Nature Conservation Body (SNCB) (Natural England), will be required to support the identified mitigation measures during project stage.

Natural England will be consulted to advise whether the options presented in this report will adversely affect the integrity of Habitats Sites. The integrity of a site is defined as the coherence of its ecological structure and function, across its whole area, that enables it to sustain the

habitat, complex of habitats and/or the levels of populations of the species for which it was designated[1].

1.3 Assumptions and limitations

Information provided by third parties, including publicly available information and databases, is considered correct at the time of publication. Due to the dynamic nature of the environment, conditions may change in the period between the preparation of this report, and the undertaking of the proposed works.

Any uncertainties surrounding, and limitations of, the assessment process are acknowledged and highlighted. Recommendations for avoidance and mitigation measures to address the potential adverse effects on the integrity of the Habitats Sites identified by this report are also based on the information available at the time of the assessment. It is acknowledged that the requirement for mitigation may change as design of the BVP Options progresses. This is expected to be through increased level of available detail at later stages of option development. A project level HRA may be required as appropriate.

Assessments have been carried out for options shortlisted under the 'Best Value' planning process, with all options belonging to one or more of these plans: Best Value Plan (BVP), OFWAT Core Plan, Best Environment and Society Plan (BESP), or Adaptive programmes (see Table 2.1 below for an overview of all options considered in the HRA AA). The environmental assessment and the assessment of cumulative effects provided primarily focusses on schemes up to 2040, with schemes post-2040 considered on a lighter touch. This is because post-2040 there is less certainty in predicted status or condition of the environment and any assessments would be undertaken in an overly precautionary manner.

[1] UK Government (2019). Guidance on the use of Habitats Regulations Assessment [online] available at: Appropriate assessment - GOV.UK (www.gov.uk) (last accessed Aug 2022).

2 Options description

2.1 Option description and site locations

Assessments have been carried out for options shortlisted under the 'Best Value' planning process, with all options belonging to one or more of these plans: Best Value Plan (BVP), OFWAT Core Plan, Best Environment and Society Plan (BESP), or Adaptive programmes , (see Table 2.1 below for an overview of all options considered in the HRA AA). ESW's Least Cost Plan and Best Value (Preferred) Plan have been found to comprise the same options and therefore it has not been considered further here. From the ESW WRMP24 constrained list of options, a total of 12 options were selected for inclusion into the BVP, 11 for the OFWAT Core plan, and 12 for the BESP. ESW-TRA-018 and ESW-TRA-023 are considered as two options for the purposes of this report, however they are a combined option in Best Value Plan under the Option ID: ESW-TRA-023.

To determine appropriate plan options, ESW adopted a planning approach that uses least-cost optimisation as well as broader criteria for 'best value' decision making, including:

- Cost to build and operate the plan
- Adaptability and flexibility of the plan to cope with uncertain future needs
- Alignment to the Water Resource East regional strategy
- Resilience of the plan to severe and extreme drought and other hazards, and the residual risks
- Deliverability of the plan with timescales needed to manage risks
- Alignment to customer preferences
- Environmental and social impacts of the plan, including net environmental benefit

Demand management is a priority for ESW. In developing the WRMP, ESW has first considered if water availability could be offset from demand management, before seeking to develop supply-side options. Although the demand management strategy is ambitious it must also be deliverable and therefore carefully targeted investment in supply-side capacity is still required. The supply-side options considered for inclusion in the WRMP 24 have been developed following industry and regulator guidance.

The HRA and other environmental studies undertaken were used as part of the decision-making criteria on environmental and social impacts of the plan to develop the BVP. The BVP provides the best value for customers in the long term whilst considering environmental and social metrics such as SEA performance, embodied carbon, biodiversity net gain, and other aspects.

In this HRA AA report, 17 options across the BVP, OFTWAT Core, BESP, and adaptive programmes are analysed. Table 2.1 summarises all options considered in this report and identifies the ones that were submitted to HRA process, as well as specifying the specific plans in which the options are included.

Table 2.1: Options Overview

	Plans	Option	Option description	LSE	LSE Screening Review	AA
1	BVP, OFWAT, BESP, Adaptive	Linford water treatment works (ID: ESW-ABS-003C)	Borehole Abstraction (7 Ml/d DO). New conventional water treatment works built on Linford WTW's existing site. Intake from existing, decommissioned borehole, outfall to existing treated water network.	Yes	Yes	Yes

	Plans	Option	Option description	LSE	LSE Screening Review	AA
	programmes					
2	BVP, OFWAT, BESP, Adaptive programmes	Barsham to Blyth transfer main (ID: ESW-TRA-001)	Transfer from Barsham WTW to Saxmundham Water Tower. Transfer consists of multiple sections: A. Barsham WTW to Shadingfield Tower – construction of new pipeline next to an existing main, length approximately 5.6km Micro-tunnelling required for one railway crossing. B. Shadingfield Tower to Holton WTW - length approximately 7.4km. Tunnelling not required. C. Holton WTW to Saxmundham Tower - length approximately 19.2km. Tunnelling (micro-tunnelling/horizontal directional drilling) likely to be required as route passes under one railway, three major roads (A144, A1120, A12), three minor roads (B1124, B1123, B1119), two river crossings (River Blyth, River Yox), and two drainage channels. The route also runs along roads (B1119) for the last section to reach Saxmundham Tower. D. Connection to Walpole WTW, taken off Transfer C - approximate length of 1.4km. This transfer joins Transfer C not long after the railway crossing. No tunnelling required.	Yes	Yes	Yes
3	BVP, OFWAT, BESP, Adaptive programmes	Transfer from Holton WTW to Eye Airfield (ID: ESW-TRA-019)	8.5 Ml/d transfer from Holton WTW to Eye Airfield. Transfer approximately 30.6km long. Transfer mainly follows roads. Critical crossings include a railway crossing in Halesworth (route follows road bridge therefore trenchless techniques not possible), and the River Dove.	Yes	Yes	Yes
4	BVP, OFWAT, BESP, Adaptive programmes	Bungay Wells to Broome WTW transfer (ID: ESW-TRA-018)	Transfer from Bungay Wells to Broome WTW. Transfer is approximately 3.6 km long, with 1 Ml/d max capacity. Route mainly follows roads.	Yes	Yes	Yes
5	BESP, Adaptive programmes	Southend Water Reuse and Transfer (ID: ESW-EFR-001)	Southend-on-Sea Effluent Re-use (max capacity). Intake from Southend-on-Sea WRC (Anglian Water owned asset), discharge to Hanningfield Service Reservoir. Two transfers required: Southend-on-Sea WRC to new effluent reuse plant (Transfer 1), new effluent reuse plant to Hanningfield reservoir (Transfer 2). Transfer 1: Transfer length approximately 991m. Route runs under an industrial estate road, no need for tunnelling. Pump station required at existing STW – located where the two existing outfalls meet. Transfer 2: Transfer length approximately 23.1km. Tunnelling (micro-tunnelling/horizontal directional drilling) required as route passes under one railway line, multiple major roads (A130, A132), two large river/estuary crossing (River Roach and River Crouch), three smaller river crossings, and one drainage channel crossing.	Yes	Yes	Yes
6	BVP, OFWAT, BESP,	Lowestoft water reuse (transfer to	Effluent Reuse Plant (11.1 Ml/d DO). Intake from Lowestoft/Corton WRC (Anglian Water owned asset), discharge to point near Ellingham Mill.	Yes	Yes	Yes

	Plans	Option	Option description	LSE	LSE Screening Review	AA
	Adaptive programmes	River Waveney) (ID: ESW-EFR-002A)	Two transfers required: Lowestoft/Corton WRC to new effluent reuse plant (Transfer 1, length approximately 200 m), new effluent reuse plant to Ellingham Mill on the River Waveney (Transfer 2, length approximately 26.3 km).			
7	BESP, Adaptive programmes	Effluent Reuse at Caister and Transfer to Ormesby (ID: 03b0478B)	Effluent Reuse - 03b0478B_16.4MLD_Effluent reuse at Caister pump lane WRC within the existing site footprint at Caister to Ormesby	Yes	Yes	Yes
8	BVP	North Suffolk Winter Storage Reservoir (ID: ESW-RES-002C1)	New winter storage reservoir to be built. Intake comes from the River Waveney/River Hundred when there's no spare capacity at Barsham WTW. When supplies are short at Barsham WTW, water is taken from the reservoir and transferred to the WTW. Includes Barsham River Works Upgrade.	Yes	Yes	Yes
9	BESP	Canvey Island Option (ID: DES-001)	The option proposes a new seawater desalination plant at Canvey Island with an abstraction from the Thames Estuary and a discharge to Hanningfield Service Reservoir. The intake / outfall will be via a pier	Yes	Yes	Yes
10	BESP, Adaptive programmes	Corton beach well desalination (Option ESW-DES-008)	Seawater abstraction from newly constructed beach wells along Corton discharging to the existing Barsham Water Treatment Works (WTW). Two parts of transfer pipelines are proposed: Transfer 1 from beach wells/infiltration galleries to the new desalination plant (722 m in length); Transfer 2 from the desalination plant to Barsham WTW (approximately 24.7 km in length).	Yes	Yes	Yes
11	BVP, OFWAT, BESP, Adaptive programmes	Langford EDR Nitrate Removal + Pipeline Option ID: (ESW-NIT-005)	Electrodialysis reversal (EDR) treatment to be positioned within the existing Lanford water treatment works (WTW) site boundary. The option also includes a waste stream discharge (brine) pipeline to Anglian Water's Maldon sewage treatment works (STW) on Osea Road.	Yes	Yes	Yes
12	BVP, OFWAT, BESP, Adaptive programmes	Langham EDR Nitrate Removal Option ID: (ESW-NIT-006)	Nitrate electrodialysis reversal (EDR) to be positioned within the existing Langham Water Treatment Works (WTW) site boundary. Includes a waste stream discharge pipeline to Anglian Water's Colchester sewage treatment works (STW).	Yes	Yes	Yes
13	BVP, OFWAT, BESP, Adaptive programmes	Abberton Raw Water Pumping Station Option ID: (ESW-PMP-001A)	This option has two distinct elements. Firstly, the replacement to enable an enhanced pumping capacity of two existing pumps, motors and controls at Abberton Reservoir Raw Water Pumping Station (RWPS). The new pumps will have duty points of 43Ml/d at 51m head. Secondly, the treatment at Langford WTW is proposed to be upgraded to accommodate the introduction of source water from Abberton raw water reservoir. The requirement is to sustain the maximum capacity of the WTW (57Ml/d), whilst simultaneously introducing up to 50Ml/d of Abberton Water raw water.	Yes	Yes	Yes

	Plans	Option	Option description	LSE	LSE Screening Review	AA
14	BVP, OFWAT, BESP, Adaptive programmes	TRA-023: Broome to Barsham Transfer Option ID: (ESW-TRA-023)	Transfer of raw water from Broome WTW to Barsham WTW - connecting to a new service reservoir.	Yes	Yes	Yes
15	BVP, OFWAT, BESP, Adaptive programmes	Langford UV - Crypto Option ID: (ESW-UVC-001)	Installation of additional ultraviolet treatment infrastructure at the existing Langford WTW to treat for cryptosporidium for the plant's full flow capacity of 57Ml/d.	Yes	Yes	Yes
16	BVP, OFWAT, BESP, Adaptive programmes	Barsham EDR Nitrate Removal and Pipeline Option ID: (ESW-NIT-004)	Nitrate electrodialysis reversal (EDR) treatment extension within Barsham WTW's existing site boundary. Includes a brine waste discharge pipeline to Beccles sewage treatment works (STW).	Yes	Yes	Yes
17	N/A	California beach desalination (ESW-DES-004)	Seawater desalination plant. Service reservoir located off site. Two transfers required: Transfer 1 from beach infiltration galleries to desalination plant, length: 1.8km. Transfer 2 from desalination plant to Barsham WTW, length: approx. 37km. Tunnelling/trenchless techniques likely to be required.	Yes	Yes	No

Source: Mott MacDonald, 2022.

3 Habitats Regulations Assessment process

3.1 Habitats Regulations Assessment process

There is a requirement under the Conservation of Habitats and Species Regulations 2017 (as amended) ("the Habitats Regulations") to determine if a plan or project may have an adverse impact on a site designated under the same (or preceding Regulations) prior to any consent or permission being determined. The process of undertaking this assessment is known as an HRA.

The Habitats Regulations include measures to establish and maintain a network of sites protecting habitats which in themselves are valuable as well as for the species they support. These sites form a network that across Europe historically were known as Natura 2000, and domestically now known as the National Site Network (NSN). Within the UK, this network consists of Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), proposed and candidate SPAs and SACs (pSPAs and cSACs). This network also extends to marine environments, with wetland sites of international importance (Ramsar Sites) also treated equally within this assessment framework. These sites are collectively referred to in this document as 'Habitats Sites'.

Regulations 63 and 64 transposed the provisions of Articles 6(3) and 6(4) of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') as they related to plans or projects in England and Wales.

Regulation 63 states that if a plan or project is *'(a) is likely to have a significant effect on a European site*[2] *or a European offshore marine site (either alone or in combination with other plans or projects); and (b) is not directly connected with or necessary to the management of the site*' then the competent authority must *'… make an appropriate assessment of the implications for the site in view of that site's conservation objectives'* before giving consent or authorisation. The plan or project can only be given effect if it can be concluded (following an 'appropriate assessment') that it *'… will not adversely affect the integrity'* of a site unless the provisions of Regulation 64 are met.

The process of undertaking this assessment is known as an HRA. An HRA determines whether a plan or project will result in LSE on any Habitats Site as a result of the plan's implementation (either on its own or 'in combination' with other plans or projects)[3] and, if so, an Appropriate Assessment ('AA') is undertaken to determine whether there will be any 'adverse effects on site

[2] The Habitats Regulations include measures to establish and maintain a network of sites protecting habitats which are valuable in themselves as well as for the species they support. These sites form a network of European sites in the Natura 2000 network, which domestically form part of the UK's National Site Network (NSN). The term 'European site' is currently retained in the EU Exit amendment to the Habitats Regulations and for all practical purposes the definition is essentially unchanged. European sites are therefore: any Special Area of Conservation (SAC) from the point at which the European Commission and the UK Government agreed the site as a 'Site of Community Importance' (SCI) (if this was before 31 Jan 2020); any classified Special Protection Area (SPA); and any candidate SAC (cSAC). However, the term is also commonly used when referring to potential SPAs (pSPAs), to which the provisions of Article 4(4) of Directive 2009/147/EC (the 'new wild birds directive') are applied; and to possible SACs (pSACs) and listed Ramsar Sites, to which the provisions of the Habitats Regulations are applied as a matter of Government policy (National Planning Policy Framework (NPPF) para. 181) when considering development proposals that may affect them. In this document the term 'Habitats Sites' is used as an umbrella term for all the above designated and listed sites, after the NPPF.

[3] The Stage 1 Screening assessment, sometimes known as the 'Test of Likely Significance'

integrity'[4]. If there may be such adverse effects on site integrity, then there will need to be a further process under Regulation 64 of considering whether there are alternatives and, if none are identified, assessment of compensation measures and whether there are imperative reasons of overriding public interest why consent should be granted or a plan published/approved notwithstanding. The Regulations define the nature and roles of statutory bodies, competent authorities and the appropriate nature conservation body as well as the requirements for information to be submitted to these bodies to enable them to undertake the required assessments.

An important relevant guidance document for HRAs in WRMPs is UKWIR (2021)[5]. Other relevant guidance such as The Habitats Regulations Assessment Handbook[6], existing EU guidance[7] and preceding domestic and European case law remains valid as a source of direction and interpretation of the requirements of the legislation[8].

3.2 Application of HRA in WRMPs

The HRA process consists of four stages, each stage being informed by the one preceding, to ensure an iterative and objective assessment. If the conclusion of Stage 1 Screening is that there will be No Likely Significant Effects (NLSE) on any features of a Habitats Site, there is no requirement to undertake further stages. Similarly, if the Stage 2 AA concludes there will be no adverse effect on Site integrity (AESI) of the Habitats Site, then the assessment is concluded at this stage. The HRA stages are summarised within Table 3.1. Stage 3 (Assessment of Alternative Solutions) and Stage 4 (Assessment where no alternative solutions exist and where adverse effects remain) were not required for this WRMP.

Table 3.1: HRA Stages

Stage	Description
Screening (Stage One) Or 'Test of Likely Significance'	This is the process which identifies the potential effects upon the Habitats Sites and considers if these are likely to be significant (see definitions below). Screening is an iterative process and before moving to Stage Two it can be repeated if required.

[4] The Stage 2 Appropriate Assessment, sometimes known as the 'Integrity Test'

[5] UKWIR (2021) Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans. UK Water Industry Research Limited, London.

[6] Tyldesley, D. & Chapman, C. (2021). The Habitats Regulations Assessment Handbook [online]. DTA Publications Limited. Available at: https://www.dtapublications.co.uk/handbook/

[7] European Commission (2018). Managing Natura 2000 Sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/CEE [online] available at: EN_art_6_guide_jun_2019.pdf (europa.eu) (last accessed April 2022).

[8] Other relevant guidance and case-practices include:

- UK Government (2019). Appropriate assessment: Guidance on the use of Habitats Regulations Assessment [online]. Available at: https://www.gov.uk/guidance/appropriate-assessment
- Tyldesley, D. & Chapman, C. (2021). The Habitats Regulations Assessment Handbook [online]. DTA Publications Limited. Available at: https://www.dtapublications.co.uk/handbook/
- Regulators' Alliance for Progressing Infrastructure Development (2022). Strategic regional water resource solutions guidance for Gate 2
- Landelijke Vereniging tot Behoud van de Waddenzeecase/ Nederlandse Vereniging tot Bescherming van Vogels, European Court of Justice, Case C-127/02 'Waddenzee 2002'
- Sweetman et al. v An Bord Pleanála, European Court of Justice, Case C-258/11 'Sweetman 2011'
- People over Wind/Sweetman v Coiltte Teorante, European Court of Justice Case C-323/17 'People over Wind 2017'

Stage	Description
	Proposals to mitigate any likely significant effects cannot be considered at the screening stage. If the Screening (Stage 1) identifies that the project or plan, alone or in combination, may have likely significant effects on a Habitats Site and/or its features of interest, or if there is uncertainty, the competent authority must undertake an Appropriate Assessment (Stage 2) of the implications for that Site in view of that Site's conservation objectives.
Appropriate Assessment (Stage Two) Or the 'Integrity Test'	This stage involves the consideration of the predicted adverse effects of the project or plan either alone, or in combination with other projects or plans, on the integrity of the Habitats Site with respect to the Site's structure, function, and conservation objectives. Additionally, where mitigation has been proposed to avoid or minimise likely significant effects, this stage includes assessment of the likely effectiveness of any mitigation applied. A key outcome of the Appropriate Assessment is to identify whether the integrity of the Habitats Sites is likely to be adversely affected by the plan/project.
Assessment of Alternative Solutions (Stage Three)	If the mitigation measures applied and assessed during Appropriate Assessment cannot avoid adverse effects on the integrity of a Habitats Site, this stage examines alternative ways of achieving the objectives of the project or plan that avoid adverse effects on the integrity of the Habitats Site.
Assessment where no alternative solutions exist and where adverse effects remain (Stage Four)	If no suitable alternative solutions are available, Stage Four requires an assessment of compensatory measures where, in the light of an assessment of Imperative Reasons of Overriding Public Interest ("IROPI"), it is considered that the project or plan should proceed. In making this assessment, it is important to recognise that it will be appropriate to the likely scale, importance, and impact of the proposed project. If it is impossible to avoid or mitigate the adverse impact, it must be demonstrated that there is IROPI.

Source: Mott MacDonald, 2022

The HRA for the ESW rdWRMP24 has been undertaken in an iterative and objective manner following the above stages. It has been undertaken with reference to best practice guidance and relevant case law to inform the interpretation and therefore correct application of the terms 'likelihood, 'significance' and 'in-combination'.

Mott MacDonald undertook this HRA following the methodology in the Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15)[9].

3.3 HRA Stage 1 Screening assessment methodology

The initial list of sites for the HRA screening was derived by adopting a pathway/receptor approach with a distance-based threshold of 10km, whilst including more distant sites subject to longer pathways; these included those sites which were hydrologically connected via surface or groundwater catchments. This is based on the premise that most significant effects on qualifying features of Habitats Sites will occur within a maximum of a 10km radius[10] . This distance of 10km is defined as the Zone of Influence (ZoI) of the ESW Options, which has been extended where appropriate to capture all potential effects on Habitats Sites.

[9] UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15), 287p.

[10] UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15), 132p.

In conducting this HRA, a number of steps were undertaken to identify the relevant information to inform the assessment. Information gathered to inform the screening included the identification of:

- Any SPA/SAC/pSPA/cSAC/Ramsar Site, including any marine elements of these sites within the potential ZoI, and any known areas of land outside the site boundary itself, which plays an important role in supporting the site and its features of interest (functionally linked land).
- Potential effects resulting from the plan or project.
- The ZoI of these effects, noting this may extend some distance from the site and are not confined to activities on or adjacent to the site.
- Any viable pathways for the project (or plan) to the receptor (Habitats Sites themselves or functionally linked land).
- The features of interest of the Habitats Site(s) in question.
- The conservation objectives of the Habitats Site, including any site sensitivities given within any supplementary advice, site improvement plan, or equivalent document published by the relevant SNCB.

The above information was reviewed in respect of each feature of interest and potential development effect / impact pathway to inform an assessment of any LSE or adverse effects on integrity. Key aspects and terms used in this assessment are defined below:

- **Likelihood:** Where an effect was considered to be potentially significant, then the assessment of its occurrence was based on the likelihood of it occurring and not certainty that it would occur. Effects are scoped in unless there was evidence to the contrary demonstrating that they would not occur e.g., there being no valid pathway, or the absence of the species in that area, at that time.
- **Significance:** The significance of any effect is considered objectively, against the scale and nature of the impact in relation to those of that particular feature or condition and in relation to the extent of that feature or condition over the entire Habitats Site. A significant effect within this assessment is one which, if it occurred, would lead to a decline in the quality or status of the habitats or distribution and/or abundance of feature(s) of interest.
- **In-combination:** The assessment of in-combination effects considers those projects or plans which:
  - Are currently in operation
  - Those which are actually proposed - defined by being a valid live planning application, or any referenced with a local plan where there is potential for them being undertaken within a reasonable time period, specified within that plan.

In line with relevant case law, this assessment is undertaken in the absence of mitigation (including measures embedded into the options where these are intended for the avoidance of effects). Where LSE were identified the assessment has taken these effects through to Stage 2 AA. Drawing on other relevant case law, the phrase ‘likely significant’ should be interpreted as ‘a credible risk that the conservation objectives will be undermined’.

3.4 Appropriate Assessment approach and methodology

3.4.1 Approach

Where a plan or project is likely to, or has the potential to, give rise to LSE upon a Habitats Site, an assessment must be made of the implications on the integrity of that site in view of that site's

structure, function and conservation objectives and considering any site-specific supplementary advice or site improvement plan.

Where mitigation measures are to be applied to eliminate or reduce any effects identified in screening, these may be considered within the AA.

Potential effects may be direct or indirect and are dependent on the relationship between the source (proposed options' actions) and the receptor (the qualifying features of the Habitats Site(s)). The significance of an impact is relative to the sensitivity, existing condition, and conservation status of the qualifying features of the site and the scale of the impact in space and time.

Potential effects on the qualifying features of the Habitat Site(s) are evaluated with respect to the scale, extent, and nature of the impact, for example the area of habitat affected, changes in hydrodynamics, potential changes in species distribution, and the duration of the impact. Given the high-level nature of the assessment at this plan stage it is not always possible to determine the exact scale and extent of the impact, when this is the case, a precautionary approach is taken when evaluating the significance of the impact.

This HRA Stage 2 AA has been formulated using the following approach:

- Review the sites identified at Stage 1 and confirm any additions or exclusions
- Assessment of the construction and operation effects of the selected options
- Assessment of the Habitat Sites' qualifying features and identification of their conservation objectives[11]
- Identification of the aspects of the proposed options that will significantly impact the conservation objectives of the Habitat Site(s)[12]

This assessment has been undertaken having regard to the following guidance:

- GOV.UK (2019) Appropriate Assessment - Guidance on the use of Habitats Regulations Assessment. Published 22 July 2019311[1]
- UK Water Industry Research (UKWIR, 2021)[13]
- European Commission (EU, 2018) Managing Natura 2000 sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC[14]

3.4.2 Consultation

It is recommended that ESW work closely with Natural England and the Habitat Site managers to agree the specific mitigation measures to be included in the HRA. The agreed mitigation measures will be expected to form part of planning conditions, development consent orders and/or conditions of relevant environmental permits, and their implementation managed through contractual obligations with supervision from an Environmental Clerk of Works.

[11] Designated Sites descriptions, qualifying features and conservation objectives are given in Appendix A.

[12] This is the Appropriate Assessment given and tabulated in Sections 4, 5 and 7.

[13] UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15).

[14] European Commission (2018). Managing Natura 2000 Sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/CEE [online] available at: EN_art_6_guide_jun_2019.pdf (europa.eu) (last accessed April 2022).

3.4.3 Potential effects considered as part of the HRA

Following UKWIR (2021) guidance and given the nature of the 'No Regret' Options[15],the potential effects considered in this assessment are summarised in Table 3.2. Proposed distances are also provided following the same guidance to ascertain if, where a pathway has been identified, the impact is likely to affect the habitats or species for which the Habitat Site(s) are designated.

Table 3.2: Potential effects and proposed Zone of Influence

Broad categories of potential effects on Habitats Sites (with examples)	Examples of activities resulting in effects and proposed ZoI
Physical loss Destruction (including offsite effects) e.g., foraging habitat, smothering	Development of built infrastructure associated with the options, e.g., reservoir embankments and access routes[16]. Physical loss may be significant where the boundary of the option extends within the boundary of the Habitats Site, or within an offsite area of known foraging, roosting, breeding habitat (that supports species for which a Habitats Site is designated or where natural processes link the option to the site, such as through hydrological connectivity downstream, or the option effects the linking habitat).
Physical damage Habitat degradation Erosion Trampling Fragmentation Severance/barrier effects Edge effects	Development of built infrastructure associated with the options, e.g., reservoir embankments and access routes. Physical loss may be significant where the boundary of the option extends within the boundary of the Habitats Site, or within an offsite area of known foraging, roosting, breeding habitat (that supports species for which a Habitats Site is designated or where natural processes link the option to the site, such as through hydrological connectivity downstream, or the option effects the linking habitat).
Non-physical disturbance Noise Visual presence Light pollution	**Noise from construction activities.** Taking into consideration the noise level generated from general building activity (c. 122dB(A)) and considering the lowest noise level identified in guidance as likely to cause disturbance to waterbird species (although this guidance is designed primarily for estuarine birds it was considered appropriate to use for this plan), it is concluded that noise effects could be significant up to **1km** from the boundary of the Habitats Site. **Noise from vehicular traffic during construction of the option** Noise from construction traffic is only likely to be significant where the transport route to and from the option is within **500m** of the boundary of the Habitats Site(s). **Plant and personnel involved in operation of the option** These effects (noise, visual/human presence) are only likely to be significant where the boundary of the option extends within or is adjacent to an offsite area of known foraging, roosting, breeding habitat that support species for which a Habitats Site is designated.

[15] Options first which address water demand risks which are present in the considered scenarios.

[16] It is acknowledged that infrastructure associated with the construction of the reservoirs may have an impact on Habitats Sites. However, for the purposes of this HRA, only the construction footprint of the reservoir itself has been used to determine the potential for significant effects.

Broad categories of potential effects on Habitats Sites (with examples)	**Examples of activities resulting in effects and proposed ZoI**
	Options that might include artificial lighting, e.g., for security around a temporary pumping station. Effects from light pollution are more likely to be significant where the boundary of the option is within **500m** of the boundary of the Habitats Site.
Water table/ availability Drying Flooding/storm water Changes to surface water levels and flows Changes to groundwater level and flows	Change to water levels and flows due to water abstraction, storage and drainage interception associated with inland options. These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the Habitats Site. However, these effects are dependent on hydrological continuity between the option and the Habitats Site and whether the option is up or downstream from the Habitats Site.
Toxic contamination Water pollution Soil contamination Air pollution	**Reduced dilution in downstream or receiving waterbodies due to changes in abstraction or reduced compensation flow releases to river systems.** These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the Habitats Site. However, these effects are dependent on hydrological continuity between the option and the Habitats Site, and sometimes whether the option is up or downstream from that site. Air emissions associated with plant and vehicular traffic during construction and operation of the option. The effect of dust is only likely to be significant where site is within or in close proximity to the boundary of a Habitats Site. Without mitigation, dust and onto the public road network and then deposited/spread by vehicles on roads up to 500m from large sites, 200m from medium sites, and 50m from small sites as measured from the site exit. Effects of road traffic emissions from the transport route to be taken by the option traffic are only likely to be significant where the Habitats Site falls within 200 metres of the edge of a road affected.
Non-toxic contamination Nutrient enrichment (e.g., of soils and water) Algal blooms Changes in turbidity Changes in sedimentation/silting Air pollution (dust)	**Changes to water salinity, nutrient levels, turbidity, thermal regime due to increased water abstraction, discharges, storage, or reduced compensation flow releases to river systems.** These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the Habitats Site. However, these effects are dependent on hydrological continuity between the option and the Habitats Site, and sometimes whether the option is up or downstream from that site. Emissions of dust during the earthworks, construction of plant and tunnel/pipeline construction associated with options.

Broad categories of potential effects on Habitats Sites (with examples)	Examples of activities resulting in effects and proposed ZoI
Biological Disturbances Direct mortality Changes to habitat availability Changes in species abundance or distribution Out-competition by non-native species Introduction of disease Introduction of invasive species	**Killing or injury due to construction activity.** Likely to be a risk where the boundary of the option extends within or is directly adjacent to the boundary of the Habitats Site, or within/adjacent to an offsite area of known foraging, roosting, breeding habitat (that supports species for which a Habitats Site is designated). **Changes in habitat availability, such as reductions in wetted width of rivers from abstraction or reduced compensation flow.** These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the Habitats Site. However, these effects are dependent on hydrological continuity between the option and the Habitats Site, and sometimes whether the option is up or downstream from that site. **Creation of new pathway for spread of non-native invasive species.** This effect is only likely to be significant where the option is situated within the Habitats Site or an upstream tributary of the Habitats Site, but also for inter-catchment water transfers.

Source: UK Water Industry Research (2021)[13]

3.4.4 Key Assumptions and standard best-practice mitigation measures

3.4.4.1 Overview

The high-level nature of this assessment undertaken at the plan stage reflects that there is some lack of detailed design for the WRMP24 options. By law, any plan being taken forward to be implemented will be subject to an AA at the project stage, when, in the light of more information relating to the construction and design of the option, a more refined HRA assessment can be undertaken. However, it is considered that this AA has been undertaken in a robust manner and to the fullest extent possible at this stage of the plan.

3.4.4.2 Standard best practice measures during construction

Based on the current level of detail available for the rdWRMP24, a number of established mitigation measures are given which can be assumed for all options. These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible. These measures will be applied to the construction of the final option and constitute mitigation to avoid or reduce adverse effects on Habitats Site integrity and therefore are only mentioned at the AA stage.

The following measures constitute best practice for the rdWRMP24 options:

Options design

- Should design be altered, every opportunity for avoiding potential effects on Habitats Sites (e.g., through alternative pipeline routes and micro siting) should be taken;
- Construction of new pipelines at watercourse crossings will be designed to avoid direct impacts on riverbed and permanent habitat loss. If project-level hydrological investigations imply that there will be disruption to the water table, it will be recommended that a directional drilling method is employed to ensure that no direct impact on the water course or adjoining Habitats Site(s) occurs. Directional drilling will be used at all watercourses >3m wide- for

water courses <3m wide, localised, and temporary water quality and hydrology changes may arise during construction, but as pollution control best practices will be applied to all water course crossings at all times, these measures are considered sufficient to mitigate for any significant effect related to water pollution. The potential for increased flood risk and groundwater impacts will be confirmed in the hydrological investigations which will inform the HRA at this stage; and

- Pipeline routes will be preferably designed to avoid unnecessary watercourses crossings and as distant as possible to Habitats Sites boundaries to offer a buffer limiting pathways through disturbance and pollution runoff. The buffers applied to access potential effects will be specific to each option and will consider the Habitats Sites and their qualifying features.

Pollution control

- Indirect construction-related pollution is identified as one key pathway through which Habitats Sites may be affected. There is numerous guidance on environment good practice measures during construction which can be relied on (at this level) to prevent significant adverse effects on a designated site occurring. The best-practice procedures detailed in the following documents should be followed for all construction works derived from this option, as a minimum standard:
  - CIRIA C741 Environmental good practice on site guide (Charles and Edwards, 2015)[17];
  - CIRIA C532 Control of water pollution from construction sites (Masters-Williams et al. 2001)[18]; and
  - Environment Agency's Pollution Prevention Guidance Notes[19] including PPG1: General Guide to Prevention of Pollution (July 2013); PPG5: Works and maintenance in or near water (October 2007), PPG6: Pollution prevention guidance for working at construction and demolition sites (April 2010); PPG21: Pollution incident response planning (March 2009); PPG22: Dealing with spills (April 2011).
- The installation of sediment traps near or in watercourses or the use of cofferdams should be specified at the project stage;
- Compliance with the provisions of the Health and Safety at Work Act 1974, the Environmental Protection Act 1990, the Environment Act 1995, the Clean Air Act 1993, and the regulations made thereunder, including the Control of Substances Hazardous to Health Regulations (SI 2002/2677) with regard to air quality management; and
- Mitigation plans to help mitigate air quality impacts to support this should include an Air Quality/Dust Management Plan and a Construction Traffic Management Plan (CTMP).

Biosecurity

- Biosecurity measures will be in place to ensure the management of invasive non-native species on construction sites and during controlled activities. The following considerations will be given pre-construction:
  - Invasive non-native species (INNS) risk assessment to be undertaken at site feasibility stage;
  - Where INNS are identified, legal requirements and mitigation plan developed at early planning stage;

[17] Charles P. and Edwards P (2015) Environmental good practice on site guide. CIRIA C741, 260p.

[18] Masters-Williams H., Heap A., Kitts H. *et al.* (2001) *Control of water pollution from construction sites*. CIRIA C532, 27p.

[19] Note, the Environment Agency Pollution Prevention Guidance Notes have been withdrawn by the Government, although the principles within them are robust and still form a reasonable basis for pollution prevention measures. Documents are still available online at: [ARCHIVED CONTENT] Environment Agency - Pollution prevention advice and guidance (PPG) (nationalarchives.gov.uk) (last accessed April 2022).

  - INNS to be included on all site method statements including CEMP and any Ecological Protection Plans. INNS risk to be managed by Clerk of Works and INNS brief given to all site contractors; and
  - Where a species requires long-term management (such as Japanese knotweed *Fallopia japonica*), a specific INNS management plan will be developed.
- The best-practice procedures detailed in the following documents should be followed to reduce the spread of INNS for all construction works derived from these options, as a minimum standard:
  - CIRIA Manual C679 'Invasive species management for infrastructure managers and the construction industry'; The Knotweed Code of Practice - managing Japanese knotweed on development sites'.

Disturbance - noise

- Construction activities will be conducted in accordance with noise limits to avoid disturbance. Specific limits for different species will be added on a case-by-case situation.
- Construction related noise disturbance will be minimised by implementing best practice such as BS 5228-1:2009+A1:2014 (The British Standards Institute, 2008)[20].

Disturbance - light

- Lighting will be kept to a minimum to reduce disturbance. Should the works be undertaken at night and flood lighting required, lighting should be kept to a minimum and hooded spotlights directed away from potentially suitable habitat for qualifying species of Habitats Sites, to reduce disturbance while ensuring standards for health and safety.
- The potential impact of artificial light may be minimised through the implementation of best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011)[21].

Construction Environmental Management Plan (CEMP)

A CEMP must be developed prior to construction, including measures to ensure that the risk of uncontrolled discharges from construction is reduced (including sediment management) and detailing an Emergency Response Plan in the event of a pollution incident. This plan must be prepared for all works and include the industry best practice measures listed above and any targeted mitigation measures identified during the formal HRA.

3.4.4.3 Standard best-practice during operation

There are no assumptions relating to best practice or otherwise during the operation of the final Option. This will be tailored to each option as needed.

[20] The British Standards Institute, 2008. BS 5228-1:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites. Noise. BSI Standards Limited, London.

[21] Institution of Lighting Professionals (2020) Guidance note for the reduction of obtrusive light. Guidance Note1/20.

4 Barsham WTW to Blyth Transfer (ESW-TRA-001)

Option ID: (ESW-TRA-001)

4.1 Option Description

This option proposes a water transfer pipeline from Barsham WTW to Saxmundham Tower (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

4.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified 12 Habitats Sites within the ZoI of this option: Dew's Ponds SAC, The Broads SAC, Broadland Ramsar Site and SPA, Minsmere-Walberswick SPA, Ramsar Site and SAC, Alde-Ore & Butley Estuaries SPA, Ramsar Site, SAC, and Outer Thames Estuary SPA and SAC as summarised in Table 4.1Table 4.1: below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 4.1: Barsham WTW to Blyth Transfer Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Dew's Ponds SAC (UK0030133) (approx. 0.49km)	Sandlings SPA (UK902086) (approx. 5.5km)
The Broads SAC (UK0013577) (approx. 2.1km)	Benacre to Easton Bavents SPA (UK9009291) (approx. 7km)
Broadland Ramsar Site (UK110100) (approx. 2.1km)	Benacre to Easton Bavents Lagoons SAC (UK0013104) (approx.8km)
Broadland SPA (UK9009243) (approx. 2.1km)	
Minsmere-Walberswick SPA (UK9009101) (approx. 3.5km)	
Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 3.5km)	
Minsmere to Walberswick Ramsar Site (UK11044) (approx. 4km)	
Alde-Ore & Butley Estuaries SAC (UK0030076) (approx. 5.5km)	
Alde-Ore Estuary Ramsar Site (UK11002) (approx. 5.5km)	
Alde-Ore Estuary SPA (UK9009112) (approx. 5.5km)	
Outer Thames Estuary SPA (UK9020309) (approx. 8km)	
Southern North Sea SAC (UK0030395) (approx. 8km)	

Source: Mott MacDonald, 2022

4.3 Stage 2 Appropriate Assessment

4.3.1 Scope

The following Habitats Sites were assessed at Stage 2 AA:

- Dew's Ponds SAC (UK0030133) (approx. 0.49km)
- The Broads SAC (UK0013577) (approx. 2.1km)
- Broadland Ramsar Site (UK110100) (approx. 2.1km)
- Broadland SPA (UK9009243) (approx. 2.1km)
- Minsmere-Walberswick SPA (UK9009101) (approx. 3.5km)
- Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 3.5km)
- Minsmere to Walberswick Ramsar Site (UK11044) (approx. 4km)
- Alde-Ore & Butley Estuaries SAC (UK0030076) (approx. 5.5km)
- Alde-Ore Estuary Ramsar Site (UK11002) (approx. 5.5km)
- Alde-Ore SPA (UK9009112) (approx. 5.5km)
- Outer Thames Estuary SPA (UK9020309) (approx. 8km)
- Southern North Sea SAC (UK0030395) (approx. 8km)

4.3.2 Potential effects on Habitats Sites

The potential effects of the construction and operation phases for the Barsham to Saxmundham Transfer Main Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential effect on the integrity of the designated sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, a worst-case scenario is assumed, with effects and required mitigation measures outlined in Table 4.2: .

Where adverse effects are deemed significant, further necessary mitigation measures are also proposed in the following section. Where stated these are in addition to the best practice outlined in Section 3.4.

4.3.2.1 Dew's Ponds SAC (approx. 0.49km east)

Construction effects

The proposed pipeline route is located less than 500m west of this SAC. Although the site is not hydrologically connected to the option footprint via surface water, there is a hydrological connection through the ground water.

Given that the Habitats Site is within the same ground water catchment as the option footprint, there may be a change in water quality due to pollution events as a result of construction. Increased turbidity and sedimentation, and reductions in water quality, could have a negative effect on the suitability of the ponds to support great crested newts *Triturus cristatus* (GCN), resulting in displacement within or from the site. Construction activities may also affect terrestrial habitat for GCN due to the temporary loss of hedgerows during construction. Hedgerows provide corridors for GCN to disperse during their terrestrial phase, therefore removal of these hedgerows may affect populations throughout displacement and reductions in functionally connected habitats. It is possible that in some locations, directional drilling can be used to avoid impacts to valuable habitat.

Operation effects

No operation effects are anticipated for this option which could affect this site and/or its qualifying features.

4.3.2.2 The Broads SAC (approx. 2.1km northeast)

Construction effects

This SAC is located approximately 2.1km northeast of the option footprint and is designated for supporting a variety of species, such as plants and invertebrates, in addition to highly mobile species such as otter. The proposed pipeline crosses the River Blyth and the River Yox which are not hydrologically connected to the Habitats Site. The Habitats Site is hydrologically connected to the option footprint via the Broadland Rivers Chalk and Crag groundwater catchment and a small ditch to the north of the option footprint which is connected to the River Waveney. Works during the construction phase may result in surface run off and sediment discharge into the River Waveney which may lead to pollution events downstream of this within the site boundary. Qualifying habitats, and habitats which support qualifying species, may be directly damaged or degraded, potentially displacing species such as otter (*Lutra lutra*) from components of the site altogether. Pollution events may also reduce the availability of prey within the site and functionally connected habitats.

In relation to the qualifying habitats, plants and invertebrate species, the option footprint is considered to be sufficiently from the site and disturbances related to human presence, lights and vehicular movements are unlikely to be observed. However, construction-related disturbance may still affect otter populations. The northernmost end of the pipeline is adjacent to a small stream, which is considered to be functionally connected to the site and the River Waveney. With wooded banks in the vicinity of the works area, it is possible that otter resting places are disturbed. Disturbing effects can result in changes to behaviours, increased energy expenditure due to fleeing, abandonment of young, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Due to this distance between the site and this option footprint (2.1km), no other impact pathways are identified during construction.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.3 Broadland SPA and Ramsar Site (approx. 2.1km northeast)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

These sites also have a significant overlap in extent to The Broads SAC. Details above relating to hydrological connectivity and potential impact pathways on the SAC also apply to these sites and their respective qualifying features.

In addition to construction-related disturbance to otters a qualifying feature under Ramsar Site criterion 2), qualifying bird populations may also be disturbed during construction. The construction area at the north end of the pipeline is outside the SPA and Ramsar Site boundary but is adjacent to Natural England's *Goose and Swan Functional Land impact risk zone (IRZ)*, which has identified suitable habitat outside of the sites' boundaries which can support qualifying species. At this distance, it is likely that the only qualifying species of geese and swans present will be affected: Bewick's swan (*Cygnus columbianus bewickii*), whooper swan (*Cygnus cygnus*), pink-footed goose (*Anser brachyrhynchus*) and greylag goose (*Anser anser*). Geese and swans will typically forage in agricultural land during the day and return to roosting sites within the Avon Valley SPA at night. Permanent or temporary loss of this habitat could

impact the ability of the surrounding functional land to support the Habitats Site's populations. The ability of these qualifying species to safely and successfully move to and from nesting, feeding and roosting areas is critical to adult fitness and survival, and future breeding success.

During construction there may also be indirect effects to the integrity of site, through disturbance; noise, visual disturbance and artificial light are all sources of disturbance which could impact upon qualifying features. Disturbing effects can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site. In relation to additional effects on otter populations within the Ramsar Site, details for The Broads SAC are applicable to this site as well.

Due to the distance between this site and the option footprint (2.1km), no other impact pathways are anticipated during construction.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.4 Minsmere-Walberswick SPA (approx. 3.5km east)

Due to the identical extent and significant overlap of qualifying features between the Minsmere-Walberswick SPA and Ramsar Site, potential effects on these sites are considered together.

Construction effects

This SPA is designated for supporting a variety of birds during breeding and wintering seasons and located approximately 3.5km east of the option footprint. Considering the bird species supported by this SPA (such as the Eurasian marsh harrier and hen harrier) a precautionary 5km buffer to include functionally linked habitat was adopted to evaluate noise/light and general construction disturbances related to human presence and machinery movement. Therefore, as some of this site qualifying bird species will require a large area for foraging, same effects and recommended mitigation listed to Broadland Ramsar Site are applicable to this SPA.

In addition, this option proposes a pipeline to transfer treated water from Barsham WTW to Saxmundham Tower where the River Blyth and the River Yox are to be crossed by the new pipeline and therefore, directly hydrologically connecting the SPA and the option footprint.

Where the pipeline route crosses the waterbodies, the potential exists for construction activities to affect downstream water quality due to pollution events. In that case, toxic and non-toxic contaminations may be observed which may lead to water/air/soil quality degradation and temporary changes in turbidity, sedimentation and/or silting associated to localised air/water pollution. Habitat degradation and associated biological disturbances may be observed as result of these changes.

Public access and disturbances as impacts upon this site bird populations affecting their distribution is listed in the SIP, in addition to pressures/threats related to air and water pollution and introduction/spread of invasive species (See Appendix F.3).

Ahead of works surveys must be undertaken to gather information on habitat use by bird species with the intention to inform best pipeline route and result in minimal habitat fragmentation.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.5 Minsmere-Walberswick Ramsar Site (approx. 3.5km east)

This Ramsar Site is designated for supporting a variety of birds during breeding and wintering seasons and located approximately 3.5km east of the option footprint. Considering the bird species supported by this Ramsar Site (such as the Eurasian marsh harrier and hen harrier) a precautionary 5km buffer to include functionally linked habitat was adopted to evaluate noise/light and general construction disturbances related to human presence and machinery movement. Therefore, as some of this site qualifying bird species will require a large area for foraging, same effects and recommended mitigation listed to Broadland Ramsar Site are applicable to this Ramsar Site.

In addition, this option proposes a pipeline to transfer treated water from Barsham WTW to Saxmundham Tower where the River Blyth and the River Yox are to be crossed by the new pipeline and therefore, directly hydrologically connecting the Ramsar Site and the option footprint.

Where the pipeline route crosses the waterbodies, the potential exists for construction activities to affect downstream water quality due to pollution events. In that case, toxic and non-toxic contaminations may be observed which may lead to water/air/soil quality degradation and temporary changes in turbidity, sedimentation and/or silting associated to localised air/water pollution. Habitat degradation and associated biological disturbances may be observed as result of these changes.

Ahead of works surveys must be undertaken to gather information on habitat use by bird species with the intention to inform best pipeline route and result in minimal habitat fragmentation.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.6 Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 3.5km)

Construction effects

This SAC overlaps to Minsmere-Walberswick SPA and is designated for supporting habitats/plant species. As there is a direct hydrological connection between this site and the option footprint, in case of pollution events toxic and non-toxic contaminations may be observed (same as described for Minsmere-Walberswick SPA).

Changes in turbidity, sedimentation and/or silting associated to water pollution may lead to short duration and localised impacts, however, may lead to temporary and permanent effects on this site and its qualifying features. Habitat degradation is likely followed by associated biological disturbances such as direct mortality, rapid population fluctuation, changes in species distribution and eventual changes in natural succession. Directional drilling and general recommendations made to Minsmere-Walberswick SPA applicable to habitats and plant species are suggested to be adopted in here.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.7 Alde-Ore & Butley Estuaries SAC (approx. 5.5km)

Construction effects

The option footprint and Alde-Ore & Butley Estuaries are directly hydrologically connected by the River Alde (through which the new pipeline proposes to cross). Therefore, water pollution and related effects may be observed.

This SAC is at 5.5km of the proposed works and effects related to light/air pollution/ dust, anthropogenic and machinery disturbances are unlikely. However, changes in turbidity, sedimentation and/or silting associated to water pollution may lead to short duration and localised impacts of temporary and/or permanent effects on this site and its qualifying features.

Habitat degradation is likely followed by associated biological disturbances such as direct mortality, rapid population fluctuation, changes in species distribution and eventual changes in natural succession. Directional drilling and general recommendations made to Minsmere-Walberswick SPA (above) applicable to habitats and plant species are suggested to be adopted in here as well.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.8 Alde-Ore Estuary Ramsar Site (approx. 5.5km)

Construction effects

The option footprint and Alde-Ore & Butley Estuaries are directly hydrologically connected by the River Alde (through which the new pipeline proposes to cross). Therefore, water pollution and related effects may be observed.

This Ramsar Site is at 5.5km of the proposed works and effects related to noise/light/air pollution/ dust, anthropogenic and machinery disturbances are unlikely. However, changes in turbidity, sedimentation and/or silting associated to water pollution may lead to short duration and localised impacts of temporary and/or permanent effects on this site and its qualifying features.

Habitat degradation is likely followed by associated biological disturbances such as changes in species distribution, rapid population fluctuation, habitat avoidance (mobile species such as birds) and eventual direct mortality, changes in natural succession. Directional drilling and general recommendations made to Minsmere-Walberswick SPA in relation to water pollution avoidance are suggested to be adopted in here as well.

Directional drilling and pollution control best practices are recommended and construction supporting area should take place as far of this site boundaries as possible. Measures to avoid invasive species spread and/or introduction are suggested to be undertaken during construction.

If all mitigation measures proposed are in place, no adverse effects to the site integrity including on the extent and distribution of qualifying species; on the structure and function of the habitats of qualifying species; and on the supporting processes on which habitats of qualifying species rely are expected.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.9 Alde-Ore SPA (approx. 5.5km)

Construction effects

The option footprint and Alde-Ore & Butley Estuaries are directly hydrologically connected by the River Alde (through which the new pipeline proposes to cross). Therefore, water pollution and related effects may be observed.

This SPA is at 5.5km of the proposed works and effects related to noise/light/air pollution/ dust, anthropogenic and machinery disturbances are unlikely. However, changes in turbidity, sedimentation and/or silting associated to water pollution may lead to short duration and localised impacts of temporary and/or permanent effects on this site and its qualifying features.

Habitat degradation is likely followed by associated biological disturbances such as changes in species distribution, rapid population fluctuation, habitat avoidance (mobile species such as birds) and eventual direct mortality, changes in natural succession. Directional drilling and general recommendations made to Minsmere-Walberswick SPA (above) in relation to water pollution avoidance are suggested to be adopted in here as well.

Directional drilling and pollution control best practices are recommended and construction supporting area should take place as far of this site boundaries as possible. Birds shooting and nest destruction are listed as pressures/threats within this site SIP. Therefore, precautionary approach including standard measures to mitigate possible effects from disturbance (vehicles and people movement), noise and light pollution are recommended. Construction phase should consider avoid the birds wintering / breeding seasons and an early consultation with Natural England is recommended to discuss timescales. Once the construction phase is complete, any habitat loss identified as functionally linked to this SPA in supporting its qualifying birds should be reinstated.

If all mitigation measures proposed are in place, no adverse effects to the site integrity including on the extent and distribution of qualifying species; on the structure and function of the habitats of qualifying species; and on the supporting processes on which habitats of qualifying species rely are expected.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.10 Outer Thames Estuary SPA (approx. 8km)

Construction effects

The option footprint and this site are directly hydrologically connected by a large number of main rivers which are to be crossed by the new pipeline.

This SPA is 8km of the proposed works and effects related to noise/light, anthropogenic and machinery disturbances are unlikely. However, given the hydrological connection, water pollution and related effects may be observed.

Changes in turbidity, sedimentation and/or silting associated to water pollution may lead to short duration and localised impacts of temporary and/or permanent effects on this site and its qualifying bird populations. Habitat degradation is likely followed by associated biological disturbances such as changes in habitat and prey availability, changes in species distribution, rapid population fluctuation, habitat avoidance and eventual direct mortality.

Directional drilling and general recommendations made to Minsmere-Walberswick SPA (above) in relation to water pollution avoidance are suggested to be adopted in here as well.

Directional drilling and pollution control best practices are recommended and construction supporting area should take place as far of this site boundaries as possible. Direct discharges into the site including low levels of radionuclides and heavy metals are known to have caused deterioration of invertebrate and small fish populations within this site. Due to large oil and chemical spills, significant impacts on important food resources and threats to diving and feeding seabirds is reported within this site SIP (See Appendix F.3). As small level of contamination already exists in this site because of normal shipping activities, further discharges to the freshwater environment upstream of this site are subject relevant licencing. Therefore, a precautionary approach including standard measures to mitigate possible effects from potential pollution events are recommended.

Construction phase should also consider avoiding the birds wintering / breading seasons and an early consultation with Natural England is recommended to discuss timescales. Once the construction phase is complete, any habitat loss identified as functionally linked to this SPA in supporting its qualifying birds should be reinstated.

Measures to avoid invasive species spread and/or introduction are also suggested to be undertaken during construction.

If all mitigation measures proposed are in place, no adverse effects to the site integrity including on the extent and distribution of qualifying species; on the structure and function of the habitats of qualifying species; and on the supporting processes on which habitats of qualifying species rely are expected.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.2.11 Southern North Sea SAC (approx. 8km)

The Southern North Sea SAC is an area of importance for harbour porpoise as includes key winter and summer habitat for this species. The SAC ranges in depth from Mean Low Water down to 75 m, with the majority of the site shallower than 40 m, and is characterised by its sandy, coarse sediments which cover much of the site. These physical characteristics are thought to be preferred by harbour porpoise, likely due to availability of prey.

Construction effects

There is no direct hydrological connection directly into the SAC itself. However, there are a number of main rivers through which the new pipeline passes that eventually lead to the marine environment (which is subsequently connected to the SAC area). Therefore, given the hydrological connection, water pollution and related effects may be observed.

This SAC is at 8km of the proposed works and effects related to noise/light, anthropogenic and machinery disturbances are on harbour porpoise are unlikely.

Habitat degradation due to toxic and non-toxic contamination is likely followed by associated biological disturbances such as changes in habitat and prey availability, which could affect harbour porpoise distribution within this site. Therefore, directional drilling and general recommendations made to Minsmere-Walberswick SPA in relation to water pollution avoidance are suggested to be adopted in here.

An early consultation with Natural England is recommended to discuss timescales and specific mitigation (if any) to avoid unnecessary pressure upon harbour porpoise.

Measures to avoid invasive species spread and/or introduction are also suggested to be undertaken during construction.

If all mitigation measures proposed are in place, no adverse effects to the site integrity including on the extent and distribution of qualifying species; on the structure and function of the habitats of qualifying species; and on the supporting processes on which habitats of qualifying species rely are expected.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

4.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 4.2: Barsham to Saxmundham transfer main – Potential effects on designated qualifying features

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
Dew's Ponds SAC (UK0030133) (approx. 0.49km)	Annex II species that are a primary reason for selection of this site: • 1166 Great crested newt (*Triturus cristatus*)	No direct hydrological connection is identified between this SAC and the option footprint. However, given the proximity between the option footprint and the Habitats Site, it is not possible to exclude effects such as habitat disturbance or pipeline associated construction effects. During construction this option is likely to result in: • Physical damage: edge effects resulting from habitat damage. • Non-physical disturbance – noise and light pollution followed by human disturbance and vibration. • Toxic contamination –air/soil pollution followed by habitat degradation from potential construction pollutions events. • Biological disturbances – habitat avoidance, rapid population fluctuations, changes to habitat availability. No effects are anticipated during the operation phase.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying newt species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.
The Broads SAC (UK0013577) (approx. 2.1km)	• 1355 Otter (*Lutra lutra*)	As otters are highly mobile species, suitable habitats for supporting the species that are located outside of this site boundaries are considered to be intrinsically linked to this site. Therefore, effects upon these external habitat features can result in affecting this site qualifying features.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance, see section 3.3.4.2. • Additionally, a pre-construction otter survey will be required to ensure that an otter breeding or resting site is not	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying newt species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
		Adverse effects are determined in relation to otter populations only and during construction may result in: • Non-physical disturbance – anthropogenic disturbance, noise and light localised disturbances. • Biological disturbances - changes to supporting habitat and prey availability resulting in habitat avoidance and rapid population fluctuation. No effects are anticipated from the operation phase of this option.	present during construction works and to search for field signs within the ZoI. If identified within the ZoI construction works will need to be undertaken under a Natural England mitigation licence and protection zones will need to be implemented. These are: - An otter holt or couch requires a 30m protection zone; and - A natal den requires a 150m protection zone2. - If a breeding or resting site is located at the abstraction point, alternative locations will need to be considered. If a breeding or resting site is located within the pipeline footprint, directional drilling will need to be considered to avoid loss of key supporting habitat. If a breeding or resting site is located within the ZoI, an appropriate buffer will need to be maintained during construction works to limit anthropogenic disturbance. • A toolbox talk will be completed by an Ecological Clerk of Works (ECoW) regarding otter ecology. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.
	• 3140 Hard oligo-mesotrophic waters with benthic vegetation of (*Chara* spp)	This site is also designated for supporting a variety of species, such as plants and invertebrates, in addition to the otters as above mentioned.	Not Applicable	Not Applicable

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	• 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation • 7210 Calcareous fens with (*Cladium mariscus*) and species of the (*Caricion davallianae*) *Priority feature • 7140 Transition mires and quaking bogs • 7230 Alkaline fens • 91E0 Alluvial forests with (*Alnus glutinosa*) and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) * Priority feature • 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) • 1016 Desmoulin's whorl snail (*Vertigo moulinsiana*) • 1903 Fen orchid (*Liparis loeselii*) • 4056 Ramshorn snail (*Anisus vorticulus*)	Given this site is located upstream of the option and at approximately 2.1km distance, no pathways have been identified where this option can affect habitats, plants and invertebrate qualifying features during construction and operation phases.		
Broadland Ramsar Site (UK110100) (approx. 2.1km)	• Ramsar Site criterion 2: • S1355 Otter (*Lutra lutra*)	Same as listed to The Broads SAC (otter as qualifying features)	Same as listed to The Broads SAC (otter as qualifying features)	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying newt species; • The structure and function of the habitats of qualifying species; and

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
				• The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.
	• Ramsar Site criterion 2: • Also under criterion 2, this site supports a number of rare species and habitats within the bio-geographical zone context, including: • H7210 Calcareous fens with (C*ladium mariscus*) and species of the (*Caricion davallianae*) Calcium-rich fen dominated by great fen sedge (saw sedge). • H7230 Alkaline fens Calcium-rich spring water fed fens. • H91E0 Alluvial forests with (*Alnus glutinosa*) and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) Alder woodlands on floodplains The site supports outstanding assemblages of rare plants and invertebrates including the British Red Data Boo plants	This site is also designated for supporting a variety of species, such as plants and invertebrates, in addition to the otters as above mentioned. Given this site is located upstream of the option and at approximately 2.1km distance, no pathways for LSE are identified where this option can affect this site habitats, plants or invertebrate qualifying features during construction and operation phases.	Not Applicable	• Not Applicable

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	and 136 British Red Data Book invertebrates. • S1016 (*Vertigo moulinsiana*) Desmoulin's whorl snail • S1903 (*Liparis loeselii*) Fen orchid			
	Ramsar Site criterion 6: Species/populations occurring at levels of international importance: Species with peak counts in winter: • Tundra swan, (*Cygnus columbianus bewickii*), NW Europe • Eurasian wigeon, (*Anas penelope*), NW Europe • Gadwall, (*Anas strepera strepera*), NW Europe • Northern shoveler, (*Anas clypeata*), NW & C Europe Species/populations identified subsequent to designation for possible future consideration under Criterion 6. Species with peak counts in winter: • Pink-footed goose, (*Anser brachyrhynchus*), Greenland, Iceland / UK • Greylag goose, (*Anser anser*), Iceland / UK, Ireland	This site is also designated for supporting a variety of bird species, which are to rely upon linkage habitat for foraging (as the pink-footed goose, for example). Therefore, same considerations made to the otters are applicable to this site qualifying birds and effects related to habitat disturbances during construction cannot be excluded. As a result, adverse effects are possible, during construction they may result in: • Non-physical disturbance – anthropogenic disturbance, noise and light localised disturbances upon particular bird species this site supports; • Biological disturbances - changes to supporting habitat and prey availability, habitat avoidance, rapid population variation. No effects are anticipated during the operation phase of this option.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance, see section 3.3.4.2. • Additionally, works should be agreed with Natural England and, if possible, to be undertaken outside the breeding period to avoid effects on this site qualifying bird species. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Working methods which will reduce disturbance during construction include: - A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise;	No adverse effects on the integrity of the site are expected. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
			- All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'.	
Broadland SPA (UK9009243) (approx. 2.1km)	During the breeding season the area regularly supports (Article 4,1 qualification): • (*Botaurus stellaris*) • (*Circus aeruginosus*) • Over winter the area regularly supports: • (*Circus cyaneus*) • (*Cygnus columbianus bewickii*) • (*Cygnus cygnus*) Article 4.2 - An Internationally Important Assemblage of Birds: • (*Anas strepera*)	This SPA is designated for a variety of birds and located at the same geographical area of Broadland Ramsar Site. This SPA is located upstream of the proposed works. Considering this site supports bird species that are widespread in this area and likely habitat specific, such as the marsh harrier (*Circus aeruginosus*), effects during the construction phase, such as habitat disturbances and associated effects during construction cannot be excluded. As a result, adverse effects are determined, and during construction may result in: • Non-physical disturbance – anthropogenic disturbance, noise and light localised disturbances upon particular bird species this site supports;	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance, see section 3.3.4.2. • Additionally, works should be agreed with Natural England and, if possible, to be undertaken outside the breeding period to avoid effects on this site qualifying bird species. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying newt species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
		• Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation. No effects are anticipated from the operation phase of this option.	• Working methods which will reduce disturbance during construction include: - A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; - All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	
Minsmere-Walberswick SPA (UK9009101) (approx. 3.5km)	Article 4.1 During the breeding season the area regularly supports: • (*Botaurus stellaris*) • (*Caprimulgus europaeus*) • (*Circus aeruginosus*) • (*Recurvirostra avosetta*) • (*Sterna albifrons*) Over winter the area regularly supports: • (*Circus cyaneus*)	This SPA is designated for a variety of birds and located approximately 3.5km east of the proposed works and is in direct hydrological connection to the option footprint. Considering this site supports bird species that are widespread in this area and likely habitat specific, such as the marsh harrier (*Circus aeruginosus*), effects during the construction phase on functionally linked habitat related to light/noise/machinery and human disturbances during construction cannot be excluded.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying newt species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	Article 4.2 - An Internationally Important Assemblage of Birds: During the breeding season the area regularly supports: • (*Anas clypeata*) • (*Anas crecca*) • (*Anas strepera*) Over winter the area regularly supports: • (*Anas clypeata*) • (*Anas strepera*) • (*Anser albifrons albifrons*)	As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Non-physical disturbance – anthropogenic disturbance, noise and light localised disturbances upon particular species this site supports; • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon bird species this site is designated for. No effects are anticipated from the operation phase of this option.		Habitats Site for the construction and operation phases of this option.
Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 3.5km)	• 1210 Annual vegetation of drift lines (*Honckenya peploides)* and (*Beta vulgaris)* • 4030 European dry heaths, predominantly NVC type H8 (*Calluna vulgaris – Ulex gallii)* heath. • 1220 Perennial vegetation of stony banks	This SAC is designated for a variety of habitats and located approximately 3.5km east of the proposed works and is in direct hydrological connection to the option footprint. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
		• Biological disturbances - changes to habitat availability; direct mortality, rapid population fluctuations, etc. No effects are anticipated from the operation phase of this option.		
Minsmere to Walberswick Ramsar Site (UK11044) (approx. 4km)	Ramsar Site criterion 1: • The site contains a mosaic of marine, freshwater, marshland and associated habitats, complete with transition areas in between. Contains the largest continuous stand of reedbeds in England and Wales and rare transition in grazing marsh ditch plants from brackish to fresh water. Ramsar Site criterion 2: • This site supports nine nationally scarce plants and at least 26 red data book invertebrates. • Supports a population of the mollusc (*Vertigo angustior*) (Habitats Directive Annex II; British Red Data Book Endangered), recently discovered on the Blyth estuary river walls. An important assemblage of rare breeding birds associated	This Ramsar Site is designated for its variety of rare plant and bird species. It is located approximately 4km east of the option works and is in direct hydrological connection to the option footprint. In addition, considering this site supports bird species that are widespread in this area and likely habitat specific, such as the marsh harrier (*Circus aeruginosus*), effects in the construction phase, such as supporting habitat disturbances and associated effects cannot be excluded as well. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Non-physical disturbance – anthropogenic disturbance, noise and light localised disturbances upon particular species this site supports; • Biological disturbances - changes to habitat availability; rapid population fluctuation; direct mortality (non-mobile species mainly);	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats, plant and invertebrate species; • The structure and function of the habitats of qualifying plant and invertebrates species; and • The supporting processes on which habitats of plants and invertebrates qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	with marshland and reedbeds including: • *Botaurus stellaris* • *Anas strepera* • *Anas crecca* • *Anas clypeata* • *Circus aeruginosus* • *Recurvirostra avosetta* • *Panurus biarmicus* •	habitat avoidance (upon bird species this site is designated for). No effects are anticipated from the operation phase of this option.		
Alde-Ore & Butley Estuaries SAC (UK0030076) (approx. 5.5km)	• 1130 Estuaries • 1140 Mudflats and sandflats not covered by seawater at low tide • 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	This SAC is designated for its variety of habitats. It is located approximately 5.5km south of the proposed works and is in direct hydrological connection to the option footprint. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Biological disturbances - changes to habitat availability; direct mortality, rapid population fluctuation, etc. No effects are anticipated from the operation phase of this option.	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.
Alde-Ore Estuary Ramsar Site (UK11002) (approx. 5.5km)	Ramsar Site criterion 2: • The site supports a number of nationally-	This Ramsar Site is designated for its variety of rare plant and bird species. It is located approximately 5.5km south-east of the proposed	The following measures will be implemented to avoid or reduce adverse impacts:	No adverse effects on the integrity of the site are expected that could affect:

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	scarce plant species and British Red Data Book invertebrates. Ramsar Site criterion 3: • The site supports a notable assemblage of breeding and wintering wetland birds. Ramsar Site criterion 6: • Species/populations occurring at levels of international importance: Species regularly supported during the breeding season: • Lesser black-backed gull, (*Larus fuscus graellsii*), W Europe/Mediterranean/W Africa Species with peak counts in winter: • Pied avocet, (*Recurvirostra avosetta*), Europe/Northwest Africa • Common redshank, (*Tringa totanus totanus*)	works and is in direct hydrological connection to the option footprint. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Biological disturbances - changes to habitat availability; direct mortality (plants and less mobile species), rapid population fluctuation, habitat avoidance (birds), etc. No effects are anticipated from the operation phase of this option.	• Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	• The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.
Alde-Ore SPA (UK9009112) (approx. 5.5km)	Article 4.1: During the breeding season the area regularly supports: • *(Circus aeruginosus)* • *(Recurvirostra avosetta)* • *(Sterna albifrons)*	This SPA is designated for its variety of bird species. It is located approximately 5.5km south of the option footprint. It should be noted that the designated features of this SPA (birds) are highly mobile. Therefore, within the wider area outside of this Habitats Site, other areas containing habitats suitable for	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	• *(Sterna sandvicensis)* Article 4.2: During the breeding season the area regularly supports: • *(Larus fuscus)* Over winter the area regularly supports: • *(Tringa totanus)*	these bird species are considered to be intrinsically linked to the SPA. Therefore, effects upon these external habitat features can result in affecting the SPA. Due to the distance between the option footprint and the Habitats Site, it is not anticipated for any effects related to construction disturbances such as light and dust. However, as in case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, potential effects for pollution events during construction phase cannot be ruled out. As a result, adverse effects are possible, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Biological disturbances - changes to habitat availability; habitat avoidance, rapid population fluctuation, etc. No effects are anticipated from the operation phase of this option.	With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	• The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.
Outer Thames Estuary SPA (UK9020309) (approx. 8km)	ARTICLE 4.1 QUALIFICATION: Over winter the area regularly supports: • (*Gavia stellata*) (North-western Europe - wintering) - 38% of the	This SPA is designated for two species of birds and located approximately 8km east of the option footprint. Due to the distance between the option footprint and the Habitats Site, it is not anticipated for any	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying features;

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
	population in Great Britain peak mean over the period 1989-2006/07 • The area supports breeding populations of: (*Sternula albifrons*) (in breeding season) - 19.64% of GB population (2011 - 2015) • (*Sterna hirundo*) (in breeding season) - 2.66% of GB population (2011 - 2015)	effects in the construction phase, such as disturbance or associated effects. However, as in case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, potential effects for pollution events during construction phase cannot be ruled out. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Biological disturbances - changes to habitat availability; habitat avoidance, rapid population fluctuation, etc. No effects are anticipated from the operation phase of this option.	• Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	• The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.
Southern North Sea SAC (UK0030395) (approx. 8km)	Annex II species that are a primary reason for selection of this site: • 1351 Harbour porpoise (*Phocoena phocoena*)	This SAC is designated for harbour porpoise (a highly mobile species with a large marine territory). The SAC is located approximately 8km east of the option footprint. There is no clear pathway from the option footprint to the marine environment where harbour porpoise could be affected, as all works are happening on land. In addition, given the distance between the option footprint and the Habitats Site, it is not anticipated for any effects in the construction phase, such as noise/lights	The following measures will be implemented to avoid or reduce adverse impacts: • Consider realignment of option during further option design development. • Implementation of widely used best practice measures for disturbance and pollution, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying feature; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity before mitigation
		disturbance or associated effects. However, as in case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, potential effects for pollution events during construction phase cannot be ruled out. As a result, adverse effects are determined, and during construction may result in: • Toxic contamination – water/air/soil quality degradation from potential construction pollutions events. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to localized air/water pollution. • Biological disturbances - changes to habitat availability; habitat avoidance, rapid population fluctuation, etc. During the operational phase, there are no anticipated effects from the operation of the pipeline itself. As such, adverse effects are not identified.		option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option.

4.3.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the overall Habitats Sites integrity and/or its qualifying features alone during the construction phase of this option (no effects are anticipated during the operation phase of this option):

- Dew's Pond SAC,
- Minsmere to Walberswick Heaths & Marshes SAC
- Alde-Ore & Butley Estuaries SAC
- Outer Thames Estuary SPA, and
- Southern North Sea SAC
- Alde-Ore & Butley Estuaries SAC
- Alde-Ore Estuary Ramsar Site
- Alde-Ore SPA.
- The Broads SAC
- Broadland Ramsar Site
- Broadland SPA (in relation to bird populations)
- Minsmere-Walberswick SPA
- Minsmere to Walberswick Ramsar Site

4.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

5 Transfer from Holton WTW to Eye Airfield (ESW-TRA-019)

Option ID: (ESW-TRA-019)

5.1 Option Description

The option proposes to transfer water from Holton WTW to Eye Airfield. The transfer length is approximately 30.6 km (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified five LSE Habitats Sites within the ZoI of this option: Minsmere-Walberswick SPA, Ramsar Site and SAC, Outer Thames Estuary SPA, and Southern North Sea SAC. This screening review is summarised in Table 5.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 5.1: Transfer from Holton WTW to Eye Airfield Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Minsmere-Walberswick SPA (UK9009101) (approx. 5km east)	Dew's Ponds SAC (UK0030133) (approx. 5.5km)
Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 5km east)	Benacre to Easton Bavents SPA (UK9009291) (approx. 8km)
Minsmere to Walberswick Ramsar Site (UK11044) (approx. 5km east)	Benacre to Easton Bavents Lagoons SAC (UK0013104) (approx. 9km)
Outer Thames Estuary SPA (UK9020309) (approx. 9.9km south-east)	Redgrave & South Lopham Fens Ramsar Site (UK11056) (approx. 9.5km)
Southern North Sea SAC (UK0030395) (approx. 9.9km south-east)	Waveney & Little Ouse Valley Fens SAC (UK0012882) (approx. 9.5km)

Source: Mott MacDonald, 2022

5.2 Stage 2 Appropriate Assessment

5.2.1 Scope

The following Habitats Sites were assessed at Stage 2 AA:

- Minsmere-Walberswick SPA (UK9009101) (approx. 5km east)
- Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 5km east)
- Minsmere to Walberswick Ramsar Site (UK11044) (approx. 5km east)
- Outer Thames Estuary SPA (UK9020309) (approx. 9.9km east)

- Southern North Sea SAC (UK0030395) (approx. 9.9km east)

5.2.2 Potential effects on Habitats Sites

The potential effects of the construction and operation phases for the water transfer from Holton WTW to Eye Airfield Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential impact on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed, summarised within Table 5.2. Where stated these are in addition to the best practice outlined in Section 3.4.4

5.2.2.1 Minsmere-Walberswick SPA and Ramsar Site (approx. 5km east)

Due to the identical extent and significant overlap of qualifying features between the Minsmere-Walberswick SPA and Ramsar Site, potential effects on these sites are considered together.

Construction effects

These sites are hydrologically connected downstream of the option footprint. The new pipeline bisects the Chediston Watercourse west of Halesworth, which runs into the River Blyth and subsequently into the site approximately 7km downstream. There is also a hydrological connection via the WFD groundwater water body ID GB40501G400600 (Waveney and East Suffolk Chalk & Crag).

Where the pipeline route crosses the waterbodies the potential exists for construction activities to affect downstream water quality due to pollution events. Toxic and non-toxic contamination may result in changes to turbidity, sedimentation and hydrological processes downstream of the crossing point. This could lead to subsequent degradation of qualifying habitats and habitats which support qualifying species. The same effects may also occur through transfer of pollutants through the groundwater. These sites are ground water dependent terrestrial ecosystems (GWDTE), and as such are particularly sensitive to changes in the quality of water in the water table.

Due to the distance of these sites from the option footprint (5km), no other impact pathways are present during construction. Although qualifying bird species are highly mobile, the habitats immediately surrounding the option footprint are predominantly sub-optimal for these species and therefore disturbance effects from noise and vibration are not anticipated to be significant. Arable land to the immediate north of the option footprint may be suitable for foraging hen harrier and greater white-fronted goose (*Anser albifrons albifrons*), thus constituting functionally connected land to the Habitats Sites. However, these habitats are not within the *Goose and swan functional land Impact Risk Zones (IRZ)*, and close to the town of Halesworth where other habitats are sub-optimal. It is only the easternmost sections of the options footprint which are considered to be within potential functional land for qualifying features of these sites. As the majority of the new pipeline infrastructure in this area follows existing roads, any disturbance to qualifying bird species is not considered to be significant over and above the existing baseline for noise, vibration and/or visual disturbance. Furthermore, due to the distance between the option footprint and the lowland heath areas of the sites (9.5km south-east), breeding nightjar (*Caprimulgus europaeus*) are not anticipated to be affected.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

5.2.2.2 Minsmere to Walberswick Heaths & Marshes SAC (UK0012809) (approx. 5km)

Construction effects

The SAC boundary has some overlap with the Minsmere-Walberswick SPA and Ramsar Site and is hydrologically connected to the option footprint via the WFD groundwater water body ID GB40501G400600 (Waveney and East Suffolk Chalk & Crag). This site is a GWDTE, so is particularly sensitive to changes in water quality of the water table. Toxic and non-toxic contamination may result in changes to turbidity, sedimentation and hydrological processes within the catchment, subsequently resulting in damage or degradation of qualifying habitats. As mentioned in relation to the Minsmere-Walberswick SPA/Ramsar Site, the pipeline bisects the Chediston Watercourse, which is upstream of the River Blyth. However, there is no direct surface water connection between the option footprint and the site. A component of the SAC is connected to the River Blyth via the Dunwich River, but this is upstream of the river close to the mouth and therefore any pollution events are unlikely to be transferred to the site.

Due to this distance between the site and the option footprint (5km), no other impact pathways are anticipated during construction.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

5.2.2.3 Outer Thames Estuary SPA (approx. 9.9km)

Construction effects

This SPA is hydrologically connected downstream of the option footprint. The new pipeline bisects the Chediston Watercourse west of Halesworth, which runs into the River Blyth and subsequently into the site boundary.

Where the pipeline route crosses the waterbodies the potential exists for construction activities to affect downstream water quality due to pollution events. Toxic and non-toxic contamination may result in changes to turbidity, sedimentation and hydrological processes, affecting prey availability for qualifying features within the site extent. This may result in displacement of these features from within the site, influencing overall distribution and population numbers.

Due to the distance between this site and the option footprint (9.9km), no other impact pathways are present during construction. The qualifying features are predominantly marine species, with red-throated diver (*Gavia stellata*) and little tern (*Sterna albifrons*) only foraging within the marine environment. Common tern (*Sterna hirundo*) does use inland waterways for foraging, but none of these species will use functionally connected land far enough inland for construction disturbance effects to be a concern.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

5.2.2.4 Southern North Sea SAC (approx. 9.9km)

Construction effects

This SAC is hydrologically connected downstream of the option footprint. The new pipeline bisects the Chediston Watercourse west of Halesworth, which runs into the River Blyth and subsequently into the site boundary.

Where the pipeline route crosses the waterbodies the potential exists for construction activities to affect downstream water quality due to pollution events. Toxic and non-toxic contamination

may result in changes to turbidity, sedimentation and hydrological processes, affecting prey availability for qualifying features within the site extent. This may result in displacement of these features from within the site, influencing overall distribution and population numbers.

Due to the distance between the site and the option footprint (9.9km), no other impact pathways are present during construction.

Operation effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

5.2.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

It is assumed that the Chediston Watercourse, crossing by the pipeline alignment, is over 3m wide and directional drilling will be an effective way to minimise impacts upon this water body.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 5.2: Transfer from Holton WTW to Eye Airfield – Potential effects on designated qualifying features

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Residual Effects after mitigation
Minsmere-Walberswick SPA and Ramsar Site (approx. 5km south-east)	All	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the groundwater catchment and bisected surface water body which could be transferred to within the Habitats Sites' boundaries and damage/degrade habitats which support qualifying features; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon some bird species this site is designated for. . The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No adverse effects have been identified during the operation of this option.	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling during construction of the pipeline when crossing the Chediston Watercourse to reduce in-channel impacts. • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.
Minsmere to Walberswick Heaths & Marshes SAC (approx. 5km south-east)	• All	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the groundwater catchment which could be transferred to within the Habitats Sites' boundaries and damage/degrade qualifying habitats; and	The following measures will be implemented to avoid or reduce adverse impacts: • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Residual Effects after mitigation
		• Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features' distributions. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No effects are anticipated from the operation phase of this option.		Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.
Outer Thames Estuary SPA (approx. 9.9km east)	• All	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the bisected surface water body which could be transferred to within the Habitats Sites' boundaries and damage/degrade habitats which support qualifying features; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon some bird species this site is designated for. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No adverse effects have been identified during the operation of this option.	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling during construction of the pipeline when crossing the Chediston Watercourse to reduce in-channel impacts. • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Residual Effects after mitigation
Southern North Sea SAC (approx. 9.9km east)	• All	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the bisected surface water body which could be transferred to within the Habitats Sites' boundaries and damage/degrade habitats which support qualifying features; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon some bird species this site is designated for. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No adverse effects have been identified during the operation of this option.	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling during construction of the pipeline when crossing the Chediston Watercourse to reduce in-channel impacts. • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. • Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option.

5.2.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the overall integrity of Minsmere to Walberswick SPA, Ramsar Site and SAC, Outer Thames Estuary SPA and Southern North Sea SAC. No residual adverse effects are anticipated on the integrity of the Habitats Sites or their qualifying features following the implementation of suggested mitigation.

5.2.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

6 Transfer from Bungay Wells to Broome WTW (ESW-TRA-018)

Option ID: (ESW-TRA-018)

6.1 Option Description

This option proposes water transfer via a new pipeline from Bungay Wells to Broome WTW (approximately 3.6 km long), with a yield of 1Ml/d. (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

6.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified three Habitats Sites within the ZoI of this option: Broadland SPA and Ramsar Site, and The Broads SAC. This screening review is summarised in Table 6.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 6.1: Transfer from Bungay Wells to Broome WTW Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approx. 3.7km east)	None
Broadland Ramsar Site (UK11010) (approx. 3.7km east)	
The Broads SAC (UK0013577) (approx. 3.7km east)	

Source: Mott MacDonald, 2022

6.3 Stage 2 Appropriate Assessment

6.3.1 Scope

The following Habitats Sites were assessed at Stage 2 AA:

- Broadland SPA (UK9009253) (approx. 3.7km east)
- Broadland Ramsar Site (UK11010) (approx. 3.7km east)
- The Broads SAC (UK0013577) (approx. 3.7km east)

6.3.2 Potential effects on Habitats Sites

The potential effects of the construction and operational phases for the Bungay Wells to Broome WTW Transfer Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential impact on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed

significant, mitigation measures are also proposed in addition to widely-used best practice measures, summarised within Table 5.2.

6.3.2.1 Broadland SPA (approx. 3.7km east)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

The Broadland SPA is hydrologically connected downstream of the option footprint. The new pipeline bisects the River Waveney along the A413, which runs adjacent to the site. There is also a hydrological connection via the WFD groundwater water body ID GB40501G400300 (Broadland Rivers Chalk & Crag).

Where the pipeline route crosses the river the potential exists for construction activities to affect downstream water quality due to pollution events. Toxic and non-toxic contamination may resulting in changes to turbidity, sedimentation and hydrological processes downstream of the crossing point. This could lead to subsequent degradation of qualifying habitats and habitats which support qualifying species. The same effects may also occur through transfer of pollutants through the groundwater. These sites are GWDTE, and as such are particularly sensitive to changes in the quality of water in the water table.

The option footprint is adjacent to floodplain grazing marsh, a habitat which is suitable for qualifying bird species of these sites. This could be functionally connected land to the sites, in which case these qualifying species may be disturbed by construction activities, including noise, vibration and visual movements of additional people and plant.

Disturbing effects can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Operation effects

During operation, the existing abstraction at Bungay Wells may result in changes to water table levels and flows potentially affecting habitats that support qualifying species. Ground water abstraction may lead to lower water levels in the SPA resulting in a decreased fish population which in turn will affect the bird species that rely on fish as prey.

An environmental flows assessment will be undertaken to understand if the proposed abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.

6.3.2.2 Broadland Ramsar Site (approx. 3.7km east)

Construction effects

This Habitat Site is hydrologically connected downstream of the option footprint. The new pipeline bisects the River Waveney along the A413, which runs adjacent to the site. There is also a hydrological connection via the WFD groundwater water body ID GB40501G400300 (Broadland Rivers Chalk & Crag).

Where the pipeline route crosses the river the potential exists for construction activities to affect downstream water quality due to pollution events. Toxic and non-toxic contamination may result in changes to turbidity, sedimentation and hydrological processes downstream of the crossing point. This could lead to subsequent degradation of qualifying habitats and habitats which

support qualifying species. The same effects may also occur through transfer of pollutants through the groundwater. These sites are GWDTE, and as such are particularly sensitive to changes in the quality of water in the water table.

The option footprint is adjacent to floodplain grazing marsh, a habitat which is suitable for qualifying bird species of these sites. This could be functionally connected land to the sites, in which case these qualifying species may be disturbed by construction activities, including noise, vibration and visual movements of additional people and plant.

Disturbing effects can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Construction-related disturbance, including night works with artificial lighting, may affect otter populations. The pipeline crosses the River Waveney, which is considered to be functionally connected to the site and could be regularly used by otter populations associated with the Ramsar Site, including resting places. Disturbing effects can result in changes to behaviours, increased energy expenditure due to fleeing, abandonment of young, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Assuming that the adjacent habitats are functionally connected to the sites, it is possible that reduced air quality and increased nitrogen deposition during construction has a significant effect on habitats which support qualifying species. An increase in construction dust and sedimentation may degrade supporting roosting and foraging habitats, for birds and otter alike.

In relation to the qualifying habitats, plants and invertebrate species, the option footprint is considered to be sufficiently from the site and disturbances related to human presence, lights and vehicular movements are unlikely to be observed. Any night works are not anticipated to affect qualifying bird species, as populations associated with the sites will typically roost within the site extent itself and only use functionally connected land for foraging during the day. Due to the distance between this option and these sites, no other impact pathways are present during construction.

Operation effects

During operation, the existing abstraction at Bungay Wells may result in changes to water table levels and flows potentially affecting habitats that support qualifying species. Ground water abstraction may lead to lower water levels in the Ramsar Site resulting in a decreased fish population which in turn will affect the bird species and otter populations that rely on fish as prey.

An environmental flows assessment will be undertaken to understand if the proposed abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.

6.3.2.3 The Broads SAC (approx. 3.7km east)

Construction effects

As the SAC overlaps with the Broadland SPA and Ramsar Site within the ZoI, the same impact pathways are present with respect to hydrological connections; the River Waveney and groundwater catchment both provide pathways for pollution of the water environment to affect

this site. Toxic and non-toxic contamination may result in changes to turbidity, sedimentation and hydrological processes downstream of the crossing point. This could lead to subsequent degradation of qualifying habitats, species, and habitats which support qualifying species.

In relation to the qualifying habitats, plants and invertebrate species, the option footprint is considered to be sufficiently from the site and disturbances related to human presence, lights and vehicular movements are unlikely to be observed. However, construction-related disturbance may still affect otter populations. Potential impact pathways which could affect otters are detailed in the section above for the Broadlands Ramsar Site and the same applies for the SAC.

Due to the distance between this option and the site, no other impact pathways are present during construction.

Operation effects

During operation, the existing abstraction at Bungay Wells may result in changes to water table levels and flows potentially affecting habitats that support qualifying species. Ground water abstraction may lead to lower water levels in the SAC resulting in a decreased fish population which in turn will affect otter that rely on fish as prey.

An environmental flows assessment will be undertaken to understand if the proposed abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.

6.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

It is assumed that the River Waveney, crossing by the pipeline alignment, is over 3m wide and the pipeline will be construction beneath the watercourse, rather than over the top and beneath the existing A143. This would result in the requirement for directional drilling to be an effective way to minimise impacts upon this water body.

It is also assumed that significant numbers of otters, populations associated with The Broads SAC and Broadlands Ramsar Site, are using the River Waveney in proximity of the option footprint and will likely be disturbed by construction activities.

Finally, it is assumed that the floodplain grazing marsh system adjacent to the option footprint is functionally connected land regularly used by overwintering qualifying bird species of the Broadlands SPA/Ramsar Site and thus these features are at risk of construction disturbance in the absence of mitigation. This does not include qualifying goose and swan species, as this option is outside of the IRZ for these species and sufficiently distance to avoid disturbance effects during construction.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 6.2: Bungay Wells to Broome WTW transfer – Potential effects on designated qualifying features

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Broadland SPA (approx. 3.7km east)	• All	This option may have the following permanent impacts on the Habitats Site during the construction phase: • Toxic contamination – pollution of the groundwater catchment and River Waveney which could be transferred to within the Habitats Site boundary. • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying habitats and species, and/or functional habitat for supporting qualifying features. During operation the existing abstraction may result in changes in water table levels.	The following measures will be implemented to avoid or reduce adverse impacts: • Avoid in-channel working where possible, or use of directional drilling to avoid impacts on the River Waveney; and • Implementation of widely used best practice measures for pollution control and dust suppression, see section 3.3.4.2. • Additionally, works should be agreed with Natural England and, if possible, to be undertaken outside the breeding period to avoid effects on this site qualifying bird species. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Working methods which will reduce disturbance during construction include: - A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; - - All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and plant species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. With appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Habitats Site for the construction and operation phases of this option. Further studies are required to assess potential effects in the water table and consequent effects on the site qualifying features during operation.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
			will be utilised, including the use of electric and hybrid alternatives; and - - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. During operation: • An environmental flows assessment will be undertaken to understand if the existing abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.	
	• Overwintering bird species	This option may have the following permanent impacts on the Habitats Site during the construction phase: • Non-toxic contamination – reduction in air quality due to construction activities likely to result in degradation of surrounding habitat and reductions in foraging areas; • Non-physical disturbance – displacement of qualifying species from noise and/or visual, associated with construction activities, increasing vehicular movement and personnel can impact survival and distribution of bird species; and • Biological disturbance – changes in habitat availability and potential for SPA populations to be displaced from current foraging areas. The effects of toxic contamination and physical loss/damage of habitat could be permanent impacts but are likely to be localised due to the distance of the option from the Habitats Site.	Same as above. Additionally, the following measures will be implemented to avoid or reduce adverse impacts: • Sensitive timing of construction works to avoid the sensitive periods for birds detailed in the Broadland SPA SDF, October to March inclusive; • Any works which are undertaken between October to March which may disturb or displace qualifying species from suitable functional land will only be permitted if the population present at risk of disturbance is less than 1% of the cited SPA population in the SDF; and This approach is considered to be conservative in the absence of recent survey data. Non-physical disturbance caused by construction is not anticipated to result in adverse effects on the integrity of the SPA	

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		During operation the existing abstraction may result in changes in water table levels.	from reductions in functional habitat availability and/or displacement effects. This is due to the small proportion of the functional land surrounding the Site within the construction area; even if birds are displaced from this area, there is sufficient foraging habitat elsewhere. However, this cannot be confirmed until records or survey data is obtained. Therefore, these mitigation measures are proposed to remove the potential adverse effects. With this in place, adverse impacts on the Habitats Site will be alleviated during construction. During operation: • An environmental flows assessment will be undertaken to understand if the existing abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.	
Broadland Ramsar Site (approx. 3.7km east)	• All	This option may have the following permanent impacts on the Habitats Site during the construction phase: • Toxic contamination – pollution of the groundwater catchment and River Waveney which could be transferred to within the Habitats Site boundary; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying habitats and species, and/or functional habitat for supporting qualifying features; The effects of toxic contamination and physical loss/damage of habitat could be permanent	The following measures will be implemented to avoid or reduce adverse impacts: • Avoid in-channel working where possible, or use of directional drilling to avoid impacts on the River Waveney; and • Implementation of widely used best practice measures for pollution control and dust suppression, see section 3.3.4.2. • Works should be agreed with Natural England and, if possible, to be undertaken outside the breeding period	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying bird species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Further studies to better understand how the qualifying species use the linked habitats are required. Therefore, bird,

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		impacts but are likely to be localised due to the distance of the option from the Habitats Site. During operation the existing abstraction may result in changes in water table levels.	to avoid effects on this site qualifying bird species. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Working methods which will reduce disturbance during construction include: - A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; - -All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. With this in place, adverse impacts on the Habitats Site will be alleviated during construction. During operation: • An environmental flows assessment will be undertaken to understand if the existing abstraction may result in	otter and habitat suitability surveys are recommended. Further studies are required to assess potential effects in the water table and consequent effects on the site qualifying features during operation

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
			adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects during the operation phase.	
	• Overwintering bird species	• Non-toxic contamination – reduction in air quality due to construction activities likely to result in degradation of surrounding habitat and reductions in foraging areas; • Non-physical disturbance – displacement of qualifying species from noise and/or visual, associated with construction activities, increasing vehicular movement and personnel can impact survival and distribution of bird species; and • Biological disturbance – changes in habitat availability and potential for SPA populations to be displaced from current foraging areas. During operation the existing abstraction may result in changes in water table levels.	Same as above. Additionally, the following measures will be implemented to avoid or reduce adverse impacts: • Sensitive timing of construction works to avoid the sensitive periods for birds detailed in the Broadland Ramsar Site RIS, October to March inclusive; • Any works which are undertaken between October to March which may disturb or displace qualifying species from suitable functional land will only be permitted if the population present at risk of disturbance is less than 1% of the cited Ramsar Site populationin the RIS; and This approach is considered to be conservative in the absence of recent survey data. Non-physical disturbance caused by construction is not anticipated to result in adverse effects on the integrity of the SPA from reductions in functional habitat availability and/or displacement effects. This is due to the small proportion of the functional land surrounding the Site within the construction area; even if birds are displaced from this area, there is sufficient foraging habitat elsewhere. However, this cannot be confirmed until records or survey data is obtained. Therefore, these mitigation	

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
			measures are proposed to remove the potential adverse effects. With this in place, adverse impacts on the Habitats Site will be alleviated during construction.	
	• Otter	This option may have the following temporary or permanent impacts on otter during the construction phase: • Toxic contamination – pollution of the water environment (River Waveney) and groundwater catchment - which could reduce prey availability within suitable functionally connected habitat; • Non-physical disturbance – displacement of qualifying species from noise, visual and/or artificial lighting pathways, associated with construction activities, increasing vehicular movement, personnel and lighting can impact survival and distribution; and During operation the existing abstraction may result in changes in water table levels.	The following measures will be implemented to avoid or reduce adverse impacts: • Sensitive timing of construction works to avoid the periods of greatest otter activity, i.e. no night-time working; • Avoid disturbance to confirmed holts until no longer in use. This can be informed from monitoring using cameras (requires Natural England licence); • If holts require closure and destruction to facilitate construction, artificial replacements will be required on the same watercourse away from the works area. These must be in-situ before construction starts. This work will require a Natural England licence; and • A pre-construction otter survey will be required to ensure that an otter breeding or resting site is not present during construction works and to search for field signs within the ZoI. If identified within the ZoI construction works will need to be undertaken under a Natural England mitigation licence and protection zones will need to be implemented. These are: - An otter holt or couch requires a 30m protection zone; and	

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
			- A natal den requires a 150m protection zone2. - If a breeding or resting site is located at the abstraction point, alternative locations will need to be considered. If a breeding or resting site is located within the pipeline footprint, directional drilling will need to be considered to avoid loss of key supporting habitat. If a breeding or resting site is located within the ZoI, an appropriate buffer will need to be maintained during construction works to limit anthropogenic disturbance. • A toolbox talk will be completed by an Ecological Clerk of Works (ECoW) regarding otter ecology. With this in place, adverse impacts on this qualifying feature will be mitigated during construction. During Construction: • An environmental flows assessment will be undertaken to understand if the existing abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.	
The Broads SAC (approx. 3.7km east)	• All	This option has the potential to have the same temporary or permanent impacts during the construction phase as those detailed above for the Broadlands Ramsar Site.	The following measures will be implemented to avoid or reduce adverse impacts: • Sensitive timing of construction works to avoid the periods of greatest otter activity, i.e. no night-time working;	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying species;

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		During operation the existing abstraction may result in changes in water table levels.	• Avoid disturbance to confirmed holts until no longer in use. This can be informed from monitoring using cameras (requires Natural England licence); • If holts require closure and destruction to facilitate construction, artificial replacements will be required on the same watercourse away from the works area. These must be in-situ before construction starts. This work will require a Natural England licence; and • A pre-construction otter survey will be required to ensure that an otter breeding or resting site is not present during construction works and to search for field signs within the ZoI. If identified within the ZoI construction works will need to be undertaken under a Natural England mitigation licence and protection zones will need to be implemented. These are: - - An otter holt or couch requires a 30m protection zone; and - - A natal den requires a 150m protection zone2. - - If a breeding or resting site is located at the abstraction point, alternative locations will need to be considered. If a breeding or resting site is located within the pipeline footprint, directional drilling will need to be considered to avoid loss of key supporting habitat. If a breeding or resting site is located within the ZoI, an appropriate buffer will need to be maintained during	• The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Further investigation on the use of functionally linked habitat by otter species is recommended to determine more targeted mitigation measures. Further studies to better understand how the qualifying species use the linked habitats are required. Therefore, bird, otter and habitat suitability surveys are recommended. Further studies are required to assess potential effects in the water table and consequent effects on the site qualifying features during operation.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
			construction works to limit anthropogenic disturbance. • A toolbox talk will be completed by an Ecological Clerk of Works (ECoW) regarding otter ecology. With this in place, adverse impacts on this qualifying feature will be mitigated during construction. During Construction: • An environmental flows assessment will be undertaken to understand if the existing abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.	

6.3.4 Stage 2 outcomes

Further investigation on the use of functionally linked habitat by these sites qualifying bird species and otter is recommended to assess potential effects in more detail and determine more targeted mitigation measures. A detailed review of the baseline ecological data is also recommended to determine further effects on these Habitats Sites qualifying features and reduce uncertainty. This applies to the following sites:

- The Broads SAC (in relation to otter populations only);
- Broadland Ramsar Site (in relation to otter and bird populations);
- Broadland SPA (in relation to bird populations).

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the overall integrity of The Broads SAC, or Broadland SPA/Ramsar Site. No residual adverse effects are anticipated on the integrity of the Habitats Sites or their qualifying features following the implementation of suggested mitigation.

During operation the existing abstraction may result in changes in water table levels and consequently further studies are required to assess these changes and effects on the Habitats Sites. An environmental flows assessment will be undertaken to understand if the existing abstraction may result in adverse effects. If this is the case environmental flows rules will be stipulated to avoid adverse effects.

6.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

7 Southend-on-Sea Water Reuse (ESW-EFR-001)

Option ID: (ESW-EFR-001)

7.1 Option description

This option proposes an effluent reuse plant (max capacity) in Southend-on-Sea, being fed from Anglian Water's WRC with a transfer to Hanningfield reservoir (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

7.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified seven Habitats Sites within the ZoI of this option: Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site and SPA, Essex Estuaries SAC, Foulness (Mid-Essex Coast Phase 5) Ramsar Site, Outer Thames Estuary SPA, and Benfleet and Southend Marshes Ramsar Site and SPA. This screening review identified LSE for seven SAC, SPA and Ramsar Sites as summarised in Table 7.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 7.1: Southend-on-Sea Water Reuse Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site (UK UK11058) (0km)	Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar Site (UK11007) (approx. 6km)
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA (UK9009244) (approx. 0km)	Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (UK9009245) (approx. 6km)
Essex Estuaries SAC (UK0013690) (approx. 0km)	Thames Estuary & Marshes SPA (UK9012021) (approx. 8.5km)
Outer Thames Estuary SPA (UK9020309) (approx. 0km)	Thames Estuary and Marshes Ramsar Site (UK11069) (approx. 8.5km)
Benfleet and Southend Marshes Ramsar Site (UK11006) (approx. 3km)	
Benfleet and Southend Marshes (SPA)(UK9009171) (approx. 3km)	
Foulness (Mid-Essex Coast Phase 5) Ramsar Site (UK11026) (approx. 7km) and SPA	

Source: Mott MacDonald, 2022

7.3 Stage 2 Appropriate Assessment

7.3.1 Scope

The following Habitats Sites were assessed at Stage 2 AA:

- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site (UK UK11058) (0km)
- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA (UK9009244) (approx. 0km)
- Essex Estuaries SAC (UK0013690) (approx. 0km)
- Foulness (Mid-Essex Coast Phase 5) Ramsar Site (UK11026) (approx. 7km)
- Outer Thames Estuary SPA (UK9020309) (approx. 0km)
- Benfleet and Southend Marshes Ramsar Site (UK11006) (approx. 3km)
- Benfleet and Southend Marshes (SPA)(UK9009171) (approx. 3km)

7.3.2 Potential effects on Habitats Sites

The potential effects of the construction and operation phases for the Southend-on-Sea Effluent Reuse Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential impact on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, a worst-case scenario is assumed, with effects and required mitigation measures outlined in Table 7.2.

Where adverse effects are deemed significant, further necessary mitigation measures are also proposed in the following section. Where stated these are in addition to the best practice outlined in Section 3.4.4.

7.3.2.1 Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site and SPA (0km)

Construction effects

This option is highly likely to affect this site as the proposed option crosses the Habitats Site at the Crouch and Roach Estuaries.

During the construction phase of this option, it is likely that effects due to disturbance to the qualifying species of this site through means of noise, vibration and visual disturbance will occur due to the proximity of the option to the Ramsar Site/SPA. Additionally, dust and airborne particles released during the works could have the potential to impact the qualifying features either directly through air pollution or indirectly by damaging supporting habitats. Furthermore, the works during the construction phase may result in surface run-off and sediment discharge which, if not managed correctly, may lead to pollution events.

Physical damage during construction as result of pollution events may include temporary habitat degradation and changes to habitat availability, which can have a direct effect to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion or supporting habitat by the bird species this site is designated for. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Changes in water quality due to pollution events as a result of construction may lead to changes in turbidity and increased sedimentation can also have negative effects on the life cycle of the qualifying species. Construction of river crossings has the potential to impact downstream water quality, siltation and/or hydrological regime, resulting in non-toxic contamination. There is also potential for water pollution events which are likely to result in toxic contamination (and are usually linked to direct mortality of species).

There is also the potential for significant effects on Ramsar Site/SPA qualifying vegetation and invertebrate species as a direct result of physical habitat loss, habitat degradation and/ or fragmentation (within the Habitats Sites itself and in adjacent areas functioning as supporting habitats).

Operational effects

No operational effects are anticipated for this option which could affect these Habitats Sites and/or their qualifying features.

7.3.2.2 Essex Estuaries SAC (0km)

Construction effects

This option is highly likely to affect this site as the proposed option crosses the Habitats Site at the Essex Estuaries.

During the construction phase of this option, it is likely that effects due to disturbance to the qualifying species of this site through means of noise, vibration and visual disturbance will occur due to the proximity of the option to the SAC. Additionally, dust and airborne particles released during the works could have the potential to impact the qualifying features either directly through air pollution or indirectly by damaging supporting habitats. Furthermore, the works during the construction phase may result in surface run-off and sediment discharge which, if not managed correctly, may lead to pollution events.

Changes in water quality due to pollution events as result of construction may lead to changes in turbidity and increased sedimentation can also have negative effects on functionally linked habitats which are relied upon by Annex II qualifying species (e.g. white clawed crawfish and fish species (bullhead and brook lamprey. These effects may result in potential temporary physical loss, degradation or fragmentation of designated habitats.

Construction activities can affect vegetation as a result of habitat loss and degradation caused by changes in water quality and turbidity, increased sedimentation, and changes in habitat availability, which could in turn lead to changes in natural succession.

Operational effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

7.3.2.3 Foulness (Mid-Essex Coast Phase 5) Ramsar Site (approx. 7km)

Construction effects

The option is sufficiently distant from the Habitats Site boundary (7km) to exclude noise and light effects; however, this option proposes to cross the River Crouch and the River Roach which both feed into this site. This hydrological connection may constitute a pathway for pollution events during the pipeline and associated structures construction.

Physical damage during construction as result of pollution events may include temporary habitat degradation and changes to habitat availability, which can have a direct effect to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion or supporting habitat by the bird species

this site is designated for. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Changes in water quality due to pollution events as a result of construction may lead to changes in turbidity and increased sedimentation can also have negative effects on the life cycle of the qualifying species. Construction of river crossings has the potential to impact downstream water quality, siltation and/or hydrological regime, resulting in non-toxic contamination. There is also potential for water pollution events which are likely to result in toxic contamination (and are usually linked to direct mortality of species).

There is also the potential for significant effects on Ramsar Site qualifying vegetation and invertebrate species as a direct result of physical habitat loss, habitat degradation and/ or fragmentation (within the Habitats Sites itself and in adjacent areas functioning as supporting habitats).

Operational effects

No operational effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

7.3.2.4 Outer Thames Estuary SPA (0km)

Construction effects

This option is highly likely to affect this site as the proposed option crosses the Habitats Site at the Crouch and Roach Estuaries.

During the construction phase of this option, it is likely that effects due to disturbance to the qualifying species of this site through means of noise, vibration and visual disturbance will occur due to the proximity of the option to the SPA. Additionally, dust and airborne particles released during the works could have the potential to impact the qualifying features either directly through air pollution or indirectly by damaging supporting habitats. Furthermore, the works during the construction phase may result in surface run-off and sediment discharge which, if not managed correctly, may lead to pollution events.

Physical damage during construction as result of pollution events may include temporary habitat degradation and changes to habitat availability, which can have a direct effect to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion or supporting habitat by the bird species this site is designated for. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Changes in water quality due to pollution events as a result of construction may lead to changes in turbidity and increased sedimentation can also have negative effects on the life cycle of the qualifying species. Construction of river crossings has the potential to impact downstream water quality, siltation and/or hydrological regime, resulting in non-toxic contamination. There is also potential for water pollution events which are likely to result in toxic contamination (and are usually linked to direct mortality of species).

There is also the potential for significant effects on SPA qualifying vegetation and invertebrate species as a direct result of physical habitat loss, habitat degradation and/ or fragmentation (within the Habitats Sites itself and in adjacent areas functioning as supporting habitats).

Operational effects

No operational effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

7.3.2.5 Benfleet and Southend Marshes Ramsar Site (approx. 3km)

Construction effects

The option is sufficiently distant from the Habitats Site boundary (3km) to exclude noise and light effects. The urban area of Southend on Sea is situated between the site and the proposed works which will act to diminish most construction impacts such as noise and visual disturbance.

Although the site is hydrologically connected via the sea, this is a very remote connection (over 37km) which further reduces the likelihood of any significant construction effects.

Operational effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

7.3.2.6 Benfleet and Southend Marshes (SPA) (approx. 3km)

Construction effects

The option is sufficiently distant to the Habitats Site boundary (3km) to exclude noise and light effects. The urban area of Southend on Sea is situated between the site and the proposed works which will act to diminish most construction impacts such as noise and visual disturbance.

Although the site is hydrologically connected via the sea, this is a very remote connection (over 37km) which further reduces the likelihood of any significant construction effects.

Operational effects

No operation effects are anticipated for this option which could affect this Habitats Site and/or its qualifying features.

7.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 7.2: Southend-on-Sea water reuse and transfer – Potential effects on designated qualifying features

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site (UK UK11058) (0km)	Ramsar Site criterion 2: Supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant and animal including 13 nationally scarce plant species: • Slender hare's ear (*Bupleurum tenuissimum*) • Divided sedge (*Carex divisa*) • Sea barley (*Hordeum marinum*) • Golden samphire (*Inula crithmoides*) • Lax flowered sea-lavender (*Limonium humile*) • Curved hard-grass (*Parapholis incurve*) • Borrer's saltmarsh grass (*Puccinellia fasciculata*) • Stiff saltmarsh grass (*Puccinellia rupestris*) • Spiral tasselweed (*Ruppia cirrhosa*) • One-flowered glasswort (*Salicornia pusilla*) • Small cord-grass (*Spartina maritima*) • Shrubby sea bite (*Suaeda vera*)	The pipeline is proposed to cross the Habitats Site at the Crouch and Roach Estuaries via directional drilling underneath these rivers. This site has been identified as an area of importance for bird assemblages, rare plants and invertebrates and the proposed works may lead to temporary and permanent effects on its designated features. During construction this option is likely to result in: • Physical loss - loss of habitat (temporary and permanent) resulting from pipeline construction with the boundary of the Habitats Site. Although it is understood that directional drilling is proposed across the estuary waterbodies, works also appear to be proposed within the terrestrial sections of the Habitats Sites including where the pipeline changes direction. • Physical damage - sedimentation, erosion, silting, habitat fragmentation resulting from habitat damage, effects on natural coastal processes are possible due to the construction of the pipelines. The construction of the effluent reuse plant also has potential to cause sedimentation effects to the Habitats Site. The plant is proposed within 400m of the Prittle Brook, which drains into the Roach Estuary 0.8km downstream. • Non-physical disturbance - noise and light disturbance, human disturbance, vibration. For example, noise from construction of the pipeline and the effluent reuse plant, could lead to physical and behavioural changes in	Standard best practice guidance should be followed which is outlined in section 3.4.4. Further mitigation measures include: • Avoid construction within Habitats Sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Habitats Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Habitats Site or functionally linked land that were temporarily lost or damaged during construction.	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species. • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Ramsar Site for the construction or operation phase of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	• Sea clover (*Trifolium squamosum*). Several important invertebrate species are also present on the site, including: • Scarce emerald damselfly (*Lestes dryas*) • Shorefly (*Parydroptera discomyzina*) • Rare soldier fly (*Stratiomys singularior*) • Large horsefly (*Hybomitra expollicata*) • The beetles *Graptodytes bilineatus* and *Malachius vulneratus* • The ground lackey moth *Malacosoma castrensis* • *Eucosoma catoprana.* Ramsar Site criterion 5: Assemblages of international importance: Species with peak counts in winter: • 16970 waterfowl (5 year peak mean 1998/99-2002/2003) Ramsar Site criterion 6: Species/populations occurring at levels of international importance. Species with peak counts in winter: • Dark-bellied brent goose, (*Branta bernicla bernicla*), 2103 individuals, representing an average	birds, thereby negatively affecting this site qualifying species distribution. • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting from pipeline construction, air pollution (dust). • Biological disturbances – the possibility of direct mortality of rare plants, invertebrates and birds. Changes to habitat availability; habitat avoidance due to changes in water quality from construction and disturbance for example. No adverse impacts are identified during operation.		

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	of 2.1% of the GB population (5 year peak mean 1998/9-2002/3)			
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA (UK9009244) (approx. 0km)	Article 4.2 qualification: Over winter the area regularly supports: • *Branta bernicla* (Western Siberia/Western Europe) 1% of the population 5 year peak mean 1989/90-1993/94. An Internationally Important Assemblage Of Birds. Over winter the area regularly supports: • 27,021 waterbirds (5 year peak mean 1990/91-1994/95) Including: *Branta bernicla.*	The pipeline is proposed to cross the Habitats Site at the Crouch and Roach Estuaries via directional drilling underneath the serivers. This site has been identified as an area of importance for bird assemblages, rare plants and invertebrates and the proposed works may lead to temporary and permanent effects on its designated features. During construction this option is likely to result in: • Physical loss - loss of habitat (temporary and permanent) resulting from pipeline construction with the boundary of the Habitats Site. Although it is understood that directional drilling is proposed across the estuary waterbodies, works also appear to be proposed within the terrestrial sections of the Habitats Sites including where the pipeline changes direction. • Physical damage - sedimentation, erosion, silting, habitat fragmentation resulting from habitat damage, effects on natural coastal processes are possible due to the construction of the pipelines. The construction of the effluent reuse plant also has potential to cause sedimentation effects to the Habitats Site. The plant is proposed within 400m of the Prittle Brook, which drains into the Roach Estuary 0.8km downstream. • Non-physical disturbance - noise and light disturbance, human disturbance, vibration. For example, noise from construction of the	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Habitats Sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Habitats Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species. • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SPA for the construction or operation phase of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		pipeline and the effluent reuse plant, could lead to physical and behavioural changes in birds, thereby negatively affecting this site qualifying species distribution. • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting from pipeline construction, air pollution (dust). • Biological disturbances – the possibility of direct mortality of rare plants, invertebrates and birds. Changes to habitat availability; habitat avoidance due to changes in water quality from construction and disturbance for example. No adverse impacts are identified during operation.	environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Habitats Site or functionally linked land that were temporarily lost or damaged during construction.	
Essex Estuaries SAC (UK0013690) (approx. 0km)	Annex I habitats that are a primary reason for selection of this site: • 1130 Estuaries • 1140 Mudflats and sandflats not covered by seawater at low tide • 1310 Salicornia and other annuals colonizing mud and sand • 1320 Spartina swards (*Spartinion maritimae*) • 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	• The pipeline is proposed to cross the Habitats Site at the Crouch and Roach Estuaries via directional drilling underneath these rivers. This site has been identified as an area of important habitats and rare flora. The proposed works may lead to temporary and permanent effects on its designated features. During construction this option is likely to result in: • Physical loss - loss of habitat (temporary and permanent) resulting from pipeline construction with the boundary of the Habitats Site. Although it is understood that directional drilling is proposed across the	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species. • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SAC for the construction or operation phase of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	• 1420 Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*) Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site: • 1110 Sandbanks which are slightly covered by sea water all the time	estuary waterbodies, works also appear to be proposed within the terrestrial sections of the designated sites including where the pipeline changes direction. • Physical damage - sedimentation, erosion, silting, habitat fragmentation resulting from habitat damage, effects on natural coastal processes are possible due to the construction of the pipelines. The construction of the effluent reuse plant also has potential to cause sedimentation effects to the designated site. The plant is proposed within 400m of the Prittle Brook, which drains into the Roach Estuary 0.8km downstream. • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting from pipeline construction, air pollution (dust). • Biological disturbances – the possibility of direct mortality of rare plants. Changes to habitat due to changes in water quality from construction for example. • No adverse impacts are identified during operation.	noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	
Foulness (Mid-Essex Coast Phase 5) Ramsar Site (UK11026) (approx. 7km)	Ramsar Site criterion 1: • This site qualifies by virtue of the extent and diversity of saltmarsh habitat present. This and four	The construction works of the plant and the pipeline are conducted over 7km from the designated site diminishing the possibly for impacts including noise and visual disturbance.	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites.	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species;

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	other sites in the Mid-Essex Coast Ramsar Site complex, include a total of 3,237 ha, that represent 70% of the saltmarsh habitat in Essex and 7% of the total area of saltmarsh in Britain. Ramsar Site criterion 2: • The site supports a number of nationally-rare and nationally-scarce plant species, and British Red Data Book invertebrates. Ramsar Site criterion 3: • The site contains extensive saltmarsh habitat, with areas supporting full and representative sequences of saltmarsh plant communities covering the range of variation in Britain. Ramsar Site criterion 5: • Assemblages of international importance: Species with peak counts in winter: - 82148 waterfowl (5 year peak mean 1998/99-2002/2003) • Species/populations occurring at levels of international importance:	There is hydrological connection to the site where the proposed pipeline crosses the River Roach and the River Crouch. These intersections are proposed over 7km from the designated site excluding the majority of possible construction effects. It is not expected that the site will be significantly affected by the river crossings given that: • directional drilling is proposed at all water courses >3m wide, including the two large estuaries (This is intrinsic to the proposal). • for water courses <3m wide, localised and temporary water quality and hydrology changes may arise during construction. However, pollution control best practice measures will be applied to all water courses subject to pipeline crossings (as a standard measure). Any effects that may arise during construction, due the crossing of small watercourses are therefore considered local and temporary with no significant effects identified that would affect the integrity of this designated site or cause significant impacts to the listed species. However, the pipeline is proposed to be constructed within terrestrial areas of neighbouring designated sites containing similar habitats and species. This may lead to biological disturbances at the Foulness sites. For example, changes to habitat availability caused for example by the displacement of birds onto this site leading to reduced foraging and nesting opportunities. Equally, the mortality of rare plants, birds or invertebrates within a neighbouring site along a habitat corridor, such as an estuary, may affect the ability of species to	• Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	• The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Ramsar Site for the construction or operation phase of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	Species with peak counts in spring/autumn: - Common redshank , (*Tringa totanus tetanus*), 2586 individuals, representing an average of 1% of the population (5 year peak mean 1998/9-2002/3) • Species with peak counts in winter: - Dark-bellied brent goose, (*Branta bernicla bernicla*), 6475 individuals, representing an average of 3% of the population (5 year peak mean 1998/9-2002/3) - Eurasian oystercatcher, (*Haematopus ostralegus ostralegus*), Europe & NW Africa -wintering 14674 individuals, representing an average of 1.4% of the population (5 year peak mean 1998/9-2002/3) - Grey plover, (*Pluvialis squatarola*), E Atlantic/W Africa - wintering 4343	successfully reproduce. Therefore, the likelihood of significant effects to this site cannot be ruled out. No adverse impacts are identified during operation.		

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	individuals, representing an average of 1.7% of the population (5 year peak mean 1998/9-2002/3) - Red knot, (*Calidris canutus islandica*), W & Southern Africa (wintering) 22439 individuals, representing an average of 4.9% of the population (5 year peak mean 1998/9-2002/3) - Bar-tailed godwit, (*Limosa lapponica lapponica*), W Palearctic 4095 individuals, representing an average of 3.4% of the population (5 year peak mean 1998/9-2002/3)			
Outer Thames Estuary SPA (UK9020309) (approx. 0km)	Article 4.1 qualification: Over winter the area regularly supports: • *Gavia stellata* (North-western Europe - wintering) - 38% of the population in Great Britain peak mean over the period 1989-2006/07 • The area supports breeding populations of:	The pipeline is proposed to cross the designated site at the Crouch and Roach Estuaries via directional drilling underneath these rivers. This site has been identified as an area of importance for birds and the proposed works may lead to temporary and permanent effects on its designated features. • During construction this option is likely to result in: • Physical loss - loss of habitat (temporary and permanent) resulting from pipeline	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling.	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	Sternula albifrons (in breeding season) - 19.64% of GB population (2011 - 2015) • *Sterna hirundo* (in breeding season) - 2.66% of GB population (2011 - 2015)	construction with the boundary of the designated site. Although it is understood that directional drilling is proposed across the estuary waterbodies, works also appear to be proposed within the terrestrial sections of the designated sites including where the pipeline changes direction. • Physical damage - sedimentation, erosion, silting, habitat fragmentation resulting from habitat damage, effects on natural coastal processes are possible due to the construction of the pipelines. The construction of the effluent reuse plant also has potential to cause sedimentation effects to the designated site. The plant is proposed within 400m of the Prittle Brook, which drains into to the site 0.8km downstream. • Non-physical disturbance - noise and light disturbance, human disturbance, vibration. For example, noise from construction of the pipeline and the effluent reuse plant, could lead to physical and behavioural changes in birds, thereby negatively affecting this site qualifying species distribution. • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting from pipeline construction, air pollution (dust). • Biological disturbances – the possibility of direct mortality of birds. Changes to habitat availability; habitat avoidance due to changes in water quality from construction and disturbance for example.	• Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SPA for the construction or operation phase of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		No adverse impacts are identified during operation.		
Benfleet and Southend Marshes Ramsar Site (UK11006) (approx. 3km)	Article 4.2 Qualification. • Over winter the area regularly supports: - *Branta bernicla* (Western Siberia/Western Europe) 1.3% of the population 5 year peak mean 1991/92-1995/96 - *Calidris alpina* (Northern Siberia/Europe/Western Africa) 2.1% of the population in Great Britain 5 year peak mean - *Calidris canutus* (North-eastern Canada/Greenland/Iceland/North-western Europe) 2.6% of the population 5 year peak mean 1991/92-1995/96 - *Charadrius hiaticula* (Europe/Northern Africa - wintering) 1.3% of the population in Great Britain 5 year peak mean 1991/92-1995/96	The construction works of the plant and the pipeline are conducted over 3km from the designated site. The main urban area of Southend on Sea is situated between the site and the proposed works acting to diminish the possibly for most construction impacts including noise and visual disturbance. Via sea, the hydrological connection to the designated site is very remote (over 37Km). The site is also proposed in a different estuary to the proposed works further reducing the likelihood of any significant construction and operation effects. Via land, there is potential for a hydrological connection to the site where construction works are carried out within 400m of the Prittle Brook allowing possibility of sediment entering the watercourse. Depending on the direction of flow of the watercourse, which is not known, it is possible that this could then discharge southward to the designated site over 3km away. However, it is not anticipated that this in itself would lead to adverse effects to site or qualifying species assuming that standard pollution control best practice measures are followed.	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying features; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Ramsar Site for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	- *Pluvialis squatarola* (Eastern Atlantic - wintering) 2.3% of the population 5 year peak mean 1991/92-1995/96 Article 4.2 Qualification: An Internationally Important Assemblage of Birds. • Over winter the area regularly supports: - 34789 waterfowl (5 year peak mean 1991/92-1995/96) Including: *Branta bernicla , Charadrius hiaticula , Pluvialis squatarola , Calidris canutus , Calidris alpina alpina*			
Benfleet and Southend Marshes (SPA) (UK9009171) (approx. 3km)	Article 4.2 qualification. Over winter the area regularly supports: • *Branta bernicla bernicla* (Western Siberia/Western Europe) 1.3% of the population 5 year peak mean 1991/92-1995/96 • *Calidris alpina alpina* (Northern Siberia/Europe/Western Africa) 2.1% of the population in Great Britain 5 year peak mean • *Calidris canutus* (North-eastern Canada/Greenland/Icelan	The construction works of the plant and the pipeline are conducted over 3km from the designated site. The main urban area of Southend on Sea is situated between the site and the proposed works acting to diminish the possibly for most construction impacts including noise and visual disturbance. Via sea, the hydrological connection to the designated site is very remote (over 37Km). The site is also proposed in a different estuary to the proposed works further reducing the likelihood of any significant construction and operation effects. Via land, there is potential for a hydrological connection to the site where construction works are carried out within 400m of the Prittle Brook allowing possibility of sediment entering the watercourse. Depending on the direction of flow	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying feature; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SPA for the construction and operation phases of this option.

Habitats Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	d/North-western Europe) 2.6% of the population 5 year peak mean 1991/92-1995/96 • *Charadrius hiaticula* (Europe/Northern Africa - wintering) 1.3% of the population in Great Britain 5 year peak mean 1991/92-1995/96 • *Pluvialis squatarola* (Eastern Atlantic - wintering) 2.3% of the population 5 year peak mean 1991/92-1995/96 • An Internationally Important Assemblage of Birds. Over winter the area regularly supports: • 34789 waterfowl (5 year peak mean 1991/92-1995/96) Including: *Branta bernicla bernicla , Charadrius hiaticula , Pluvialis squatarola , Calidris canutus , Calidris alpina alpina*	of the watercourse, which is not known, it is possible that this could then discharge southward to the designated site over 3km away. However, it is not anticipated that this in itself would lead to adverse effects to site or qualifying species assuming that standard pollution control best practice measures are followed.	• Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	

7.3.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the Habitat Sites integrity during the construction and operation phases of this option:

- Benfleet and Southend Marshes Ramsar Site
- Benfleet and Southend Marshes SPA
- Crouch & Roach Estuaries Ramsar Site
- Crouch & Roach Estuaries SPA
- Essex Estuaries SAC
- Foulness Ramsar Site
- Outer Thames Estuary SPA

7.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

8 Lowestoft Water Reuse to Ellingham Mill (ESW-EFR-002A)

Option ID: (ESW-EFR-002A)

8.1 Option Description

This option proposes an Effluent Reuse Plant (11.1 Ml/d DO) with intake from Lowestoft/Corton WRC (Anglian Water owned asset) and a discharge point near Ellingham Mill. Three transfers required: Lowestoft/Corton WRC to new effluent reuse plant (Transfer 1, length approximately 200m), new effluent reuse plant to Ellingham Mill on the River Waveney (Transfer 2, length approximately 26.3km), and a transfer of treated water from Barsham to Holton (Transfer 3, length approximately 12.5km). (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

8.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified fourteen Designated Sites within the ZoI of this option of which seven were assessed as LSE: Broadland SPA and Ramsar Site, The Broads SAC, Southern North Sea SAC, Outer Thames Estuary SPA, and Breydon Water Ramsar Site and SPA. This screening review is summarised in Table 8.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Designated Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 8.1: Lowestoft Water Reuse to Ellingham Mill Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approx. 0.4km)	Minsmere-Walberswick SPA (UK9009101) (approx..4.8km)
Broadland Ramsar Site (UK11010) (approx. 0.4km)	Minsmere-Walberswick Ramsar Site (UK11044) (approx. 4.8km)
The Broads SAC (UK0013577) (approx. 0.4km)	Dew's Ponds SAC (UK0030133) (approx. 7km)
Southern North Sea SAC (UK0030395) (approx. 0.55km)	Minsmere to Walberswick Heaths & Marshes SAC (UK0012809 (approx. 7.5km)
Outer Thames Estuary SPA (UK9020309) (approx. 0.55km)	Benacre to Easton Bavents SPA (UK9009291) (approx. 7.5km)
Breydon Water Ramsar Site (UK11008) (approx. 3.5km)	Great Yarmouth North Denes SPA (UK9009271) (approx. 7.5km)
Breydon Water SPA (UK9009181) (approx. 3.5km)	Benacre to Easton Bavents Lagoons SAC (UK0013104) (approx. 8km)

Source: Mott MacDonald, 2022

8.3 Stage 2 Appropriate Assessment

8.3.1 Scope

The following Designated Sites were assessed at Stage 2 AA:

- Broadland SPA (UK9009253) (approx. 0.4km)
- Broadland Ramsar Site (UK11010) (approx. 0.4km)
- The Broads SAC (UK0013577) (approx. 0.4km)
- Southern North Sea SAC (UK0030395) (approx. 0.55km)
- Outer Thames Estuary SPA (UK9020309) (approx. 0.55km)
- Breydon Water Ramsar Site (UK11008) (approx. 3.5km)
- Breydon Water SPA (UK9009181) (approx. 3.5km)

8.3.2 Potential effects on Designated Sites

The potential effects of the construction and operation phases for the Lowestoft Water Reuse Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential impact on the integrity of the designated sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in addition to widely-used best practice measures, summarised within Table 8.2.

Due to the identical extent and significant overlap of qualifying features between two or more Designated Sites, potential effects on these Designated Sites are considered together.

8.3.2.1 Broadland SPA and Ramsar Site (approx. 0.4km)

Construction effects

This Ramsar Site/SPA is located approximately 0.4km from the option and the new pipeline crosses a number of small water bodies and dykes (such as the New Cut) which are connected to the River Yare and feeds into this Ramsar Site/SPA.

During the construction phase, effects due to disturbance to the qualifying habitat and species through noise, light, machinery movement, human presence and vibration are likely to be observed. Additionally, dust and airborne particles released during the works could have the potential to impact the qualifying features either directly through air pollution or indirectly by damaging functionally linked habitats. Furthermore, the works during the construction phase may result in surface run-off and sediment discharge which, if not managed correctly, may lead to pollution events and adverse effects on all qualifying features.

Changes in water quality due to pollution events may lead to changes in turbidity and increased sedimentation, which can compromise the life cycle of the qualifying species. Where the pipeline route crosses waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example. Potential for adverse effects on the Ramsar Site qualifying vegetation and invertebrate species may be observed as a direct result of physical habitat loss, habitat degradation and/ or fragmentation due to rapid population fluctuation related to direct mortality.

In relation to high mobile species, otters can occupy very large ranges (around 32km for males and 20km for females) and the habitats close to the scheme may be used as functionally linked to the Ramsar Site. Physical damage during construction as result of pollution events may include temporary habitat degradation and changes to habitat and prey availability. These effects can have a direct effect on birds feeding or roosting behaviours, increased energy

expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival and breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from the Ramsar Site/SPA.

Operation effects

No operation effects are anticipated for this option which could affect this designated site and/or its qualifying features.

8.3.2.2 The Broads SAC (approx. 0.4km)

Construction effects

This SAC is located approximately 0.4km from the option and the new pipeline crosses a number of small water bodies and dykes (such as the New Cut) which are connected to the River Yare and feeds into this SAC.

Given the geographical location and similar designations and qualifying features, the effects above described to the Broadland Ramsar Site are applicable to this SAC.

Operation effects

No operation effects are anticipated for this option which could affect this designated site and/or its qualifying features.

8.3.2.3 Southern North Sea SAC (approx. 0.55km)

Construction effects

This SAC is located approximately 0.55km from the option and the new pipeline crosses a number of small waterbodies and dykes (such as the New Cut) which are connected to the River Yare and feeds into this SAC.

As the construction works are to take place inland, noise, vibration and visual disturbances during the construction phase may affect harbour porpoise given the proximity of the option to the SAC. Machinery traffic and human presence are equally likely to adversely affect this species as disturbance may lead to rapid population fluctuation and/or habitat avoidance.

Changes in water quality due to pollution events as a result of construction may lead to changes in turbidity and increased sedimentation. The pipeline crossings have the potential to impact downstream water quality, siltation and/or hydrological regime, resulting in non-toxic contamination and, to this SAC, in coastal effects. These may lead to habitat degradation and effects of displacement (temporary or long-lasting) resulting in redistribution of harbour porpoise within this site.

Operation effects

No operation effects are anticipated for this option which could affect this designated site and/or its qualifying features.

8.3.2.4 Outer Thames Estuary SPA (approx. 0.55km)

Construction effects

This SPA is located approximately 0.55km from the option and the new pipeline crosses a number of small water bodies and dykes which eventually merge into the marine environment where this SPA is located.

This SPA is designated for supporting wintering and breeding bird species and during the construction phase, effects related to noise and light disturbances are likely to be observed. Additionally, this site qualifying birds may rely on the surrounding habitat for foraging, using it as functionally-connected habitat to support its populations. Along the pipeline area dust and airborne particles released during the works could have the potential to impact the functionally-connected habitat either directly through habitat loss/damage or indirectly by air (dust) /soil (spills) pollution. Physical damage during construction as result of pollution events may include temporary habitat degradation and changes to habitat availability and are likely to lead to habitat avoidance. Furthermore, given the hydrological connection, the works proposed may result in surface run-off and sediment discharge which, if not managed correctly, may lead to changes in turbidity and increased sedimentation. Downstream water quality may also be affected and changes in the hydrological regime, or effects related to toxic contamination may be observed. These effects may affect the life cycle of the designated bird species and are particularly applicable to breeding populations.

Operation effects

No operation effects are anticipated for this option which could affect this designated site and/or its qualifying features.

8.3.2.5 Breydon Water Ramsar Site and SPA (approx. 3.5km)

Construction effects

Breydon Water Ramsar Site/SPA is sufficiently distant from the proposed pipeline route (approximately 3.5km) and there are not reasonably foreseeable effects on the qualifying bird species within these sites due to noise, light or human disturbance during pipeline construction. However, Breydon Water Ramsar Site/SPA is hydrologically connected to the proposed pipeline route via the drainage network and tributaries of the River Yare. Construction of water course crossings has the potential to impact downstream water quality, siltation and/or hydrological regime, resulting in potential physical loss, degradation and/or fragmentation of habitats. There is also a potential for the loss or habitat damage due to toxic contamination as an indirect result of waterbodies crossing. Changes in water quality are likely to have adverse effects on the life cycle of the qualifying species and trigger habitat avoidance in high mobile species, such as birds. Pollution events and associated habitat degradation may lead to changes on habitat and prey availability, may resulting in the displacement (permanent or temporary) of species.

Operation effects

No operation effects are anticipated for this option which could affect this designated site and/or its qualifying features.

8.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 8.2: Lowestoft water reuse and transfer – Potential effects on designated qualifying features

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Broadland SPA (UK9009253) (approx. 0.4km)	ARTICLE 4.1 QUALIFICATION. During the breeding season the area regularly supports: • *Botaurus stellaris, Circus aeruginosus* Over winter the area regularly supports: • *Circus cyaneus* • *Cygnus columbianus bewickii* • *Cygnus cygnus* ARTICLE 4.2 QUALIFICATION. Over winter the area regularly supports: • *Anas strepera*	This SPA is designated for supporting bird species and is located approximately 0.4km south of the options footprint. It should be noted that within the wider area outside of this SPA other areas of habitat suitable for these bird species are considered to be intrinsically linked to the SPA. Therefore, impacts upon these habitat features can result in affecting the designated bird species. In case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example). In addition, due to the close proximity of the sites, it is likely for disturbance effects during the construction phase to occur (noise and light). As such, adverse effects are possible. As a result, adverse effects are determined and during construction, this option is likely to result in: • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust). • Disturbance on designated features (visual, noise, dust, etc.) leading to habitat avoidance and rapid population fluctuation, for example. During the operational phase, all changes will be below ground. It is possible that due to an	Standard best practice guidance should be followed which is outlined in section 3.4.4. Further mitigation measures include: • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying birds; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SPA for the construction and operation phases of this option. Further investigation on the use of functionally linked habitat by bird species is recommended to assess potential effects in more detail and determine more targeted mitigation measures.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the SPA from the discharge location it is not considered for effects to arise.	• A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	
Broadland Ramsar Site (UK11010) (approx. 0.4km)	Ramsar Site criterion 2: The site supports a number of rare species and habitats within the bio-geographical zone context, including the following Habitats Directive Annex I features: • H7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* Calcium-rich fen dominated by great fen sedge (saw sedge). • H7230 Alkaline fens Calcium-rich spring water fed fens. • H91E0 Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) Alder woodlands on floodplains, and the Annex II species • S1016 (*Vertigo moulinsiana)* Desmoulin's whorl snail • S1355 (*Lutra lutra)* Otter • S1903 (*Liparis loeselii*) Fen orchid	This Ramsar Site is designated for a variety of habitat features and mobile species such as otter and a protected snail species. The Ramsar Site is located approximately 0.4km south of the option footprint. It should be noted that within the wider area outside of this Ramsar Site other areas of habitat suitable for the designated mobile species are considered to be intrinsically linked to the Ramsar Site itself. Therefore, impacts upon these habitat features can result in affecting the designated features of the Ramsar Site. In case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example). In addition, due to the close proximity of the sites, it is likely for disturbance effects during the construction phase to occur (noise and light). As such, adverse effects are possible. As a result, adverse effects are determined and during construction, this option is likely to result in: • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust).	Standard best practice guidance should be followed which is outlined in section 3.4.4. Further mitigation measures include: • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying features; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Ramsar Site for the construction and operation phases of this option. Further investigation on the use of functionally linked habitat by otter and bird species is recommended to assess potential effects in more detail and determine more targeted mitigation measures. A detailed review of the baseline ecological data is also recommended to determine further effects on this Designated Site qualifying features and reduce uncertainty.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	The site supports outstanding assemblages of rare plants and invertebrates including the British Red Data Book plants and 136 British Red Data Book invertebrates. Ramsar Site criterion 6: Species / populations occurring at levels of international importance. Species with peak counts in winter: • Tundra swan, (*Cygnus columbianus bewickii*), NW Europe • Eurasian wigeon, (*Anas Penelope*), NW Europe • Gadwall, (*Anas strepera strepera)*, NW Europe • Northern shoveler, (*Anas clypeata*), NW & C Europe Species / populations identified subsequent to designation for possible future consideration under criterion 6: Species with peak counts in winter: • Pink-footed goose, (*Anser brachyrhynchus*), Greenland, Iceland / UK	• Disturbance on designated features (visual, noise, dust, etc.) leading to habitat avoidance and Biological disturbances (such as direct mortality, rapid population fluctuations, changes to habitat availability and natural succession). During the operational phase, all changes will be below ground. It is possible that due to an increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the Ramsar Site from the discharge location it is not considered for effects to arise.	for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	• Greylag goose, (*Anser anser*), Iceland / UK, Ireland			
The Broads SAC (UK0013577) (approx. 0.4km)	• 3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp • 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation • 7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* *Priority feature • 7140 Transition mires and quaking bogs • 7230 Alkaline fens • 91E0 Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) * Priority feature • 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) • 1016 Desmoulin's whorl snail (*Vertigo moulinsiana*) • 1903 Fen orchid (*Liparis loeselii*) • 4056 Ramshorn snail (*Anisus vorticulus*)	This SAC is designated for a variety of habitat features and mobile species such as otter and a protected snail species. The SAC is located approximately 0.4km south of the option footprint. It should be noted that within the wider area outside of this SAC other areas of habitat suitable for the designated mobile species are considered to be intrinsically linked to the SAC itself. Therefore, impacts upon these habitat features can result in affecting the designated features of the SAC. In case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example). In addition, due to the close proximity of the sites, it is likely for disturbance effects during the construction phase to occur (noise and light). As such, adverse effects are possible. As a result, adverse effects are determined and during construction, this option is likely to result in: • Toxic contamination - water quality degradation from potential pollutions events, air pollution. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust). • Disturbance on designated features (visual, noise, dust, etc.) leading to habitat avoidance and Biological disturbances (such as direct mortality, rapid population	Standard best practice guidance should be followed which is outlined in section 3.4.4. Further mitigation measures include: • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying feature; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the SAC for the construction and operation phases of this option. Further investigation on the use of functionally linked habitat by otter species is recommended to assess potential effects in more detail and determine more targeted mitigation measures.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	• 1355 Otter (*Lutra lutra*)	fluctuations, changes to habitat availability and natural succession). During the operational phase, all changes will be below ground. It is possible that due to an increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the SAC from the discharge location it is not considered for effects to arise.	• A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	
Southern North Sea SAC (UK0030395) (approx. 0.55km)	• Harbour porpoise (*Phocoena phocoena*)	This SAC is designated for harbour porpoise (a highly mobile species with a large marine territory). The SAC is located approximately 0.55km east of the option footprint. In case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example). In addition, due to the close proximity of the sites, it is likely for disturbance effects during the construction phase to occur (noise and light). As a result, adverse effects are determined in case of pollution events during construction phase, and are likely to result in: • Toxic contamination - water quality degradation from potential pollutions events. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust). • Biological Disturbance on designated features leading to habitat avoidance and rapid population fluctuation, for example.	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design.	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying bird; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the site for the construction or operation phase of this option.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		No adverse impacts are identified during operation.	• The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	
Outer Thames Estuary SPA (UK9020309) (approx. 0.55km)	ARTICLE 4.1 QUALIFICATION. Over winter the area regularly supports: • *Gavia stellata* (North-western Europe - wintering) - 38% of the population in Great Britain peak mean over the period1989-2006/07 The area supports breeding populations of: • *Sternula albifrons* (in breeding season) - 19.64%of GB population (2011 - 2015) • *Sterna hirundo* (in breeding season) - 2.66% of GB population (2011 - 2015)	This SPA is designated for a number of bird species and is located approximately 0.55km east of the options footprint. It should be noted that within the wider area outside of this SPA other areas of habitat suitable for these bird species are considered to be intrinsically linked to the SPA. Therefore, impacts upon these habitat features can result in affecting the designated bird species. In case of pipeline route crosses the waterbodies there is a potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination, for example). In addition, due to the close proximity of the sites, it is likely for disturbance effects during the construction phase to occur (noise and light). As such, adverse effects are possible. As a result, adverse effects are determined in case of pollution events during construction phase, and are likely to result in:	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated sites. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying features; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Site for the construction and operation phases of this option. Further investigation on the use of functionally linked habitat by bird species is recommended to assess potential effects in more detail and determine more targeted mitigation measures. A

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		• Toxic contamination - water quality degradation from potential pollutions events. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust). • Biological Disturbance on designated features leading to habitat avoidance and rapid population fluctuation, for example. During the operational phase, all changes will be below ground. It is possible that due to an increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the SPA from the discharge location it is not considered for effects to arise.	agreed with Natural England and, if possible, to be undertaken outside the wintering period (to protect the Red-throated diver). • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	detailed review of the baseline ecological data is also recommended to determine further effects on this Designated Site qualifying feature and reduce uncertainty.
Breydon Water Ramsar Site (UK11008) (approx. 3.5km)	Ramsar Site criterion 5: • Assemblages of international importance. Species with peak counts in winter: - 68175 waterfowl (5 year peak mean 1998/99-2002/2003)	This Ramsar Site is designated for a variety of bird species and is located approximately 3.5km north of the option footprint. It should be noted that (due to the highly mobile nature of the designated bird species) within the wider area outside of this Ramsar Site, other areas of habitat suitable for the designated bird species are considered to be intrinsically linked to the Ramsar Site. Therefore, impacts upon these	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	Ramsar Site criterion 6 - Species/populations occurring at levels of international importance. Species with peak counts in winter: • Tundra swan , (*Cygnus columbianus bewickii*), NW Europe • Northern lapwing , (*Vanellus vanellus*), Europe - breeding Species/populations identified subsequent to designation for possible future consideration under criterion 6. Species with peak counts in winter: • Pink-footed goose , (*Anser brachyrhynchus*), Greenland, Iceland/UK • Eurasian wigeon , (*Anas Penelope*), NW Europe • Northern shoveler , (*Anas clypeata*), NW & C Europe • European golden plover , (*Pluvialis apricaria apricaria)*, Iceland & Faroes/E Atlantic • Black-tailed godwit , (*Limosa islandica*), Iceland/W Europe	habitat features can result in affecting the designated bird species. The Ramsar Site is hydrologically connected to the works footprint by a main river. Where the pipeline route crosses the waterbodies there is potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination. The proposed works are considered too far away to result in dust generation effects and other disturbances such as noise and light. However, as this site supports Pink-footed goose and the surrounding area is likely to be represented by arable fields, it is possible to observe effects related to feeding areas availability for this species during winter. As a result, adverse effects are determined upon particular bird species and pollution events during construction only and are likely to result in: • Toxic contamination - water quality degradation from potential pollutions events. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust). • Biological Disturbance on designated features leading to habitat avoidance and rapid population fluctuation, for example. During the operational phase, all changes will be below ground. It is possible that due to an increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the Ramsar Site from the discharge location it is not considered that effects will arise.	downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the Ramsar Site for the construction or operation phase of this option.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Breydon Water SPA (UK9009181) (approx. 3.5km)	Article 4.1. During the breeding season the area regularly supports:● • *Sterna hiruno* Over winter the area regularly supports: • *Cygnus columbianus bewickii* • *Pluvialis apricaria* • *Recurvirostra avosetta* On passage the area regularly supports: • Philomachus pugnax Article 4.2. Over winter the area regularly supports: • *Vanellus vanellus* An Internationally Important Assemblage of Birds. Over winter the area regularly supports: • 43225 waterfowl (5 year peak mean 01/07/1999) Including: *Cygnus columbianus bewickii , Recurvirostra avosetta, Pluvialis apricaria , Vanellus vanellus.*	This SPA is designated for a variety of bird species and is located approximately 3.5km north of the option footprint. It should be noted that (due to the highly mobile nature of the designated bird species) within the wider area outside of this SPA, other areas of habitat suitable for the designated bird species are considered to be intrinsically linked to the SPA. Therefore, impacts upon these habitat features can result in affecting the designated bird species. The SPA is hydrologically connected to the works footprint by a main river. Where the pipeline route crosses the waterbodies there is potential to affect downstream water quality, siltation and/or hydrological regime, or result in toxic contamination. The proposed works are considered too far away to result in dust generation effects and other disturbances such as noise and light. However, as this site supports a variety of bird species and the surrounding area is likely to be represented by arable fields, it is possible to observe effects related to feeding areas availability for some of these species during winter. As a result, adverse effects are determined upon particular bird species and pollution events during construction only and are likely to result in: • Toxic contamination - water quality degradation from potential pollutions events. • Non-toxic contamination - changes in turbidity' changes in sedimentation/silting, air pollution (dust).	Standard best practice guidance should be followed which is outlined in section 3.4.4. Further mitigation measures include: • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Avoid in-channel works but using alternative methods such as direction drilling. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works including silt screening around the area of works to limit the movement and redeposition of material. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	Assuming all proposed mitigation is implemented it is considered there will not be a significant change in: • The extent and distribution of qualifying species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place this option is not expected to have an adverse effect on the integrity of the site for the construction or operation phase of this option.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
		• Biological Disturbance on designated features leading to habitat avoidance and rapid population fluctuation, for example. During the operational phase, all changes will be below ground. It is possible that due to an increase in the amount of effluent discharged at Ellingham Mill, there may be localised impacts on water quality. However, due to the distance of the Ramsar Site from the discharge location it is not considered that effects will arise.		

8.3.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the Habitat Sites integrity and/or its qualifying features alone during the construction phase of this option (no effects are anticipated during the operation phase of this option):

- Southern North Sea SAC
- Breydon Water Ramsar Site
- Breydon Water SPA

For the remaining sites scoped no adverse effects (from this option alone) are anticipated during operation phase. However, further investigation on the use of functionally linked habitat by these sites qualifying otter / bird species is recommended to assess to further inform mitigation measures. These sites are:

- The Broads SAC (in relation to otter populations only);
- Broadland Ramsar Site (in relation to otter and bird populations);
- Broadland SPA (in relation to bird populations);
- Outer Thames Estuary SPA (in relation to bird populations).

8.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

9 Effluent Reuse at Caister and Transfer to Ormesby (03b0478B)

Option ID: (03b0478B)

9.1 Option Description

This option proposes an effluent reuse treatment within the existing site footprint at Caister to Ormesby (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

9.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified The Broads SAC, Broadland SPA and Ramsar Site as sites with potential for LSE within the ZoI of this option. In light of the new design the distances were amended but this screening review has not changed the overall ToLS assessment and the summary of Designated Sites progressed to Stage 2 AA is shown in Table 9.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Designated Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 9.1: Effluent Reuse at Caister and Transfer to Ormesby Option Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
The Broads SAC (UK0013577) (approx. 0.2km)	Great Yarmouth North Denes SPA (UK9009271) (approx. 0.8m)
Broadland SPA (UK9009253) (approx. 0.6km)	Southern North Sea SAC (UK0030395) (approx. 1km)
Broadland Ramsar Site (UK11010) (approx. 0.6km)	Outer Thames Estuary SPA (UK9020309) (approx. 1km)
	Greater Wash SPA (UK9020329) (approx. 1.2km)
	Breydon Water Ramsar Site (UK11008) (approx. 1.8km)
	Breydon Water SPA (UK9009181) (approx. 1.8km)
	Winterton-Horsey Dunes SAC (UK0013043) (approx. 4km)

Source: Mott MacDonald, 2022

9.3 Stage 2 Appropriate Assessment

9.3.1 Scope

The following Designated Sites were assessed at Stage 2 AA:

- The Broads SAC (UK0013577) (0.2km)

- Broadland SPA (UK9009253) (0.6km)
- Broadland Ramsar Site (UK11010) (0.6km)

9.3.2 Potential effects on Designated Sites

The potential effects of the construction and operation phases for the Caister Water Reuse and Transfer Option are described below, taking into account the type, size and scale of the option.

An assessment of each potential impact on the integrity of the designated sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in addition to widely-used best practice measures, summarised within Table 9.2.

Due to the identical extent and significant overlap of qualifying features between the Broadland SPA and Ramsar Site, potential effects on these two Designated Sites are considered together.

9.3.2.1 The Broads SAC (approx. 0.2km)

Construction effects

This option is likely to affect this site as the proposed option footprint is located at 200m of the designated site boundary. This site is not direct hydrologically connected to the proposed pipeline route therefore, potential pollution effects related to hydrological connections are dismissed.

This SAC is designated for supporting a variety of species, such as plants and invertebrates, in addition to highly mobile species such as otter. This SAC comprises a series of fragments of complex habitats (formed by inland water bodies, water fringed vegetation - dry and humid grassland, and deciduous woodland). Given the proximity to the option footprint (<200m) and the fact that the option footprint is surrounded by The Broads SAC fragments, the habitats close to the scheme may be used as functionally-connected habitats supporting its qualifying features (Otter populations, for example, as high mobile species, can occupy very large ranges of habitat, reaching around 32km for males and 20km for females).

This site qualifying habitats (including functionally linked habitats) are likely to be directly damaged and/or degraded by the construction of the new pipeline due to physical habitat loss, degradation and/ or fragmentation (in particular around Ormesby area). Disturbances to qualifying habitats, plants and invertebrate species within this SAC may occur due to light pollution, air pollution (dust), soil pollution (spills), vehicular and human movements. These impacts may lead to habitat degradation and biological disturbances (including rapid population fluctuation, direct mortality, changes in natural succession and habitat avoidance).

Effects on this site, as well as on functionally linked habitats related to human presence, noise and vibration are likely to affect this site qualifying otter species and may lead to rapid population fluctuation due to habitat avoidance.

Dust and airborne particles released during the works could have the potential to impact the qualifying features either directly through air pollution or indirectly by damaging supporting habitats. Pollution related to construction and machinery movement may lead to toxic pollution (air (dust) /soil (spills)), further reducing habitat availability, quality, as well as prey availability (for invertebrates and otter species). The introduction and/or spread of invasive species due to machinery movement may also occur. Invasive species presence can potentially increase the pressure on plant and invertebrate populations due to competition for space and resources, eventually compromising this site qualifying populations. These effects may be observed along the pipeline route within this site boundaries as well as within functionally linked habitats.

Construction effects are of short duration but may lead to temporary and permanent effects. Depending on the magnitude of the adverse effect and on the group affected, this option may result in species displacement from this site (all qualifying species) and/or functionally linked habitats (otter).

Operation effects

No operation effects are anticipated for this option which could affect these designated sites and/or its qualifying features.

9.3.2.2 Broadland SPA and Ramsar Site (approx. 0.6km)

Broadland SPA and Ramsar Site have identical geographical extent, therefore, potential effects on these sites are considered together.

Both sites will also overlap in extent to The Broads SAC. Therefore, as mentioned above, no considerations for potential hydrological pollution effects were made.

Broadland Ramsar Site supports a number of unique habitats, rare plant / invertebrate species and highly mobile species such as otter and birds. Broadland SPA supports a large number of birds assemblage.

Construction effects

Broadland SPA and Ramsar Site are located approximately at 600m from the option footprint.

During the construction phase of this option, it is likely that effects due to disturbance to the qualifying mobile species of these sites through means of noise, vibration and visual disturbance may occur due to the proximity of the option footprint.

No direct effects related to dust, light and machinery disturbances are anticipated on non-mobile/low-mobile species (plants and invertebrates) due to the distance between these sites and the option. However, effects related to air pollution, noise and light disturbances due to the construction of the option components may lead to habitat degradation and associated biological disturbances on functionally linked habitats affecting this site qualifying features.

When supporting mobile species, such as birds, activities during construction could result in permanent and temporary habitat loss of the Habitat in functionally linked land used by qualifying species. Therefore, the considerations made above for The Broads SAC to otter populations can be extended for this SPA and Ramsar Site qualifying birds.

Bird populations are likely to be disturbed by noise, human presence, machinery and vehicular movement during construction. Disturbance effects can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Furthermore, habitat loss and damage can reflect on the reduction of habitat and prey availability. Disturbance to birds when foraging may jeopardise adult fitness, survival and breeding success by displacing populations from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution of the species within or from a site.

Operation effects

No operation effects are anticipated for this option which could affect these designated sites and/or its qualifying features.

9.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

Table 9.2: Caister water reuse and transfer – Potential effects on designated qualifying features

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
The Broads SAC (UK0013577) (approx. 0.2km)	• 3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp • 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation. • 7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* * Priority feature • 7140 Transition mires and quaking bogs • 7230 Alkaline fens • 91E0 Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) * Priority feature • 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) • 1016 Desmoulin`s whorl snail (*Vertigo moulinsiana*) • 1903 Fen orchid (*Liparis loeselii*) • 4056 Ramshorn snail (*Anisus vorticulus*) • 1355 Otter (*Lutra lutra*)	This option is likely to affect this site as the proposed option footprint is in proximity to the designated site boundary (< 0.2km). The option is not hydrologically connected to this site, therefore pathways for potential hydrological pollution are excluded. All qualifying features are likely to be affected directly or indirectly by this option during construction phase and may result in permanent and temporary effects . on this site and its qualifying features. Construction impacts are considered localized and of short duration. During construction this option is likely to result in: • Physical damage – Edge effects • Non-physical disturbance – dust, noise and light disturbance, human presence and traffic disturbance; vibration. • Toxic and non-toxic contamination – Air (dust) and soil pollution (spills) leading to habitat degradation. • Biological disturbances – spread of invasive species due to machinery movement; rapid population fluctuation through: – direct mortality (non-mobile/low-mobile species) of rare plant and invertebrate species may lead to changes in natural succession; – habitat avoidance (mobile species) of otter due to disturbances and changes in habitat and prey availability; . No adverse effects are identified during operation.	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Avoid construction within Designated site. • Works in the vicinity of this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitat and species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place, this option is not expected to have adverse effects on the overall Designated Site integrity. However, during construction phase (only), low and localized adverse effects may still be possible in relation to its otter population distribution. Further investigation on the use of functionally linked habitat by otter is recommended to assess potential effects in more detail and determine more targeted mitigation measures.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Broadland SPA (UK9009253) (approx. 0.6km)	ARTICLE 4.1. During the breeding season the area regularly supports: • *Botaurus stellaris, Circus aeruginosus* • Over winter the area regularly supports: • *Circus cyaneus, Cygnus columbianus bewickii, Cygnus cygnus* ARTICLE 4.2. Over winter the area regularly supports: • *Anas strepera*	This option is likely to affect this site as the proposed option footprint is in proximity to the designated site boundary (< 0.6km). The option is not hydrologically connected to this site, therefore pathways for potential hydrological pollution are excluded. All qualifying features are likely to be affected directly or indirectly by this option during construction phase. Construction impacts are considered localized and of short duration but may result in permanent and temporary effects on these qualifying bird populations. At this stage the following effects are anticipated: • During construction this option is likely to result in: • Physical loss and/or damage on functionally linked habitat • Non-physical disturbance –noise and light, human presence and traffic disturbances on functionally linked habitat. • Toxic and non-toxic contamination – Air (dust) and soil pollution (spills) leading to habitat degradation on functionally linked habitat. • Biological disturbances – spread of invasive species due to machinery movement; rapid population fluctuation through: – habitat avoidance due to disturbances and changes in habitat and prey availability; . No adverse effects are identified during operation.	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying birds; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place, this option is not expected to have adverse effects on the overall Designated Site integrity. However, during construction phase (only) and in relation to bird populations, low and localized effects may still be possible. Further investigation on the use of functionally linked habitat by bird species is recommended to assess potential effects in more detail and determine more targeted mitigation measures. A detailed review of the baseline ecological data is also recommended to determine further effects on this Designated Site qualifying feature and reduce uncertainty.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
Broadland Ramsar Site (UK11010) (approx. 0.6km)	Ramsar Site criterion 2: • The site supports a number of rare species and habitats within the bio-geographical zone context, including the following Habitats Directive Annex I features: • H7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* • Calcium-rich fen dominated by great fen sedge (saw sedge). • H7230 Alkaline fens Calcium-rich spring water fed fens. • H91E0 Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) Alder woodland on floodplains, • and the Annex II species • S1016 (*Vertigo moulinsiana)* Desmoulin`s whorl snail • S1355 (*Lutra lutra*) Otter • S1903 (*Liparis loeselii*) Fen orchid. The site supports outstanding assemblages of rare plants and invertebrates including	This option is likely to adversely affect this site mobile species (birds and otter populations) as the construction footprint may represent a functionally linked habitat for supporting their populations. No direct effects are anticipated from construction of the new structures (such as dust and light pollution) within this site boundaries that could affect its qualifying habitats, plants and invertebrate species. However, indirect effects related to air pollution leading to habitat degradation along the pipeline route needs to be considered. There is no hydrological connection between this site and the proposed option, therefore pathways for potential hydrological pollution are excluded. Qualifying birds and otter populations are likely to be affected directly or indirectly by this option during construction phase which may result in permanent and temporary displacement effects. Construction impacts are considered localized and of short duration. During construction this option is likely to result in: • Physical loss/damage on functionally linked habitat – loss of supporting habitat for mobile species (temporary and permanent) resulting from pipeline construction. • Non-physical disturbance– noise and light, human presence and traffic disturbances on functionally linked habitat. • Toxic and non-toxic contamination on functionally linked habitat reducing habitat and prey availability – Air (dust) and soil	Standard best practice guidance should be followed which is outlined in section 3.4.4. • Consideration to critical seasonal period for bird species must be given (winter and breeding seasons). • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Consideration of the relevant conservation objective targets for the Designated Site and the site-specific qualitative and quantitative thresholds at the time of the project-level design. • The application of recommendations, regardless of economic considerations, from consultation with the relevant non-departmental public bodies (responsible for nature conservation and the environment) and the competent authority. • A post-construction habitats restoration plan to restore/rehabilitate the habitats within a Designated Site or functionally linked land that were temporarily lost or damaged during construction.	No adverse effects on the integrity of the site are expected that could affect: • The extent and distribution of qualifying habitats and species; • The structure and function of the habitats of qualifying species; and • The supporting processes on which habitats of qualifying species rely. Consequently, with appropriate mitigation measures in place, this option is not expected to have adverse effects on the overall Designated Site integrity. However, during construction phase (only) and in relation to otter and bird populations, low and localized effects may still be possible. Further investigation on the use of functionally linked habitat by otter and bird species is recommended to assess potential effects in more detail and determine more targeted mitigation measures.

Designated Sites	Qualifying Features	Potential adverse effects on integrity before mitigation	Proposed Mitigation Measures	Potential adverse effects on integrity after mitigation
	nine British Red Data Book plants and 136 British Red Data Book invertebrates. Ramsar Site criterion 6: Species/populations occurring at levels of international importance. Species with peak counts in winter: • Tundra swan, (*Cygnus columbianus bewickii)*, NW Europe • Eurasian wigeon, (*Anas Penelope*), NW Europe • Gadwall, (*Anas strepera strepera*), NW Europe • Northern shoveler, (*Anas clypeata*), NW & C Europe • Species/populations identified subsequent to designation for possible future consideration under criterion 6. • Species with peak counts in winter: • Pink-footed goose, (*Anser brachyrhynchus*), Greenland, Iceland/UK • Greylag goose, (*Anser anser*), Iceland/UK, Ireland •	pollution (spills) leading to habitat degradation along the pipeline route. • Biological disturbances – spread of invasive species due to machinery movement along the pipeline route; rapid bird and otter population fluctuation through: – habitat avoidance due to disturbances and changes in habitat and prey availability; . No adverse effects are identified during operation.		

9.3.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the overall Habitats Sites integrity and/or its qualifying features alone during the construction phase of this option. However, further investigation on the use of functionally linked habitat by qualifying birds (Broadland SPA and Ramsar Site) and otter species (The Broads SAC and Broadland Ramsar Site) is recommended to assess potential construction effects in more detail and determine more targeted mitigation measures.

9.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

10 Canvey Island Desalination Terrestrial (ESW-DES-001)

Option ID: (ESW-DES-001)

10.1 Option Description

The option proposes a new seawater desalination plant at Canvey Island with an abstraction from the Thames Estuary and a discharge to Hanningfield Service Reservoir. The intake / outfall will be via a pier (See Table 2.1 for full option description). Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

10.2 Stage 1 Screening – Review

The Stage 1 Screening carried out in 2022 identified twelve Habitats Sites within the ZoI of this option, with all assessed as having potential for LSE. This screening review has not changed the overall ToLS assessment and the summary of Habitats Sites progressed to Stage 2 AA is shown in Table 10.1.

This option has proceeded to the next HRA stage – AA. The full HRA Screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 10.1: Canvey Island Desalination Terrestrial Stage 1 screening results reviewed

Potential for Significant Effects	No Likely Significant Effects
Benfleet and Southend Marshes Ramsar Site (UK11006) (approx. 0.6m east)	None
Benfleet and Southend Marshes (SPA) (UK9009171) (approx. 0.6km east)	
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site (UK UK11058) (approx. 1.5km east)	
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA (UK9009244) (approx. 1.5km east)	
Essex Estuaries SAC (UK0013690) (approx. 1.5km east)	
Thames Estuary & Marshes SPA (UK9012021) (approx. 1.3km south)	
Thames Estuary and Marshes Ramsar Site (UK11069) (approx. 1.3km south)	
Outer Thames Estuary SPA (UK9020309) (approx. 8km east)	
Medway Estuary & Marshes Ramsar Site (UK11040) (approx. 8km south-east)	

Potential for Significant Effects	No Likely Significant Effects
Medway Estuary & Marshes SPA (UK9012031) (approx. 8km south-east)	
Foulness (Mid-Essex Coast Phase 5) Ramsar Site (UK11026) (approx. 14km east)	
Foulness (Mid-Essex Coast Phase 5) SPA (UK9009246) (approx. 14km east)	

10.3 Stage 2 Appropriate Assessment

10.3.1 Scope

The following Habitats Sites were assessed at Stage 2 AA:

- Benfleet and Southend Marshes Ramsar Site (UK11006) (approx. 0.6km east)
- Benfleet and Southend Marshes (SPA)(UK9009171) (approx. 0.6km east)
- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site (UK UK11058) (approx. 1.5km east)
- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA (UK9009244) (approx. 1.5km east)
- Essex Estuaries SAC (UK0013690) (approx. 1.5km east)
- Thames Estuary & Marshes SPA (UK9012021) (approx. 1.3km south)
- Thames Estuary and Marshes Ramsar Site (UK11069) (approx. 1.3km south)
- Outer Thames Estuary SPA (UK9020309) (approx. 8km east)
- Medway Estuary & Marshes SPA (UK9012031) (approx. 8km south-east)
- Medway Estuary & Marshes Ramsar Site (UK11040) (approx. 8km south-east)
- Foulness (Mid-Essex Coast Phase 5) SPA (UK9009246) (approx. 14km east)
- Foulness (Mid-Essex Coast Phase 5) Ramsar Site (UK11026) (approx. 14km east)

10.3.2 Potential effects on Habitats Sites

The potential effects of the construction and operation phases for Canvey Island Desalination Terrestrial are described below, taking into account the type, size and scale of the option. An assessment of each potential impact on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in addition to widely used best practice measures, summarised within Table 10.2.

10.3.2.1 Benfleet and Southend Marshes SPA and Ramsar Site (approx. 0.8km east/2.3km downstream at the closest point)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

The option footprint is hydrologically connected to the Habitats Sites through two separate surface water pathways. Firstly, the construction of the new pier and intake/outfall location is approximately 3.7km upstream of the Habitats Sites at the closest point. Further to the north, the pipeline alignment crosses the East Haven Creek, which is approximately 2.3km front the

sites' boundaries through the surface water. It is possible that pollution events, including additional sedimentation, during construction will affect these sites, damaging or degrading the saltmarsh and mudflat habitats which support the qualifying features. This may subsequently result in displacement of qualifying bird species, resulting to changes in distribution within or outside of the sites.

The construction of the proposed desalination plant may result in adverse disturbance effects during construction at this location. The location is in sub-optimal grassland habitat for most of the qualifying features and adjacent to built-up residential and industrial areas. However, in the absence of management information for the grassland, it cannot be ruled out as functionally connected foraging habitat for dark-bellied brent goose (*Branta bernicla bernicla*). Construction within, and adjacent to, this suitable habitat may result in indirect effects on the integrity of the sites, through disturbance; noise, visual disturbance and artificial light are all sources of disturbance which could impact upon qualifying features. Disturbing effects can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, and desertion of supporting habitat. Disturbance to qualifying bird species of the SPA and Ramsar Site when foraging may jeopardise adult fitness, survival and future breeding success by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Although there is some potential suitable mudflat habitat adjacent to the works area, this a thin strip adjacent to regularly disturbed areas and is not considered to be functionally connected habitat to the sites which would support a significant proportion of the population.

There is also suitable habitat to the north-west of the plant which may be directly impacted by construction of the pipeline. This area is approximately 0.8km west of the sites' boundaries, but extensive areas of floodplain and coastal grazing marsh is considered to be functionally connected optimal habitat, and as such, may support significant populations of qualifying features when foraging. Considering the extent of the habitat in this area, and the temporary nature of the pipeline construction, reductions in available habitat are not expected to have a significant effect on overall habitat availability. Furthermore, it is anticipated that the East Haven Creek will be crossed using directional drilling to reduce watercourse impacts; this is an intrinsic component of the option and therefore does not constitute additional mitigation for these sites. It is assumed that this method will also avoid direct impacts to the saltmarsh and mudflat habitat within the creek. Construction within, and adjacent to, these suitable habitats may result in indirect effects to the integrity of the sites, through disturbance of qualifying features.

Due to the distance between this option and these sites (0.8km at the closest point), no other impact pathways are present during construction.

Operation effects

There is potential for adverse effects on the sites' integrity during operation. Brine discharge from the outfall may affect hydrological processes, water quality and temperature. It is currently unknown how localised these effects will be and how they may change the ecosystem dynamics. As such, any changes in turbidity, salinity and temperature, and subsequent effects to aquatic invertebrates (prey availability for qualifying features) may adversely affect the integrity of the sites. It may also result in damage and/or degradation to habitats within the site which support roosting qualifying bird species.

It is unknown if the desalination plant will include appropriate measures to reduce the discharge of heavy metals such as copper. It is therefore possible that discharge from the outfall results in alterations to the water chemistry, which could also result in degradation of habitats which support the sites' qualifying features.

10.3.2.2 Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA and Ramsar Site (approx. 1.9km east/2.2km downstream)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

This option is hydrologically connected to the Habitats Sites via the River Crouch. The pipeline alignment bisects this watercourse to the west of the A130, immediately east of Wickford, which is approximately 2.2km upstream of the sites' boundaries. Although it is anticipated that the river will be crossed using directional drilling (an intrinsic component of the option) it is still possible that pollution events, including additional sedimentation, during construction are transferred to within the sites, damaging or degrading the floodplain grazing marsh, saltmarsh and mudflat habitats which support the qualifying features. This may subsequently result in the loss of rare plant species (a component of Ramsar Site criterion 2), or displacement of qualifying invertebrate and bird species, resulting to changes in distribution within or outside of the sites.

Due to the distance of these sites from the option footprint (1.9km in a straight line), no other impact pathways are present during construction. Although qualifying bird species are highly mobile, the habitats immediately surrounding the option footprint are predominantly sub-optimal for these species (including dark-bellied brent goose) and therefore disturbance effects from visual stimuli, noise and vibration are not anticipated to affect the integrity of the sites.

Operation effects

Due to the distance between the intake / outfall pier and this site (12km at the closest point), and no direct hydrological connectivity between the two, no impact pathways are present during operation.

10.3.2.3 Essex Estuaries SAC (approx. 1.3km east/2.2km downstream)

Construction effects

This option is hydrologically connected to the Habitats Sites via the River Crouch. The pipeline alignment bisects this watercourse to the west of the A130, immediately east of Wickford, which is approximately 2.2km upstream of the site boundary. This site boundary overlaps with the Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA and Ramsar Site, and so the impact pathways from this location are the same as those mentioned in the relevant section above. There is therefore potential for pollution events, including additional sedimentation, during construction to transferred to within the site, damaging or degrading the qualifying Annex I habitats.

Additional hydrological connectivity is present downstream of the River Thames, although at this distance (14km), any pollution events during construction are not anticipated to affect site integrity. Due to the tidal nature of the estuary and the greater dilution potential of the North Sea at its mouth, any pollution events which may occur are anticipated to be reduced to insignificance on the Habitats Sites and their qualifying features.

Due to the distance of these sites from the option footprint (no other impact pathways are present during construction.

Operation effects

Although there is hydrological connectivity between this option and the Habitats Site, the distance downstream on the River Thames (14km) is considered to be sufficient that adverse effects on integrity from changes in hydrological processes during operation are unlikely. Operational effects from brine outfall; changes to turbidity, salinity and temperature are

anticipated to be localised and will not affect qualifying Annex I habitats at this distance. There are no other pathways for operational effects on the SAC.

10.3.2.4 Thames Estuary & Marshes SPA and Ramsar Site (approx. 1.3km south)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

The option footprint is hydrologically connected to the Habitats Sites through the River Thames, with the sites on the south bank. It is possible that pollution events, including additional sedimentation, during construction are transferred to within the sites, damaging or degrading the saltmarsh and mudflat habitats which support the qualifying features. This may subsequently result in the loss of rare plant species (a component of Ramsar Site criterion 2), or displacement of qualifying invertebrate and bird species, resulting in changes in distribution within or outside of the sites.

Due to the distance between the proposed desalination plant (and intake/outfall pier) and the sites' boundaries, there are not anticipated to be any adverse disturbance effects during construction at this location. None of the qualifying features forage within the channel of the River Thames, so are anticipated to be no closer to the construction area than 1.3km, on the south bank of the river. At this distance, the additional stimuli (noise, vibration and visual) from construction of the intake/outfall pier in the River Thames is not anticipated to have additional adverse effects over and above baseline levels of disturbance in an already highly developed area. Although there is some potential suitable mudflat habitat adjacent to the works area, this a thin strip adjacent to regularly disturbed areas and is not considered to be functionally connected habitat to the sites which would support a significant proportion of the population.

Operation effects

There is potential for adverse effects on the sites' integrity during operation. Brine discharge from the outfall may affect hydrological processes, and it is currently unknown how localised these effects will be and how they may change the ecosystem dynamics. As such, any changes in turbidity, salinity and temperature, and subsequent knock-on effects to aquatic invertebrates (prey availability for qualifying features) may adversely affect the integrity of the sites. It may also result in damage and/or degradation to qualifying scarce plants (Ramsar Site criterion 2) and habitats within the site which support roosting qualifying bird species.

It is unknown if the desalination plant will include appropriate measures to reduce the discharge of heavy metals such as copper. It is therefore possible that discharge from the outfall results in alterations to the water chemistry, which could also result in degradation of habitats which support the sites' qualifying features.

10.3.2.5 Outer Thames Estuary SPA (approx. 8km east)

Construction effects

The option footprint is hydrologically connected to the Habitats Site through the River Thames, approximately 8km downstream. It is possible that pollution events, including additional sedimentation, during construction are transferred to within the site, damaging or degrading the habitats which support the qualifying features' foraging grounds. This may subsequently result in displacement of qualifying bird species, resulting in changes to distribution within or outside of the site.

Due to the distance of this site from the option footprint (8km), no other impact pathways are present during construction. Although common tern (*Sterna hirundo*) may forage within the Thames estuary and therefore encroach into visual line of sight of construction works, it is not

anticipated that any disturbance will have an adverse effect on the population associated with the SPA.

Operation effects

There is potential for adverse effects on the sites' integrity during operation. Brine discharge from the outfall may affect hydrological processes, and it is currently unknown how localised these effects will be and how they may change the ecosystem dynamics. As such, any changes in turbidity, salinity and temperature, and subsequent knock-on effects to fish (prey availability for qualifying features) may adversely affect the integrity of the site. It may also result in damage and/or degradation to habitats within the site which support foraging qualifying bird species.

It is unknown if the desalination plant will include appropriate measures to reduce the discharge of heavy metals such as copper. It is therefore possible that discharge from the outfall results in alterations to the water chemistry, which could also result in degradation of habitats and prey availability which support the sites' qualifying features.

10.3.2.6 Medway Estuary & Marshes SPA and Ramsar Site (approx. 8km south-east/16km downstream)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

Although there is hydrological connectivity between this option and these Habitats Sites, the distance downstream is considered to be sufficient that significant effects from pollution events during construction are unlikely. This site is over 16km from this option via the River Thames and Medway Estuary, but due to the tidal nature of the estuaries and the greater dilution potential of the North Sea at their mouth, any pollution events which may occur are anticipated to be reduced to insignificance on the Habitats Sites and their qualifying features; scarce plants, invertebrates, and breeding and overwintering birds are unlikely to be affected.

Due to the distance between these sites and the option, no other impact pathways are present during construction. Although common tern may forage within the Thames estuary, as functionally connected habitat, and therefore encroach into visual line of sight of construction works, it is not anticipated that any disturbance effects will have an adverse effect on the SPA population. The potentially affected foraging area of the estuary is so small that it is unlikely that disturbance to individuals during construction will result in displacement from the site.

Operation effects

Operational effects from brine outfall are likely to be diluted by tidal nature of the estuary and the North Sea at its mouth; changes to hydrological processes, including turbidity, salinity and temperature are not anticipated to be significant 16km downstream and will not affect habitats or prey availability which support qualifying features of the Habitats Sites.

It is unknown if the desalination plant will include appropriate measures to reduce the discharge of heavy metals such as copper, but the sites are sufficiently distant that alterations to the water chemistry will not result in degradation of habitats and prey availability which support the sites' qualifying features.

It is not considered that the integrity of these sites will be affected by this option, and therefore no mitigation is required. As such, these sites are not included within Table 10.2.

10.3.2.7 Foulness (Mid-Essex Coast Phase 5) SPA and Ramsar Site (approx. 14km east)

Due to the identical extent and significant overlap of qualifying features between the two Habitats Sites, potential effects on these sites are considered together.

Construction effects

Although there is hydrological connectivity between this option and these Habitats Sites, the distance downstream is considered to be sufficient that significant effects from pollution events during construction are unlikely. This site is over 14km downstream from this option via the River Thames, but due to the tidal nature of the estuary and the greater dilution potential of the North Sea at its mouth, any pollution events which may occur are anticipated to be reduced to insignificance on the Habitats Sites and their qualifying features; coastal saltmarsh (Ramsar Site criteria 1 and 3), scarce plants, invertebrates, and breeding and overwintering birds are unlikely to be affected.

Additional hydrological connectivity exists through the River Crouch. The Habitats Sites are downstream of the option where the pipeline crosses the river, however this is over 24km. At this distance, any pollution events during construction are not anticipated to have a significant effect due to dilution through the river and estuary.

Due to the distance between these sites and this option, no other impact pathways are present during construction.

Operation effects

Operational effects from brine outfall are likely to be diluted by tidal nature of the estuary and the North Sea at its mouth; changes to hydrological processes, including turbidity, salinity and temperature are not anticipated to be significant 14km downstream and will not affect qualifying habitats, or habitats and prey availability which support qualifying features of the Habitats Sites.

It is unknown if the desalination plant will include appropriate measures to reduce the discharge of heavy metals such as copper, but the sites are sufficiently distant that alterations to the water chemistry will not result in degradation of qualifying habitats, or habitats and prey availability which support the sites' qualifying features.

It is not considered that the integrity of these sites will be affected by this option, and therefore no mitigation is required. As such, these sites are not included within Table 10.2.

10.3.3 Assumptions and mitigation measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to mitigate adverse effects on site integrity.

It is assumed that significant proportions of qualifying features use functionally connected habitats outside of the Habitats Site boundaries, if these habitats are considered to be optimal for foraging. Therefore, without information to the contrary, the integrity of these features (and their corresponding sites) will be compromised in the absence of mitigation.

In the absence of detailed ecological information and distribution mapping for the qualifying features of all Habitats Sites, it is assumed that all features of a site are present throughout that site's extent. This represents a precautionary approach and may overestimate the impact pathways present. The provision of detailed survey information and/or biological records for the Habitats Sites is recommended for future assessments to determine qualifying features which may be affected by this option with greater precision.

The proposed standard mitigation measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible. They are not listed hereafter as mitigation required to alleviate adverse effects on Habitats Sites' integrity but are included in full within Section 3.4.4.

Table 10.2: Canvey Island Desalination Terrestrial - Potential effects on Habitats Sites

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
Benfleet and Southend Marshes SPA & Ramsar Site (approx. 0.6km east)	• All	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction and operation phases: • Toxic contamination – pollution of the River Thames and East Haven Creek during construction which could be transferred to within the Habitats Sites' boundaries and damage/degrade habitats which support qualifying features; • Toxic contamination – pollution of the River Thames through changes in water chemistry, associated with heavy metal concentrations within discharge during operation, transferred downstream into the sites; • Non-toxic contamination – increased turbidity and/or sedimentation within the River Thames and East Haven Creek during construction which could be transferred to within the Habitats Sites and damage/degrade habitats which support qualifying features; • Non-toxic contamination – changes is sedimentation, turbidity, salinity and temperature associated with brine discharge into the River Thames during operation, transferred downstream into the sites. • Physical loss/damage – significant localised habitat degradation during construction and operation, leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances – changes to habitat availability during construction and operation; habitat avoidance and rapid population fluctuation upon qualifying features of the sites.	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling will be implemented (intrinsically) where the pipeline alignment crosses the East Haven Creek to reduce adverse effects on the surface watercourse and adjacent and downstream habitats (mudflats, coastal saltmarsh); • Engineering control measures incorporated into the desalination plant to separate heavy metals from the discharge and avoid release into the water environment; and, • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction. Toxic contamination during operation will be reduced through the control measures within the desalination plant, but the effects of brine discharge on hydrological processes cannot be ruled out in the absence of further information. As such, no mitigation is proposed to alleviate this effect.	There will be no adverse effects on the integrity of these sites during construction, provided the proposed mitigation is implemented. However, residual effects remain during the operation phase at this stage. Additional information is required to determine the effects of brine discharge (non-toxic effects) on the integrity of the sites in order to propose mitigation, if deemed necessary. The inability to rule out residual impacts beyond scientific doubt, even after the implementation of mitigation, does not mean that this option requires progressing to Stage 3. When additional information is available, it is recommended that this document is updated.

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
		The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised.		
	• Qualifying bird species listed under Articles 4.1 and 4.2 of the Birds Directive in the SPA citation, and criteria 5 and 6 of the Ramsar Site convention (Please refer to Appendix F.3 for details on qualifying species)	This option may have the following additional temporary or permanent adverse effects on the Habitats Sites during the construction phase, in addition to the above: • Non-physical disturbance – displacement of qualifying species due to noise, visual and/or artificial lighting pathways, associated with construction activities, increasing vehicular movement, personnel and lighting can impact survival and distribution of bird species; and • Biological disturbance – Temporary changes in habitat availability and potential for SPA/Ramsar Site populations to be displaced from current foraging areas. No additional effects are anticipated from the operation phase of this option.	The following measures will be implemented to avoid or reduce adverse impacts during construction • Sensitive timing of construction works to avoid the passage and overwintering period for birds detailed in the SPA Standard Data Form (SDF)[22] and Ramsar Site Information Sheet (RIS)[23]; and, • Any works which are undertaken between September and April which may disturb or displace these species from suitable functional land will only be permitted if the population present at risk of disturbance is less than 1% of the cited SPA and Ramsar Site populations in the SDF and RIS respectively, or qualifying species are sufficiently distant from the works (>300m) to avoid disturbance. This approach is considered to be conservative in the absence of recent survey data. Habitat loss and non-physical disturbance effects caused by construction cannot be confirmed until records or survey data is obtained. Therefore, these mitigation measures are proposed to remove the potential adverse effects.	

[22] JNCC (1999). Benfleet and Southend Marshes SPA Standard Data Form [online] available at: Benfleet and Southend Marshes SPA - UK9009171A (naturalengland.org.uk)

[23] JNCC (1994). Benfleet and Southend Marshes Ramsar Site Information Sheet [online] available at: untitled (jncc.gov.uk)

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA and Ramsar Site (approx. 1.5km east)	• All (Please refer to Appendix F.3 for details on qualifying features)	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the River Crouch which could be transferred to within the Habitats Sites' boundaries and damage/degrade qualifying habitats and habitats which support qualifying features; • Non-toxic contamination – increased turbidity and/or sedimentation within the River Crouch which could be transferred to within the Habitats Sites and damage/degrade qualifying habitats and habitats which support qualifying features; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon qualifying features of the sites. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No adverse effects are identified during operation.	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling will be implemented (intrinsically) where the pipeline alignment crosses the River Crouch to reduce adverse effects on the surface watercourse and downstream habitats (mudflats, coastal saltmarsh) within the sites; and, • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	There will be no adverse effects on the integrity of these sites during construction, provided the proposed mitigation is implemented. No adverse effects are identified during operation and so adverse effects on site integrity can be ruled out, beyond reasonable scientific doubt.
Essex Estuaries SAC (approx. 1.5km east)	• All (Please refer to Appendix F.3 for details on qualifying features)	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction phase: • Toxic contamination – pollution of the River Crouch which could be transferred to within the Habitats Sites' boundaries and damage/degrade qualifying habitats and habitats which support qualifying features;	The following measures will be implemented to avoid or reduce adverse impacts: • Directional drilling will be implemented (intrinsically) where the pipeline alignment crosses the River Crouch to reduce adverse effects on the surface watercourse and downstream habitats	There will be no adverse effects on the integrity of these sites during construction, provided the proposed mitigation is implemented. No adverse effects are identified during operation and so adverse effects on site

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
		• Non-toxic contamination – increased turbidity and/or sedimentation within the River Crouch which could be transferred to within the Habitats Sites and damage/degrade qualifying habitats and habitats which support qualifying features; • Physical loss/damage – significant localised habitat degradation leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability; habitat avoidance and rapid population fluctuation upon qualifying features of the sites. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised due to the distance between the Habitats Sites and this option. No adverse effects are identified during operation.	(mudflats, coastal saltmarsh) within the sites; and, • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	integrity can be ruled out, beyond reasonable scientific doubt.
Thames Estuary & Marshes SPA and Ramsar Site (approx. 1.3km south)	All (Please refer to Appendix F.3 for details on qualifying features)	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction and operation phases: • Toxic contamination – pollution of the River Thames during construction which could be transferred to within the Habitats Sites' boundaries and damage/degrade qualifying habitats and habitats which support qualifying features; • Toxic contamination – pollution of the River Thames through changes in water chemistry, associated with heavy metal concentrations within discharge during operation, transferred downstream into the sites; • Non-toxic contamination – increased turbidity and/or sedimentation within the River Thames	The following measures will be implemented to avoid or reduce adverse impacts: • Engineering control measures incorporated into the desalination plant to separate heavy metals from the discharge and avoid release into the water environment; and, • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction. Toxic contamination during operation will be reduced through the control measures	There will be no adverse effects on the integrity of these sites during construction, provided the proposed mitigation is implemented. However, residual effects remain during the operation phase at this stage. Additional information is required to determine the effects of brine discharge (non-toxic effects) on the integrity of the sites in order to propose mitigation, if deemed necessary. The Inability to rule out residual impacts beyond scientific doubt, even after the implementation of mitigation, does not mean that this option requires progressing to Stage 3. When additional information is available, it is

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
		during construction which could be transferred to within the Habitats Sites and damage/degrade qualifying habitats and habitats which support qualifying features; • Non-toxic contamination – changes is sedimentation, turbidity, salinity and temperature associated with brine discharge into the River Thames during operation, transferred downstream into the sites. • Physical loss/damage – significant localised habitat degradation during construction and operation, leading to a reduction in qualifying features and/or functional habitat for supporting qualifying features; and • Biological disturbances – changes to habitat availability during construction and operation; habitat avoidance and rapid population fluctuation upon qualifying features of the sites. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised.	within the desalination plant, but the effects of brine discharge on hydrological processes cannot be ruled out in the absence of further information. As such, no mitigation is proposed to alleviate this effect.	recommended that this document is updated.
Outer Thames Estuary SPA (approx. 8km east)	All (Please refer to Appendix F.3 for details on qualifying features)	This option may have the following temporary or permanent adverse effects on the Habitats Sites during the construction and operation phases: • Toxic contamination – pollution of the River Thames during construction which could be transferred to within the Habitats Sites' boundaries and damage/degrade habitats which support qualifying features; • Toxic contamination – pollution of the River Thames through changes in water chemistry, associated with heavy metal concentrations within discharge during operation, transferred downstream into the site;	The following measures will be implemented to avoid or reduce adverse impacts: • Engineering control measures incorporated into the desalination plant to separate heavy metals from the discharge and avoid release into the water environment; and, • Implementation of widely used best practice measures for pollution control, see section 3.3.4.2. With this in place, adverse impacts on the Habitats Sites will be alleviated during construction.	There will be no adverse effects on the integrity of these sites during construction, provided the proposed mitigation is implemented. However, residual effects remain during the operation phase at this stage. Additional information is required to determine the effects of brine discharge (non-toxic effects) on the integrity of the sites in order to propose mitigation, if deemed necessary. The inability to rule out residual impacts beyond scientific doubt, even after the implementation of mitigation, does not mean that this option requires

Habitats Sites	Qualifying features affected	Potential adverse effects on integrity before mitigation	Proposed mitigation measures	Residual effects after mitigation
		• Non-toxic contamination– increased turbidity and/or sedimentation within the River Thames during construction which could be transferred to within the Habitats Sites and damage/degrade habitats which support qualifying features; • Non-toxic contamination – changes is sedimentation, turbidity, salinity and temperature associated with brine discharge into the River Thames during operation, transferred downstream into the site. • Physical loss/damage – significant localised habitat degradation during construction and operation, leading to a reduction in functional habitat for supporting qualifying features; and • Biological disturbances - changes to habitat availability during construction and operation; habitat avoidance and rapid population fluctuation upon qualifying features of the site. The effects of toxic contamination and physical/loss damage of habitat could be permanent effects but are likely to be localised.	Toxic contamination during operation will be reduced through the control measures within the desalination plant, but the effects of brine discharge on hydrological processes cannot be ruled out in the absence of further information. As such, no mitigation is proposed to alleviate this effect.	progressing to Stage 3. When additional information is available, it is recommended that this document is updated.

10.3.4 Stage 2 outcomes

Following this HRA AA, it is considered that with adherence to the proposed mitigation, the proposed works associated with the option are not expected to have adverse effects on the following Habitats Sites identified within this chapter:

- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA
- Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar Site
- Essex Estuaries SAC
- Medway Estuary & Marshes SPA
- Medway Estuary & Marshes Ramsar Site
- Foulness (Mid-Essex Coast Phase 5) SPA
- Foulness (Mid-Essex Coast Phase 5) Ramsar Site

However, residual unknowns relating to the operation of this option, and specifically the effect of brine discharge on hydrological processes and the aquatic environment. As such, adverse effects on integrity of the following Habitats Sites cannot be ruled out at this stage:

- Benfleet and Southend Marshes SPA
- Benfleet and Southend Marshes Ramsar Site
- Thames Estuary & Marshes SPA
- Thames Estuary & Marshes Ramsar Site
- Outer Thames Estuary SPA

Further information is required to complete a revised AA and determine the potential effects of this option on these Habitats Sites during operation. The inability to rule out residual impacts beyond scientific doubt, even after the implementation of mitigation, does not mean that this option requires progressing to Stage 3. When additional information is available, it is recommended that this document is updated.

10.3.5 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

11 Linford New WTW (ESW-ABS-003C)

Option ID: (ESW-ABS-003C)

11.1 Option Description

This option consists of multiple components, proposing the following:

- A recommissioned borehole at the existing Linford water treatment works (WTW) site, with a confirmed capacity of 3.5 megalitres per day (Ml/d). A new raw water transfer main will be constructed between this borehole and a new WTW site, approximately 3.02km in length. The location of the new WTW will be one of four sites; for the purpose of this assessment, 'Site C' is used as the surrogate because it has the largest construction footprint with the longest associated pipeline infrastructure.
- Site C will be the new WTW with a capacity of 10Ml/d, potentially expanded up to 13Ml/d, with a treated water pumping station. The new site will also contain a new borehole, with a capacity of 6.6Ml/d. Treatment at the new site will include water recycling and solids disposal, as a well as a lagoon settlement prior to a run-to waste. Treated water will be transferred to the existing distribution system through a new main of approximately 0.87km in length.
- Two separate run-to-waste pipelines will be required from the new and existing sites respectively. The run-to-waste from Site to the Mar Dyke watercourse (north-west of the site) will be approximately 4km in length, crossing two minor roads, the A13 and running through the village of Baker Street.
- The run-to-waste from the existing borehole site to the River Thames (south-east of the site) crosses a stream, two minor roads and a twin-track railway line.

Essex & Suffolk Water have yet to confirm which of the four sites will be used for the new WTW, and this will only be known once drilling and raw water sampling and analyses have been undertaken. Further environmental assessments of the sites and options for suitable main tie-in have been identified and should be conducted as part of the project level HRA. This option is programmed for delivery in 2027. Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

11.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified two Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for either of these sites (Table 11.1).

This option therefore needs progressing to Stage 2 of the HRA process: Appropriate Assessment.

Table 11.1: ESW-ABS-003C Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Thames Estuary & Marshes SPA (UK9012021) (option is within the SPA)	
Thames Estuary & Marshes Ramsar Site (UK11069) (option is within the Ramsar Site)	
Medway Estuary & Marshes SPA (UK9012031) (approximately 10km south-east)	
Medway Estuary & Marshes Ramsar Site (UK11040) (approximately 10km south-east)	

The Swale SPA (UK9012011) (approximately 22.3km south-east)
The Swale Ramsar Site (UK11071) (approximately 22.3km south-east)
Benfleet and Southend Marshes SPA (UK9009171) (approximately 14.5km east)
Benfleet and Southend Marshes Ramsar Site (UK11006) (approximately 14.5km east)

Source, Mott MacDonald, 2023

11.3 Stage 2 Appropriate Assessment

11.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Thames Estuary & Marshes SPA (UK9012021)
- Thames Estuary & Marshes Ramsar Site (UK11069)
- Medway Estuary & Marshes SPA (UK9012031)
- Medway Estuary & Marshes Ramsar Site (UK11040)
- The Swale SPA (UK9012011)
- The Swale Ramsar Site (UK11071)
- Benfleet and Southend Marshes SPA (UK9009171)
- Benfleet and Southend Marshes Ramsar Site (UK11006)

11.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 11.2.

11.3.2.1 Thames Estuary & Marshes SPA (UK9012021) (option is within the SPA boundary)

The Thames Estuary and Marshes SPA is located in the outer Thames Estuary on the south-east coast of England which separates Kent and Essex. The majority of the site is located on the south bank of the estuary, which stretches from the western side of Cliffe Pools to Grain Tower, the farthest eastern part of the Isle of Grain. The site also covers a small part of the northern bank of the outer estuary between Coalhouse Point in East Tilbury, to the most western part of the reclaimed land at Mucking Flats (Essex).

The site is predominantly characterised by extensive intertidal mudflats that are visible at low tide. Additionally, there is saltmarsh, for example around the Isle of Grain, and complex channel systems such as the Yantlet Inlet. A series of disused quarry pits have been transformed to create an extensive series of ponds and lakes at Cliffe Pools. The intertidal areas are bound mostly by levees and seawalls, such as those at Cooling Marshes and Yantlet, occasionally featuring small beaches, such as those around the Isle of Grain and Cooling Marshes. There are important habitats that lie above the highest astronomical tide, such as flooded mineral works and large areas of grazing marsh, and birds may use habitat outside of the SPA

boundary too, such as at Holehaven Creek SSSI. It is thought that qualifying features move around the Thames Estuary between neighbouring SPAs (Medway Estuary and Marshes SPA, The Swale SPA and Thames Estuary and Marshes SPA).

The SPA has a variety of habitat types, which are important feeding and roosting sites for the large populations of bird species here, including those during the spring and autumn migration periods.

Over winter, the area regularly supports 75,019 waterfowl, including internationally important populations of: hen harrier (*Circus cyaneus*), avocet (*Recurvirostra avosetta*), dunlin (*Calidris alpina alpina*), grey plover (*Pluvialis squatarola*), knot (*Calidris canutus islandica*), black-tailed godwit (*Limosa limosa islandica*) and redshank (*Tringa totanus*). Internationally important populations of ringed plover (*Charadrius hiaticula*) are also supported during passage. Other non-qualifying Annex I and nationally important populations of waterfowl are supported by the habitats within the SPA.

Construction effects

The run-to-waste pipeline infrastructure from the existing borehole is located within the SPA boundary, which is designated for a diverse assemblage of passage and overwintering bird species. It is therefore likely that there will be significant localised habitat loss during construction, which could result in direct mortality of qualifying features, in addition to reductions in the extent and distribution of supporting habitats, such as saltmarsh and mudflats.

There is also likely to be disturbance to qualifying features during construction. Visual, noise and vibration are all pathways which can disturb birds, resulting in increased energy expenditure from flight events. This can result in abandonment of preferred foraging areas during the critical overwintering period, ultimately leading to reduced adult survival and population viability as birds are displaced to other, potential sub-optimal, feeding grounds. The effects of displacement can be permanent and lead to changes in abundance and/or diversity of the overall assemblage associated with the SPA. Disturbance is most likely within the SPA boundary itself and immediately adjacent habitats within 500m. The proposed run-to-waste pipeline and other infrastructure associated with this option at Site C do not bisect habitats outside the SPA boundary which are considered to be functionally linked and suitable for qualifying features. Therefore, it is likely that any adverse effects from disturbance are limited to the construction works within and immediately adjacent to the SPA boundary.

There is a hydrological connection between the option and the SPA boundary, where the proposed run-to-waste pipelines (both from the existing borehole and the new Site C borehole) bisect surface watercourses which flow into the SPA and the River Thames. The construction of outfalls within the SPA are likely to result in pollution of suitable habitats, through chemical spills (toxic) or increased sedimentation and siltation (non-toxic), for example. The construction of the Mar Dyke outfall, although outside of the SPA boundary, may be upstream of suitable functionally connected saltmarsh and mudflat habitat further west on the River Thames' banks. It is possible that any pollution events, if they were to occur during construction, are transferred downstream and degrade functionally linked habitats which support the qualifying features, reducing the total area of optimal foraging habitats and displacing the qualifying features to other, potentially less suitable, areas within and outside the site boundary.

There is also a groundwater connection between the option and the SPA, through the Water Framework Directive (WFD) groundwater waterbody IDs GB40503G000400 (Essex Gravels) and GB40602G401000 (South Essex Lower London Tertiaries). This could provide an additional impact pathway for pollution events through the groundwater. However, as the habitats within the SPA are not dependent on the groundwater, any pollution which occurs through this pathway is only anticipated to have a localised significant effect on the SPA if it occurs within the site boundary or immediately adjacent habitats.

Due to the proximity of the option to the SPA, there may be temporary reductions in air quality due to emissions from construction machinery, which could degrade sensitive wetland habitats and further displace birds from within the site boundary. Based on publicly available data from 2020 (2019 – 2021 three-year average)[24], nitrogen deposition at the site is 9.2kg/ ha/ year on average with a critical load of 10kg/ ha/ year on the saltmarsh habitats, which are assumed to be densely vegetated upper marsh in the vicinity of the proposed works. This represents a precautionary approach, as pioneer saltmarsh has a higher critical load of 20 - 30kg/ ha/ year, and this may be more representative of the habitats surrounding the option. Even as a worst-case scenario in terms of saltmarsh sensitivity, the site is currently below its critical level.

Both nitrogen oxides and ammonia are below the critical level with nitrogen oxides at 23.7µg m^{-3} with a critical level of 30µg m^{-3} and ammonia at 1.2µg m^{-3} with a critical level of 3µg m^{-3}. No critical level information was available for sulphur dioxide (SO_2). No critical load information is available for the mudflat habitats and the qualifying species themselves are not sensitive to the air quality impacts on these broad habitats. Therefore, it is not anticipated that construction works will have an adverse effect on air quality in relation to the Habitats Sites critical loads and levels.

Any pollution events of the surface water environment may have adverse effects on both components of the SPA, the Mucking Flats and Marshes SSSI on the north bank of the River Thames, and the South Thames Estuary and Marshes SSSI on the south bank. Pollution through the groundwater will only affect the Mucking Flats and Marshes SSSI. Similarly, effects of displacement from construction-related disturbance are only anticipated top affect qualifying features which are present within the Mucking Flats and Marshes SSSI at the time, due to the distance between the works and the south side of the river (>1km). There are not anticipated to be any adverse effects on hen harrier, avocet or knot from disturbance or habitat loss and/or damage, as these species are not monitored features of the underpinning Mucking Flats and Marshes SSSI. These species are only likely to be affected by the indirect loss of habitats from pollution degradation, if such an event was to occur and traverse the River Thames to the underpinning South Thames Estuary and Marshes SSSI.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

During operation, the additional groundwater abstraction from boreholes is not anticipated to have an adverse effect on the SPA, as the habitats which support the qualifying features are not dependent on groundwater provision. This is the same for supporting habitats both within and outside of the SPA boundary.

However, the discharge of waste effluent within the SPA boundary is anticipated to result in localised changes to the water chemistry through changes in turbidity, temperature and nutrients. These changes could exceed the chemical, temperature or sedimentation thresholds of invertebrate prey species, resulting in indirect on qualifying features through changes to the composition and distribution within preferred feeding grounds. This may displace qualifying features from affected areas and change distribution within or from the SPA. Localised changes in water chemistry may also lead to reductions in supporting habitats, primarily saltmarsh, if

[24] Air Pollution Information System (2021). Site Relevant Critical Loads and Source Attribution (APIS GIS map tool). Accessed from: APIS app | Air Pollution Information System

colonising plant species are damaged or lost, or the new conditions are no longer within their tolerances.

The run-to-waste discharge may also result in the transfer of invasive species to within the SPA boundary, such as non-native *Spartina* species which could outcompete and degrade natural saltmarsh communities which support roosting and foraging qualifying features. The same impact pathways are present from discharge into the Mar Dyke, potential resulting in degradation of functionally linked habitats outside of the SPA boundary, such as floodplain grazing marsh and mudflats which are downstream of the discharge; these habitats are functionally linked to the SPA and may support qualifying features whilst foraging.

Adverse effects on the integrity of the SPA during operation cannot currently be excluded, as the effective area and composition of the effluent discharge plumes are unknown. The impact pathways described are not necessarily applicable to the entirety of the SPA; it is anticipated that species supported by the Mucking Flats and Marshes SSSI, and the intertidal habitats of the South Thames Estuary and Marshes SSSI could be affected by the localised changes in water quality, in the absence of detailed information. It is not likely that the floodplain grazing marsh of the South Thames Estuary and Marshes SSSI, and species supported by this habitat, will be adversely affected by changes in water quality at this Thames run-to-waste discharge. This means that hen harrier are not anticipated to be affected during operation.

Although estuarine habitats such as saltmarsh and mudflats are resilient to temporary and localised changes in water quality and turbidity, the approach remains precautionary in order to account for the unknown effective area and composition of the run-to-waste discharge plume.

No other impact pathways are anticipated during operation.

11.3.2.2 Thames Estuary & Marshes Ramsar Site (UK11069) (option is within the Ramsar Site boundary)

The Thames Estuary & Marshes Ramsar Site is a complex of brackish, floodplain grazing marsh ditches, saline lagoons and intertidal saltmarsh and mudflat, overlapping in extent with the corresponding SPA described above. The marshes extend for approximately 15km along the south side of the Thames Estuary and also include intertidal areas of the north side. To the south of the river, much of the area is brackish grazing marsh, although some has been converted to arable use. At Cliffe, there are flooded clay and chalk pits, some of which have been infilled with dredgings. Outside the sea wall, there is a small extent of saltmarsh and broad intertidal mudflats.

These habitats together support internationally important numbers of wintering waterfowl. The saltmarsh and grazing marsh are of international importance for their diverse assemblages of wetland plants and invertebrates.

The qualifying bird species which are supported by the Ramsar Site are the same as detailed for the SPA above. The site supports one endangered plant species, least lettuce (*Lactuca saligna*), and 14 nationally scarce wetland plant species. The site also supports more than 20 British Red Data Book (RDB) invertebrates, including the endangered weevil *Bagous longitarsis*.

Construction effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Thames Estuary & Marshes SPA above, with the addition of qualifying vascular plant species and invertebrates as receptors of the effects of pollution events and localised habitat loss and/or damage. Effects of construction-related disturbance are not applicable to notable plant or invertebrate species.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during operation are the same as described for the Thames Estuary & Marshes SPA above. Qualifying invertebrate species are likely to be directly affected by localised changes in water quality as a result of the Thames run-to-waste discharge. These changes could exceed the chemical, temperature or sedimentation thresholds of qualifying invertebrate species, resulting in mortality or displacement from parts of the Ramsar Site. Localised changes in water chemistry may also lead to reductions in supporting habitats, resulting in changes to the composition and distribution of saltmarsh and mudflat invertebrate communities for which the Ramsar Site is designated (criterion 2).

The Mucking Flats and Marshes SSSI does not support any of the qualifying floral species of the Ramsar Site, but those notable species which are present within intertidal habitats of the South Thames Estuary and Marshes SSSI may still be lost or damaged during operation, considering the uncertainty surrounding the effective area of the run-to-waste discharge. These features may be directly lost and/or damage from associated changes in water quality.

No other impact pathways are anticipated during operation.

11.3.2.3 Medway Estuary & Marshes SPA (UK9012031) (approximately 10km south-east)

The Medway Estuary and Marshes is located in north Kent. The estuary forms a single tidal system with the Swale and joins the southern part of the Thames Estuary between the Isle of Grain and Sheerness.

The site has a complex arrangement of tidal channels, which drain around large islands of salt marsh and peninsulas of grazing marsh. There are large areas of mudflat, which have high densities of invertebrates providing a good food source for wading birds. Grazing marsh can also be found landward of some sea walls in the area. Small shell beaches occur too, particularly in the outer parts of the estuary. The area is very flat and low lying, with large expanses of uninterrupted views.

The complex and diverse mixes of coastal habitats support important numbers of waterbirds throughout the year. In summer, the estuary supports breeding waders and terns, whilst in winter it holds important numbers of geese, ducks, grebes and waders. The middle and outer parts of the estuary represent the most important areas for the birds. Important areas for birds include the Saltings and Hoo flats on the north side and the stretch from Copperhouse marshes eastwards towards Chetney marshes on the south side. The islands within the Medway also provide good habitat for SPA birds, in particular some of the breeding species.

During the breeding season the area regularly supports internationally important breeding populations of avocet, little tern (*Sternula albifrons*) and common tern (*Sterna hirundo*). A diverse assemblage of breeding migratory waterfowl are also supported, including oystercatcher (*Haematopus ostralegus*), lapwing (*Vanellus vanellus*), ringed plover, redshank, shelduck (*Tadorna tadorna*), mallard (*Anas platyrhynchos*), teal (*Anas crecca*), shoveler (*Anas clypeata*) and pochard (*Aythya ferina*).

Over winter, the area regularly supports 65,496 waterfowl, including: Bewick's swan (*Cygnus columbianus bewickii*), avocet, pintail (*Anas acuta*), dark-bellied brent goose (*Branta bernicla bernicla*), dunlin, grey plover, knot, redshank, shoveler, teal, wigeon (*Anas penelope*), turnstone (*Arenaria interpres*), ringed plover, oystercatcher, black-tailed godwit, curlew (*Numenius arquata*), shelduck and greenshank (*Tringa nebularia*).

Construction effects

There is a hydrological connection between this option and the SPA, approximately 26km downstream through the River Thames and then upstream through the River Medway. Due to this distance and the strong tidal influence at the mouth of the Thames and Medway estuaries, is it not anticipated that there will be any adverse effects within the SPA from pollution events, if they were to occur during construction.

However, as it is thought that there is exchange and movement between qualifying features of all SPAs within the Greater Thames Complex (Thames Estuary & Marshes, Benfleet and Southend Marshes SPA, Medway Estuary & Marshes, and The Swale SPAs), the Mucking Flats and Marshes SSSI is considered to be functionally linked land for qualifying features outside of the SPA boundary, despite its distance approximately 10km to the north-west. In order to identify which qualifying species of the SPA may be using the functionally linked land surrounding the proposed option, the British Trust for Ornithology's (BTO) wetland bird survey (WeBS) data[25] for the Thames Estuary site was used. This data did not specify which specific survey sector of the estuary the records came from, nor when they were within the November to March survey period. The following species have been recorded within the estuary in numbers which exceed the international threshold for importance and are therefore considered to be qualifying features for one of the Greater Thames Complex SPAs: dark-bellied brent goose, knot, dunlin, oystercatcher, black-tailed godwit, avocet, shoveler, ringed plover, and bar-tailed godwit (*Limosa lapponica*). Bar-tailed godwit is not a qualifying feature of any Greater Thames Complex SPA but is considered to be part of the overall overwintering waterbird assemblages.

The Mucking Flats and Marshes SSSI and immediately surrounding habitat is also within Natural England's *Goose and Swan Functional Land Impact Risk Zone (IRZ)*, which has identified suitable habitat outside of the sites' boundaries which can support qualifying species. This further strengthens the evidence that dark-bellied brent geese will use the habitats surrounding the option for foraging and/or roosting outside of the SPAs for which they are qualifying features.

The impact pathways applicable to the qualifying bird species within functionally linked land during construction are the same as described for the Thames Estuary & Marshes SPA above; the loss and/or damage to functionally linked habitat, pollution of supporting habitats, and construction-related disturbance are all impact pathways which could displace birds from preferred foraging and/or roosting areas and result in adverse effects on the integrity of the SPA. These pathways also apply to the overall breeding bird assemblage associated with the SPA, which may utilise the functionally linked habitat surrounding the option for foraging during the breeding season. Disturbance and displacement during this period could result in failed breeding attempts and jeopardise future population viability, in addition to the effects detailed previously for overwintering birds.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the SPA during operation are the same as described for the Thames Estuary & Marshes SPA above,

[25] Austin, G.E., Calbrade, N.A., Birtles, G.A., Peck, K., Shaw, J.M. Wotton, S.R., Balmer, D.E. and Frost, T.M. (2023). *Waterbirds in the UK 2021/22: The Wetland Bird Survey and Goose & Swan Monitoring Programme.* BTO/RSPB/JNCC/NatureScot. Thetford.

although there are no impact pathways to habitats within the boundary of this SPA; only functionally linked habitats may be affected. Additional qualifying features which are not relevant to the Thames Estuary & Marshes SPA include: dark-bellied brent goose, oystercatcher and shoveler, although the potential effects on these species are the same. There is also the potential for the same operational effects to affect the breeding bird assemblage of the SPA.

No other impact pathways are anticipated during operation.

11.3.2.4 Medway Estuary & Marshes Ramsar Site (UK11040) (approximately 10km south-east)

The Ramsar Site is a complex of rain-fed, brackish, floodplain grazing marsh with ditches, intertidal saltmarsh and mudflat, overlapping in extent with the corresponding SPA described above. These habitats together support internationally important numbers of overwintering waterfowl and rare breeding wetland birds; the species included in these assemblages are the same as detailed for the SPA above.

The saltmarsh and grazing marsh are of international importance for their diverse assemblages of wetland plants, at least 10 nationally scarce species, and at least 12 species of RDB wetland invertebrates. A significant number of non-wetland RDB invertebrate species have also been recorded.

Construction effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during construction. Due to the distance between the option and the Ramsar Site (10km), no adverse effects are anticipated on the qualifying plant and invertebrate assemblages.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during operation are the same as described for the Medway Estuary & Marshes SPA and Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during operation. Due to the distance between the option and the Ramsar Site (10km), no adverse effects are anticipated on the qualifying plant and invertebrate assemblages.

11.3.2.5 The Swale SPA (UK9012011) (approximately 22.3km south-east)

The Swale is located in North Kent on the south-east coast of England and separates the Kent mainland from the Isle of Sheppey. It adjoins the Medway Estuary to the west. The Swale was originally part of a river valley, however, due to isostatic sea level change, the water divided the mainland from the Isle of Sheppey to form the Swale estuary. The Swale comprises extensive intertidal mudflats that encompass the entire northern and southern shores of the estuary extending from Ferry Marshes in the west down to Whitstable on the southern shore and Leysdown-on-Sea on the northern shore.

The SPA also contains the largest expanse of grazing marsh in Kent, which provide important feeding and roosting grounds for many waterbirds. Elmley National Nature Reserve (NNR) is

the best example of grazing marsh and covers an area of 1212.43ha. The grazing marshes contain a complex of brackish and freshwater ditches and areas of open water. Other areas of grazing marsh include Graveney Marshes and Teynham Level on the southern shore.

Areas of saltmarsh can be found bordering the intertidal mudflats at the north bank of the Swale NNR and a large area east of Flanders Mare on the north shore, in addition to areas bordering muddy creeks such as at Conyer Creek and Windmill Creek located on the southern and northern shores respectively. There are also fragmented patches located within the South Bank of the Swale Nature Reserve and Oare Marshes Nature Reserve.

There are several patches of littoral rock located at Shellness point on the northern shore (mussel beds are also located here), in addition to north of Cleve marshes on the southern shore.

The large areas of intertidal mudflats are submerged at high tide, and exposed in the estuary at low tide, providing an important feeding habitat for birds. The estuary also provides extensive roosting sites for large populations of waterbirds and is of major importance during the winter for duck and wader species and for supporting wader populations moving to the south-east coast of Britain during the spring and autumn migration periods.

Over winter the area regularly supports 65,588 waterfowl, including: dark-bellied brent goose, dunlin, redshank, gadwall (*Anas strepera*), teal, oystercatcher, ringed plover, grey plover and curlew. The grazing marshes support a typical assemblage of breeding species including: shelduck, mallard, moorhen (*Gallinula chloropus*), coot (*Fulica atra*), lapwing, redshank, reed warbler (*Acrocephalus scirpaceus*) and reed bunting (*Emberiza schenicul*us).

Construction effects

There is a hydrological connection between this option and the SPA, approximately 40km downstream through the River Thames. Due to this distance and the strong tidal influence at the mouth of the Thames and Swale, is it not anticipated that there will be any adverse effects within the SPA from pollution events, if they were to occur during construction.

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above. The only qualifying features of the site which have been identified as using the Thames Estuary and the functionally linked habitat surrounding the option (based on the BTO WeBS data) are dark-bellied brent goose, dunlin, oystercatcher and ringed plover. There are not expected to be any adverse effects on the breeding bird assemblage during construction, as the species listed are unlikely to travel as far as the Mucking Flats and Marshes SSSI to forage.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the SPA during operation are the same as described for the Thames Estuary & Marshes SPA above although there are no impact pathways to habitats within the boundary of this SPA; only functionally linked habitats may be affected. Additional qualifying features which are not relevant to the Thames Estuary & Marshes SPA include: dark-bellied brent goose and oystercatcher, although the potential effects on these species are the same. There are not expected to be any adverse effects on the breeding bird assemblage during construction, as the species listed are unlikely to travel as far as the Mucking Flats and Marshes SSSI to forage.

No other impact pathways are anticipated during operation.

11.3.2.6 The Swale Ramsar Site (UK11071) (approximately 22.3km south-east)

The Ramsar Site is a complex of brackish and freshwater floodplain grazing marsh with ditches, and intertidal saltmarsh and mudflat, overlapping in extent with the corresponding SPA described above. These habitats together support internationally important numbers of overwintering waterfowl and rare breeding wetland birds; the species included in these assemblages are the same as detailed for the SPA above. Additional species cited in the Ramsar Site for subsequent consideration under criterion 6 include wigeon, pintail and black-tailed godwit.

The saltmarsh and grazing marsh are of international importance for their diverse assemblages of wetland plants, at least eight nationally scarce species, and at least 10 species of RDB invertebrates.

Construction effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Swale SPA, the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during construction. Due to the distance between the option and the Ramsar Site (22.3km), no adverse effects are anticipated on the qualifying plant and invertebrate assemblages.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during operation are the same as described for The Swale SPA, the Medway Estuary & Marshes SPA and Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during operation. Due to the distance between the option and the Ramsar Site (10km), no adverse effects are anticipated on the qualifying plant and invertebrate assemblages.

11.3.2.7 Benfleet and Southend Marshes SPA (UK9009171) (approximately 14.5km east)

Benfleet and Southend Marshes SPA is located in south-east Essex, on the northern bank of the Thames Estuary. It qualifies under Article 4.2 of the Birds Directive by supporting internationally important populations of regularly occurring migratory species, and an internationally important assemblage of waterfowl.

Much of the site is below national sea level and it is made up of several intertidal, subtidal and terrestrial habitat types that birds rely upon for loafing, roosting and foraging. In many locations the presence of a seawall separates the terrestrial parts of the site (such as freshwater and coastal grazing marsh) from the intertidal and marine zones (mixed and coarse sediments, saltmarsh, sand and mud flats, shell banks and seagrass beds).

Due to the high flood risk in the Thames Estuary basin as a result of sea-level rise and erosion, coastal squeeze and intertidal habitat loss is a concern within this site. Most of the intertidal habitat is muddy in character, with extensive areas of saltmarsh and saltmarsh basins, inlets, seagrass beds and lagoons in the low-lying areas. The significant saltmarsh roost areas at Two

Tree and Canvey Point in the SPA are considered to be in unfavourable condition when assessed through its component SSSI units; the remaining inner creek saltmarsh has experienced no deterioration or improvement in unfavourable condition, and is generally considered to be recovering.

Over winter the area regularly supports 34,789 waterfowl, including: dark-bellied brent goose, dunlin, knot, ringed plover and grey plover.

Construction effects

There is a hydrological connection between this option and the SPA, approximately 14.5km downstream through the River Thames. Due to this distance and the strong tidal influence at the mouth of the Thames, it is not anticipated that there will be any adverse effects within the SPA from pollution events, if they were to occur during construction.

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above. The only qualifying features of the site which have been identified as using the Thames Estuary and the functionally linked habitat surrounding the option (based on the BTO WeBS data) are dark-bellied brent goose, knot, dunlin and ringed plover.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 11.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the SPA during operation are the same as described for the Thames Estuary & Marshes SPA above although there are no impact pathways to habitats within the boundary of this SPA; only functionally linked habitats may be affected. Dark-bellied brent goose is the only additional qualifying features which is not relevant to the Thames Estuary & Marshes SPA, although the potential effects on this species are the same.

No other impact pathways are anticipated during operation.

11.3.2.8 Benfleet and Southend Marshes Ramsar Site (UK11006) (approximately 14.5km east)

The Ramsar Site comprises an extensive series of saltmarshes, mudflats and grassland which support a diverse flora and fauna, including internationally important numbers of overwintering wildfowl. There is significant overlap in qualifying features with the corresponding SPA described above, with the addition of red knot (*Calidris canutus islandica*) as a species with peak counts in winter (criterion 6).

Construction effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during construction are the same as described for the Benfleet and Southend Marshes SPA, the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a CEMP produced at the project stage. These measures are listed in Table 1.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The impact pathways and potential adverse effects on the qualifying bird species of the Ramsar Site during operation are the same as described for Benfleet and Southend Marshes SPA, the Medway Estuary & Marshes SPA and the Thames Estuary & Marshes SPA above.

No other impact pathways are anticipated during operation.

11.3.3 Assumptions and mitigation measures

11.3.3.1 Assumptions

Based on the current level of information a number of assumptions have been made, relating to principles and established mitigation measures, which will be followed during option development at the project level.

The assumption, in the absence of detailed design or recent survey data, is that the land required for the construction of the infrastructure associated with this option constitutes optimal habitat for the qualifying species of sites within the Greater Thames Complex; significant proportions of the overall Habitats Sites' populations regularly use this area over winter, even where this is outside of the individual SPA boundaries but constitutes functionally linked foraging habitat.

The plan level measures will be delivered at the project level using the principles set out below:

1. An engagement plan will set out the expectations and timescales of consultation so that stakeholders can provide advice during the design and consenting processes.
2. Option design and the development of measures to safeguard the Habitats Sites will be informed by further research (listed within the conclusion below).
3. In planning the location of estuarine infrastructure, the emphasis should be on avoiding Habitats Sites. If this is not possible, adverse effects must be minimised through design, so they are no longer significant.
4. Where it is necessary to minimise adverse effects of estuarine infrastructure at the project level, appropriate measures should ideally be agreed with statutory stakeholders and be capable of being secured within project design and/or consents. Mitigation measures will also need to be acceptable to competent authorities.
5. 'Best available techniques' (BAT) for preventing or minimising impacts on the environment. Consideration of BAT will include the use of technology, design as well as construction, operation, maintenance and decommissioning methods.
6. Current best practice environmental considerations, guidance and advice from statutory nature conservation bodies (e.g. Natural England) will be taken into account during the detailed design process.
7. Planning of estuarine infrastructure should be undertaken in consultation with key stakeholders (e.g. Natural England and, where appropriate, JNCC). Other non-statutory consultees should also be included in the consultation (e.g. RSPB).

If avoidance is not possible then this must be clearly justified, including reasons why alternative locations, either inside or outside the Habitats Site, is unsuitable. If mitigation is included in the design this must be capable of being secured in the project's consents. For example, there may be a number of locations where existing built infrastructure is located on the banks of the River Thames and therefore opportunities to reinstate decommissioned Environment Agency assets.

The application of the above principles, and the targeted mitigation and industry-wide best practice (within Table 11.3 below), can be relied upon in the plan-level assessment to conclude no adverse effect on site integrity during the construction phase.

Whilst it is not possible for the WRMP24 assessment to reasonably predict the effects on the Habitats Sites in a detailed way, as a lower tier plan to the Thames river basin district (RBD) River Basin Management Plan (RBMP), which is the principal safeguard related to river basin management, the WRMP24 contains measures that would ensure compliance with the policies of the RBMP. The operational limits of groundwater abstraction, transfers and run-to-waste discharges associated with the Habitats Sites will be constrained by the updated RBMP. With respect to water quality, the river basin management plan aims to sustain geomorphological processes, meet the hydro-ecological requirements of the constituent species and dilute contaminants. The environmental objectives in the RBMP are legally binding once the plan is approved by Secretary of State for Environment, Food and Rural Affairs. All public bodies (e.g. Northumbrian Water Limited) must have regard to these objectives when making decisions that could affect the quality of the water environment. The environmental objectives of the RBMP include, inter alia: preventing deterioration of the status of surface waters and groundwater; achieving objectives and standards for protected areas; and aiming to achieve good ecological status for all water bodies.

The Water Framework Directive (WFD) assessment to inform the WRMP24 concluded, in relation to this option and the 'Middle Thames', that the temporary reduction in WFD status and the potential to prevent target WFD objectives from being achieved was unlikely, with this transitional waterbody not requiring a Level 2 assessment. However, the WFD assessment concluded the confidence in the screening outcome is low, due to the insufficient detail on the receiving environment and the construction and operation of this option; there may still be adverse effects on Habitats Sites as a result. Any run-to-waste water transfer into the River Thames must be incorporated into the RBMP and the implications of future design changes on the conservation objectives of the Habitats Sites should be assessed in accordance with the Habitats Regulations.

11.3.3.2 Mitigation

The specific mitigation within Table 11.3 below includes industry-wide best practice measures and mitigation which have all been implemented on consented nationally significant infrastructure projects (NSIPs) to address common risks in the construction and development sectors. Therefore, there is practical certainty they can be implemented and in place at the relevant time when the project level HRA is undertaken. The full implementation of these measures, together with any site-specific efficacy research, will be secured and enforced as it has on other projects, in the project planning process.

A CEMP will be developed, which will include relevant measures described in the best practice guidance outlined within rdWRMP. The design of the measures within the CEMP will be based on the anticipated site conditions and construction methods whilst also allowing for a precautionary margin of error to account for extreme events, such as unprecedented rainfall which could increases the risk of flooding and pollution. The efficacy of the mitigation measures will be monitored and evaluated by the construction site environmental manager during the construction phase to inform adaptive management.

11.3.4 Monitoring

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

It is recommended that wintering bird surveys are undertaken within the construction footprint with an additional 500m buffer to determine if functionally linked habitat is present within the ZoI. In addition, a desk-based noise assessment should be undertaken once more information is provided on the construction methodology to determine the extent of elevated noise disturbance

above ambient conditions. The distribution of qualifying birds could then be overlayed with noise contours to determine potential adverse effects from anthropogenic disturbance and inform more targeted mitigation measures.

Publicly available water quality (2012 – 2017 on Environment Agency Water Quality Archive) data is limited for the last 3 – 5 years, so additional monitoring is recommended to ascertain a baseline water quality level. Implementation of water quality monitoring at the run-to-waste discharge outfalls within the Thames Estuary & Marshes SPA and the Mar Dyke is required to allow early identification of any changes which could lead to adverse effects within the SPA and/or functionally linked habitats during operation.

The monitoring recommendations for habitats and species are summarised below in Table 11.2 with relevant monitoring guidance.

Table 11.2: Monitoring recommendations to address evidence gaps in relation to the option

Habitats Sites	Monitored Feature	Monitoring Guidelines
Thames Estuary & Marshes SPA	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
	Water quality	UK Technical Advisory Group on the Water Framework Directive (2008). UK Environmental Standards and Conditions (Phase 1). WFD UK Tag, 1- 73 UK Government (2015). The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. 1 – 66.
Thames Estuary & Marshes Ramsar	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
	Wetland invertebrates	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Terrestrial and freshwater invertebrates, Version March 2008. JNCC, Peterborough.
	Water quality	UK Technical Advisory Group on the Water Framework Directive (2008). UK Environmental Standards and Conditions (Phase 1). WFD UK Tag, 1- 73 UK Government (2015). The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. 1 – 66.
Medway Estuary & Marshes SPA	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
Medway Estuary & Marshes Ramsar	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.

The Swale SPA	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
The Swale Ramsar	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
Benfleet and Southend Marshes SPA	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.
Benfleet and Southend Marshes Ramsar	Birds (wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p.

Source: Mott MacDonald, 2023.

Table 11.3: Option ABS-003C - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Thames Estuary & Marshes SPA (option is within the SPA boundary)	Avocet (Overwintering) Dunlin (Overwintering) Grey plover (Overwintering) Knot (Overwintering) Black-tailed godwit (Overwintering) Redshank (Overwintering) Ringed plover (Passage)	This option has the potential to cause the following permanent or temporary adverse effects on the SPA during the construction phase: • Toxic contamination – chemical pollution in the River Thames within the Mucking Flats and Marshes SSSI component of the SPA boundary. Pollution could potentially also be transferred to the south bank of the Thames, within the South Thames Estuary and Marshes SSSI component of the SPA. Toxic contamination is likely to cause damage to supporting habitats and reduce prey availability for qualifying features. • Non-toxic contamination – additional sedimentation or siltation within the Mucking Flats and Marshes SSSI component of the SPA boundary. This could potentially also be transferred to the south bank of the Thames, within the South Thames Estuary and Marshes SSSI component of the SPA, leading to degradation or smothering of supporting habitats within the site boundary. • Physical damage – significant localised habitat loss and/or degradation from pollution, both toxic and non-toxic, within the SPA boundary and functionally linked habitat. • Biological disturbances – reductions in and displacement of the prey availability and/or extent of habitats which support qualifying species, both of which may subsequently lead to displacement of qualifying features within or from the site, as a result of the above impact pathways.	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Scottish Environment Protection Agency's (SEPA) good practice guide for intakes and outfalls (WAT-SG-28). • Environment Agency's best practice guide for screening intakes and outfalls (Science report SC030231). • Intake heads should be designed for slow suction velocity to further reduce impingement of freshwater biota against the intake screen. Heads should be fitted orthogonal to downstream currents to reduce forcing against the screens, thus minimising velocity of approach for sensitive species. • Specific mitigation to reduce increased sedimentation and silt deposition include[3]: - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. - Planning silt screening around the area of works to limit the movement and redeposition of material.	No adverse effects.

This option has the potential to cause the following permanent adverse effects on the SPA during the operation phase:

- Physical damage - sedimentation, siltation, erosion, habitat fragmentation, which will vary depending on the impact of the waste discharge plume.
- Toxic contamination - water quality degradation due to waste discharge, displacing prey species from their preferred habitats and damaging supporting habitats such as mudflats and saltmarsh.
- Non-toxic contamination - changes in turbidity, sedimentation, siltation, water temperature and possibly nutrients. This may displace prey species from their preferred habitats.
- Biological disturbances – disturbance to qualifying features and reductions in the extent of habitats which support qualifying species, both of which may subsequently lead to changes in distribution and extent of qualifying features, as a result of the above impact pathways.

The effects of toxic and non-toxic pollution, and physical damage of habitat, could result in permanent impacts but are likely to be localised due to the nature of the option.

The identified effects have the potential to reduce the distribution, extent and population sizes of qualifying species.

- Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport.

- Directional drilling techniques should follow the most up-to-date technologies[4] to reduce impacts to the intertidal habitats within the SPA.
- The pipeline (directionally drilled) will also be installed to a depth that does not cause vibration disturbance of the intertidal habitats. This will reduce impacts to supporting habitats and prey species and reduce the likelihood of habitat loss and pollution events within the SPA.

The development of a Construction and Environmental Management Plan will include all the above proposed mitigation measures and any further measures identified from additional studies at the project stage.

Works within the Thames Estuary & Marshes SPA and surrounding functionally linked habitats should be agreed with Natural England, to determine the appropriate measures taken to protect the surrounding Habitats Sites within the Greater Thames Complex.

Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction.

Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed groundwater abstraction, transfer and run-to-waste discharge to the River Thames.

The operational limits of the transfer and run-to-waste discharge to the River Thames that will be imposed by the updated Thames RDB RBMP

		are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity during operation.	
Dunlin (Overwintering) Grey plover (Overwintering) Black-tailed godwit (Overwintering) Redshank (Overwintering) Ringed plover (Passage)	In addition to the effects listed above, the following temporary or permanent adverse effects are applicable to these qualifying features during construction: • Physical loss – significant localised loss of supporting mudflat and/or saltmarsh habitat from within the SPA boundary (Mucking Flats and Marshes SSSI) in order to construct the run-to-waste pipeline to the River Thames. • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement from preferred foraging or nesting areas and ultimately a reduction in winter survival and future population viability. • Biological disturbances – direct mortality of qualifying features from collision events with increased construction machinery. Reductions in and displacement of the prey availability and/or extent of habitats which support qualifying species, both of which may subsequently lead to displacement of qualifying features within or from the site, as a result of the above impact pathways. There are no additional effects during operation, although the qualifying features within this row are monitored features of the Mucking Flats and Marshes SSSI, which means that effects are likely to occur within the SPA boundary, as opposed to within functionally linked habitat outside of the SPA boundary, as for all qualifying features except hen harrier (not included above).	In addition to the mitigation detailed for all qualifying features of the SPA above, the following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • Sensitive timing of construction works to avoid the overwintering and passage period for qualifying bird species detailed in the Thames Estuary & Marshes SPA conservation advice during July to April inclusive. • Given the sensitivity of the qualifying species at this site, it is strongly recommended that construction works avoid the sensitive period stated above (July to April inclusive). However, if this cannot be avoided, additional mitigation will be required. This should be informed by additional monitoring and assessment, but may involve the following as a guideline: • Avoidance of night working to prevent disturbance to qualifying features when roosting, both within the SPA and functionally linked roosting habitat within or adjacent to the proposed works area. • Best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011) to avoid significant effects due to increased light (if works are programmed at night). • Additional working methods which will reduce disturbance to breeding birds during construction include:	No adverse effects.

- Slow construction start allowing plant engines to idle for five minutes to allow acclimatisation to additional noise.
- All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives.
- All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'.

Works within the Thames Estuary & Marshes SPA and surrounding functionally linked habitats should be agreed with Natural England, to determine the appropriate measures taken to protect the surrounding Habitats Sites within the Greater Thames Complex.

Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction.

Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed groundwater abstraction, transfer and run-to-waste discharge to the River Thames.

The operational limits of the transfer and run-to-waste discharge to the River Thames that will be imposed by the updated Thames RDB RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity during operation.

	Hen harrier (Overwintering)	There are no impact pathways identified for this qualifying feature. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
Thames Estuary & Marshes Ramsar (option is within the Ramsar boundary)	Dunlin (Overwintering) Grey plover (Overwintering) Knot (Overwintering) Black-tailed godwit (Passage) Redshank (Overwintering) Ringed plover (Passage)	See "Possible adverse effects before mitigation" listed above for avocet, dunlin, grey plover, knot, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See "Mitigation measures" listed above for avocet, dunlin, grey plover, knot, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.
	Dunlin (Overwintering) Grey plover (Overwintering) Black-tailed godwit (Passage) Redshank (Overwintering) Ringed plover (Passage)	See "Possible adverse effects before mitigation" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See "Mitigation measures" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.
	Endangered and nationally scarce wetland plants British RDB invertebrates	This option has the potential to cause the following permanent or temporary effects on the Ramsar during the construction phase: • Toxic contamination – chemical pollution in the River Thames within the Mucking Flats and Marshes SSSI component of the Ramsar boundary. Pollution could potentially also be transferred to the south bank of the Thames, within the South Thames Estuary and Marshes SSSI component of the Ramsar. Toxic	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites).	No adverse effects.

contamination is likely to cause damage to supporting habitats.

- Non-toxic contamination – additional sedimentation or siltation within the Mucking Flats and Marshes SSSI component of the Ramsar boundary. This could potentially also be transferred to the south bank of the Thames, within the South Thames Estuary and Marshes SSSI component of the Ramsar, leading to degradation or smothering of supporting habitats within the site boundary.
- Physical loss – significant localised loss of supporting mudflat and/or saltmarsh habitat from within the Ramsar boundary (Mucking Flats and Marshes SSSI) in order to construct the run-to-waste pipeline to the River Thames.
- Physical damage – significant localised habitat loss and/or degradation from pollution, both toxic and non-toxic, within the Ramsar boundary and functionally linked habitat.
- Biological disturbances – reductions in the extent of habitats which support qualifying species, which may subsequently lead to displacement of qualifying features within or from the site, as a result of the above impact pathways.

This option has the potential to cause the following permanent or temporary effects on the Ramsar during the operation phase:

- Physical damage - sedimentation, siltation, erosion, habitat fragmentation, which will vary depending on the impact of the waste discharge plume.
- Toxic contamination - water quality degradation due to waste discharge, displacing prey species from their preferred habitats and damaging supporting habitats such as mudflats and saltmarsh.

- Scottish Environment Protection Agency's (SEPA) good practice guide for intakes and outfalls (WAT-SG-28).
- Environment Agency's best practice guide for screening intakes and outfalls (Science report SC030231).
  - Intake heads should be designed for slow suction velocity to further reduce impingement of freshwater invertebrates against the intake screen. Heads should be fitted orthogonal to downstream currents to reduce forcing against the screens, thus minimising velocity of approach for prey species.
- Best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011) to avoid significant effects due to increased light (if works are programmed at night).
- Specific mitigation to reduce increased sedimentation and silt deposition include[5]:
  - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
  - Planning silt screening around the area of works to limit the movement and redeposition of material.
  - Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport.
- Directional drilling techniques should follow the most up-to-date technologies[6] to reduce impacts to the intertidal habitats within the Ramsar.
- The pipeline (directionally drilled) will also be installed to a depth that does not cause vibration disturbance of the intertidal habitats. This will reduce impacts to

		• Non-toxic contamination - changes in turbidity, sedimentation, siltation, water temperature and possibly nutrients. This may displace prey species from their preferred habitats. • Biological disturbances – disturbance to qualifying features and reductions in the extent of habitats which support qualifying species, both of which may subsequently lead to changes in distribution and extent of qualifying features, as a result of the above impact pathways. The effects of toxic and non-toxic pollution, and physical damage of habitat, could result in permanent impacts but are likely to be localised due to the nature of the option. The identified effects have the potential to reduce the distribution, extent and population sizes of qualifying species.	supporting habitats and prey species and reduce the likelihood of habitat loss and pollution events within the Ramsar. The development of a Construction and Environmental Management Plan which will include all the above proposed mitigation measures and any further measures identified at the project stage. Works within the Thames Estuary & Marshes SPA and surrounding functionally linked habitats should be agreed with Natural England, to determine the appropriate measures taken to protect the surrounding Habitats Sites within the Greater Thames Complex. Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction. Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed groundwater abstraction, transfer and run-to-waste discharge to the River Thames. The operational limits of the transfer and run-to-waste discharge to the River Thames that will be imposed by the updated Thames RDB RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity during operation.	
Medway Estuary & Marshes SPA (approximately 10km south-east)	Dark-bellied brent goose (overwintering) Bewick's swan (overwintering) Dunlin (overwintering)	See "Possible adverse effects before mitigation" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See "Mitigation measures" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.

Black-tailed godwit (passage) Oystercatcher (overwintering) Ringed plover (overwintering) Shoveler (overwintering)			
Breeding bird assemblage Avocet (breeding/overwintering) Little tern (breeding) Common tern (breeding) Pintail (overwintering) Shelduck (overwintering) Teal (overwintering) Wigeon (overwintering) Mallard (overwintering) Turnstone (overwintering) Grey plover (overwintering) Hen harrier (overwintering) Merlin (overwintering) Red-throated diver (overwintering) Curlew (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.

	Cormorant (overwintering) Great-crested grebe (overwintering)			
Medway Estuary & Marshes Ramsar (approximately 10km south-east)	Dark-bellied brent goose (overwintering) Dunlin (overwintering) Black-tailed godwit (Passage) Knot (overwintering) Ringed plover (overwintering) Grey plover (Passage)	See “Possible adverse effects before mitigation” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See “Mitigation measures” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.
	Shelduck (overwintering) Pintail (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
	Nationally scarce plants RDB invertebrate species	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
The Swale SPA (approximately 22.3km south-east)	Dark-bellied brent goose (overwintering) Dunlin (overwintering) Oystercatcher (overwintering) Ringed plover (overwintering)	See “Possible adverse effects before mitigation” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See “Mitigation measures” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.

	Teal (overwintering) Gadwall (overwintering) Curlew (overwintering) Grey plover (overwintering) Redshank (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
The Swale Ramsar (approximately 22.3km south-east)	Dark-bellied brent goose (overwintering) Ringed plover (passage) Shoveler (overwintering) Blac-tailed godwit (overwintering)	See “Possible adverse effects before mitigation” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See “Mitigation measures” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.
	Redshank (passage) Grey plover (overwintering) Wigeon (overwintering) Pintail (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
	Nationally scarce plants RDB invertebrate species	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
Benfleet and Southend Marshes SPA (approximately 14.5km east)	Dark-bellied brent goose (overwintering) Knot (overwintering) Dunlin (overwintering)	See “Possible adverse effects before mitigation” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See “Mitigation measures” listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.

	Ringed plover (overwintering)			
	Grey plover (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.
Benfleet and Southend Marshes Ramsar (approximately 14.5km east)	Dark-bellied brent goose (passage) Knot (overwintering) Dunlin (overwintering)	See "Possible adverse effects before mitigation" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	See "Mitigation measures" listed above for dunlin, grey plover, black-tailed godwit, redshank and ringed plover for the Thames Estuary & Marshes SPA.	No adverse effects.
	Grey plover (overwintering)	There are no impact pathways identified for these qualifying features. Therefore, no adverse effects are anticipated.	None required	No adverse effects.

11.3.5 Stage 2 outcomes

Following this HRA AA, no adverse effects on site integrity are anticipated on any of the Habitats Sites during the construction phase, provided the principles outlined in the 'Assumptions' section above, and the recommended mitigation measures, are implemented at the project level. Mitigation which may be progressed at the project stage could include pre-construction surveys, timing restrictions, habitat avoidance via directional drilling, toolbox talks, and the presence of an Ecological Clerk of Works (ECoW). The construction of the run-to-waste discharge outfall, and associated pipeline infrastructure, are within the boundary of the Thames Estuary & Marshes SPA. Therefore, consent from Natural England is required before any works can begin.

No adverse effect on site integrity can be concluded for during operation, on the understanding that further research identified in the conclusion of this Appropriate Assessment on the potential environmental effects of future design iterations (including the use of alternative water transfer operating procedures or water sources), will lead to a final project that will operate in compliance with the legally binding environmental objectives set out in the RBMP. The operational limits that will be imposed by the RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for construction phases at all sites. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Hydro-ecology studies to identify whether the changes in the water quality and turbidity from the new run-to-waste discharges into the River Thames and Mar Dyke would have an adverse effect on the quality of water required to maintain the integrity of any of the Habitats Sites within the Greater Thames Complex, and their qualifying features.
- A detailed review of the baseline ecological data including birds and wetland invertebrates is also recommended to determine data gaps and additional surveys required to inform more targeted mitigation measures during construction and operation.
- Desk based noise assessment to determine extent of the ZoI once more information is available on construction methodology.
- Evaluation and modelling of emissions from traffic (heavy goods vehicles), plant and non-road mobile machinery to determine if heavy goods vehicle restrictions are required during construction works within close proximity to the Thames Estuary & Marshes SPA and Ramsar Site.
- Finally, the adverse effects identified through this HRA may be compounded through the more frequent and intense effects of climate change, including heat waves, droughts, floods, and rising sea levels. Therefore, a climate change scenario analysis is also recommended to account for mid and long-term effects on the Habitats Sites.

It is also recommended that a Construction Environmental Management Plan be put in place that would include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time and are primarily informed by available,

appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

11.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

12 Corton beach well desalination (Option ESW-DES-008)

Option ID: (ESW-DES-008)

12.1 Option Description

This option proposes seawater abstraction from newly constructed beach wells along Corton discharging to the existing Barsham Water Treatment Works (WTW). Two parts of transfer pipelines are proposed: Transfer 1 from beach wells/infiltration galleries to the new desalination plant (722 m in length); Transfer 2 from the desalination plant to Barsham WTW (approximately 24.7 km in length). Tunnelling (micro-tunnelling/horizontal directional drilling) is likely to be required as route crosses one dual carriageway (A47), three rivers (River Waveney (twice – one existing road bridge, one new crossing), Haddiscoe Cut) and one railway. However, the route follows roads therefore river crossings are already in place so it is proposed that the pipeline will be hung below any bridge. It is assumed a tie-in to the treated sewage outfall at Corton Water Recycling Centre (WRC) such that the brine will mix with the treated sewage effluent prior to discharge.

12.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified eight Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for seven of these eight sites (Table 12.1).

Option ESW-DES-008 therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA).

Table 12.1: Corton beach well desalination (ESW-DES-008) Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Outer Thames Estuary Special Protection Area (SPA) (UK9020309) (0km)	Great Yarmouth North Denes SPA (UK9009271) (approx. 7.5km north)
Southern North Sea Special Area of Conservation (SAC) (UK0030395) (0km)	
Broadland SPA (UK9009253) (approx. 0.05km west)	
Broadland Ramsar Site (UK11010) (approx. 0.05km west)	
The Broads SAC (UK0013577) (approx. 0.05km west)	
Breydon Water SPA (UK9009181) (approx. 3km north)	
Breydon Water Ramsar Site (UK11008) (approx. 3km north)	

12.3 Stage 2 Appropriate Assessment

12.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Outer Thames Estuary SPA (UK9020309)
- Southern North Sea SAC (UK0030395)
- Broadland SPA (UK9009253)

- Broadland Ramsar Site (UK11010)
- The Broads SAC (UK0013577)
- Breydon Water SPA (UK9009181)
- Breydon Water Ramsar Site (UK11008)

12.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 12.2.

12.3.2.1 Outer Thames Estuary SPA (UK9020309) (0km)

The site has been selected for the following qualifying features:

- A001 *Gavia stellata*; Red-throated diver (Non-breeding)
- A193 *Sterna hirundo*; Common tern (Breeding)
- A195 *Sternula albifrons*; Little tern (Breeding)

The conservation objectives set for this Habitats Site states: with regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed above), and subject to natural change:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The populations of each of the qualifying features
- The distribution of the qualifying features within the site

Construction effects

Six proposed wells and associated transfer pipeline is located in close proximity to the Habitats Site, while the proposed desalination plant is approximately 0.75km to the site. During construction there would be temporary land take from the intertidal area from construction of wells/infiltration galleries and transfer pipelines. Therefore, an impact pathway has been identified due to construction works, including physical loss/damage, disturbance and toxic and non-toxic contamination. The potential effects arising during construction are discussed below:

- Physical loss and/or damage – temporary loss/damage to habitat resulting from construction of the wells and transfer pipelines. Footprint of construction works on the intertidal area could result in temporary habitat damage of the Habitats Site itself and/or in functionally linked land used by its qualifying species. There can be an effect of physical damage on foraging and/or roosting behaviours which can lead to increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion or supporting habitat by qualifying species.

- Non-physical disturbance – visual presences, noise (airborne and underwater), vibration and light disturbances. Construction works could cause noise, vibration and visual disturbances which may affect qualifying species of this site when they are foraging. Red-throated diver are also susceptible to underwater noise should construction feature piling or drilling be used. These potential effects may jeopardise adult fitness, survival and breeding success by displacing birds from preferred foraging grounds.
- Toxic contamination – water quality degradation from potential pollution events. During construction there is a risk of oil/chemical spills which could have the potential for toxic contamination on qualifying birds through direct ingestion or indirect effect on their prey species or supporting habitat.
- Non-toxic contamination – changes in turbidity. During construction there is a potential for turbidity to be caused by disturbed sediments, which could affect the foraging of qualifying birds. Terns are known to use the proposed well construction areas for breading and roosting, so their nearby supporting foraging habitat could be affected by changes in water quality due to any construction activities that could lead to changes in turbidity and increased sedimentation/siltation. This may lead to changes in species abundance and distribution of the qualifying terns.
- Biological disturbances – this may include changes to habitat quality and availability of breeding and foraging habitats, habitat avoidance due to changes in water quality and disturbances and changes to habitat natural succession. These may all lead to changes in species abundance and distribution. The effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site. Construction works may result in the spread of invasive species impacting on wintering red-throated diver due to habitat degradation.

Mitigation

The following mitigation measures are proposed to mitigate the effects identified and discussed above. They involve best practice and design and engineering solutions:

- Construction Industry Research and Information Association (CIRIA) C741 Environmental good practice on site guide
- Environment Agency's Pollution Prevention Guidelines (PPGs) (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites), 'Guidance Notes for the Reduction of Obtrusive Light'.
- Due regard will be had to implementing the TIDE Toolbox: Guiding Estuarine Management
- Biosecurity measures to ensure appropriate removal and/or management control of Invasive Non-Native Species (INNS) at source.
- Trenchless techniques in the near shore/ intertidal zone.
- Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England.
- Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill.
- Specific mitigation to reduce elevated turbidity/sedimentation and silt deposition downstream of the proposed works should include silt screening around the area of works to limit the movement and redeposition of material.
- Consideration to critical seasonal periods for bird species must be given (winter and breeding seasons).
- Development of a Construction and Environmental Management Plan (CEMP) which will include all the above proposed mitigation measures and any further measures identified at the project stage.

Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

During operation, the new wells/infiltration galleries and transfer pipelines will result in land take from the intertidal area, potentially affecting habitats and prey species that support the qualifying birds. Desalination process requires discharge of hyper saline waters (brine) which it is currently understood to be discharged after mixing with existing flows from the existing discharge location at the wastewater treatment works near Corton. This could have the potential to impact local habitats and qualifying species given sensitivity to changes to existing salinity levels. Brine discharge is likely to result in adverse effects on qualifying species due to the following reasons:

- Physical loss and/or damage – loss of intertidal habitat where wells/galleries and pipelines are installed. The installation may affect fish population which in turn may affect the qualifying bird species that rely on fish as prey. This may damage the foraging habitat of red-throated diver indirectly through impacting the suitability of the site for its prey species. Nevertheless, effects are likely to be temporary and the bird communities are likely to shift to nearby areas within the site as the likely affected area is small compared to the overall Habitats Site area.
- Non-toxic contamination - changes in water quality (salinity levels) due to brine discharge. This may impact the suitability of the area for qualifying bird species indirectly through impacting the suitability of the site for its prey species.

Mitigation

The following mitigation measures are proposed to mitigate the operation effects identified and discussed above:

- Installation of a salinity and residual chemical diffuser on the discharge point. This will increase mixing and enhance rapid initial dilution of the concentrate, minimising increases in local salinity and its influence on the coastal habitat.
- Methods for brine discharge or processing that will remove the need to discharge into the sea. This could include discharge of brine to discharge lagoons on land removing potential effects. If this option were to be pursued then the use and harvesting of salt or highly concentrated brine for use as refrigerating fluid, water softening and purification and de-icing should be considered.
- Further brine dilution with cooling water (this will also be mitigated by permits governing the temperature of discharged water)

Following assessment, during the operation phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

12.3.2.2 Southern North Sea SAC (UK0030395) (0km)

The site has been selected for the following qualifying features:

- Harbour porpoise (*Phocoena phocoena*)

The conservation objectives for the Southern North Sea SAC are to ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status for harbour porpoise in UK waters. In the context of natural change, this will be achieved by ensuring that:

- Harbour porpoise is a viable component of the site.
- There is no significant disturbance of the species.

- The condition of supporting habitats and processes, and the availability of prey is maintained.

Construction effects

Wells or infiltration galleries will need to be constructed on the foreshore with aims to sit below water level. Depending upon the construction methodology (e.g., piling), potential underwater noise could be generated over a certain area which could cause disturbance to harbour porpoise or their prey species. Depending upon the timing of construction works, during winter periods when Harbour porpoises are expected closer to the south, effects of underwater construction noise could be more significant. Therefore, an impact pathway has been identified due to construction works, including disturbances and toxic contamination. The potential effects arising during construction are discussed below:

- Non-physical disturbance – noise, vibration and light disturbance. Potential adverse effects from indirect impacts such as underwater construction noise, vibration and light disturbance have also been identified for harbour porpoise during wells/galleries and pipeline installation. Exposure to anthropogenic disturbance could have indirect effects on species abundance and spatial distribution. Harbour porpoises are likely to avoid areas within the vicinity of the works due to anthropogenic disturbance. Nevertheless, this disturbance is minimal considering the size of the Habitats Site available to harbour porpoises and will not result in significant effects.
- Toxic contamination – water quality degradation from potential pollution events. Construction activities may lead to adverse effects via the loss of foraging habitat and degradation due to increases in suspended sediment, pollution incidents and the introduction of INNS. The deposition of excess sediments could smother benthic communities, reducing the availability of prey. The incidental release of pollutants during construction could also increase contaminant levels in the water column and sediment, which over time could bioaccumulate into residing species.
- Biological disturbance – changes to prey availability, changes to habitat availability, changes to habitats natural succession, habitat avoidance due to changes in water quality and disturbance, spread of invasive species.

Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features. The justification for this is outlined below.

The discharge of brine mixed with the existing flows are not anticipated to cause a salinity level that would be considered as a threat or pressure on the qualifying species of this site, i.e., Harbour porpoise, or its prey which are small pelagic fish. Also, given the expanse of similar habitats and prey available within this Habitats Site, operation of this option is unlikely to result in a significant disturbance to Harbour porpoise or effect to the SAC. Under the conservation objectives, the condition of supporting habitats and processes, and the availability of prey for Harbour porpoise will not be affected by the option operation. It can be concluded that during the operation phase all potential effects on site integrity are not likely to be significant and the site's conservation objectives will not be adversely affected.

12.3.2.3 Broadland SPA (UK9009253) (approximately 0.05km west)

The site has been selected for the following qualifying features:

- A021 *Botaurus stellaris*; Great bittern (Breeding)

- A037 *Cygnus columbianus bewickii*; Bewick's swan (Non-breeding)
- A038 *Cygnus cygnus*; Whooper swan (Non-breeding)
- A050 *Anas penelope*; Eurasian wigeon (Non-breeding)
- A051 *Anas strepera*; Gadwall (Non-breeding)
- A056 *Anas clypeata*; Northern shoveler (Non-breeding)
- A081 *Circus aeruginosus*; Eurasian marsh harrier (Breeding)
- A082 *Circus cyaneus*; Hen harrier (Non-breeding)
- A151 *Philomachus pugnax*; Ruff (Non-breeding)

The conservation objectives set for this Habitats Site is similar to that for Outer Thames Estuary SPA, to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive.

Construction effects

The impact pathways and potential significant effects on this site during construction are similar to that described for the Outer Thames Estuary SPA above, except that there will not be any physical loss of the site. The closest boundary of this Site is approximately 0.05km from the proposed transfer pipeline. Nevertheless, this Site is at least approximately 3.5km from the proposed desalination plant. Impact pathways identified due to construction works include disturbances, toxic and non-toxic contamination. The potential effects arising during construction are discussed below:

- Non-physical disturbance – visual presences, noise (airborne), vibration and light disturbances. Construction works could cause noise, vibration and visual disturbances which may affect qualifying species of this site when they are foraging. These potential effects may jeopardise adult fitness, survival and breeding success by displacing birds from preferred foraging grounds.
- Toxic contamination – water quality degradation from potential pollution events. During construction of wells/galleries, desalination plant and pipeline there is a risk of oil/chemical spills into waterbodies which could have the potential for toxic contamination on qualifying birds through direct ingestion or indirect effect on their prey species or supporting habitat.
- Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition. Construction of the wells/galleries, desalination plant and pipeline may lead to changes in water quality, including increased turbidity and sedimentation, which can have negative effects on the life cycle of the qualifying bird species.
- Biological disturbances – changes in habitat quality and availability; potential for bird populations to be displaced from current foraging areas. This may include changes to availability of breeding and foraging habitats, habitat avoidance due to changes in water quality, disturbances or introduction of invasive species, and changes to habitat natural succession. These may lead to changes in species distribution, while the effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Mitigation measures proposed for the Outer Thames Estuary SPA are applicable for mitigating the effects discussed. Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features.

12.3.2.4 Broadland Ramsar Site (UK11010) (approximately 0.05km west)

The site has been selected for the following criteria:

Ramsar Site Criterion 2: The site supports a number of rare species and habitats within the biogeographical zone context, including the following Habitats Directive Annex I features:

- H7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* Calcium-rich fen dominated by great fen sedge (saw sedge).
- H7230 Alkaline fens Calcium-rich spring water-fed fens.
- H91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) Alder woodland on floodplains,

and the Annex II species:

- S1016 Vertigo moulinsiana (Desmoulin's whorl snail)
- S1355 Lutra lutra (Otter)
- S1903 *Liparis loeselii* (Fen orchid).

The site supports outstanding assemblages of rare plants and invertebrates including nine British Red Data Book plants and 136 British Red Data Book invertebrates.

Ramsar Site Criterion 6: Species/populations occurring at levels of international importance. The following species have peak counts in winter:

- Tundra swan, *Cygnus columbianus bewickii*, Northwest (NW) Europe
- Eurasian wigeon, *Anas penelope*, NW Europe
- Gadwall, *Anas strepera strepera*, NW Europe
- Northern shoveler, *Anas clypeata*, NW & Central (C) Europe
- Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK
- Greylag goose, *Anser anser*, Iceland/UK, Ireland

Conservation objectives are not produced for Ramsar Sites. In this instance, regard has been had to the high-level conservation objective established in the Ramsar Site Convention's "wise use of wetlands" which states: *"…the maintenance of ecological character, achieved through the implementation of ecosystem approaches within the context of sustainable development" (Ramsar Site Convention Secretariat, 2010)."*

Furthermore, with the reference to the relevant qualifying interest features of the Ramsar Site, the conservation advice package produced by Natural England for the overlapping SPA designation (i.e., Broadland SPA) will be, in most cases, sufficient to support the management of the Ramsar Site interests.

Construction effects

The geographical range of this site is the same as the Broadland SPA. The impact pathways and potential significant effects on this site during construction are mostly the same as described for the Broadland SPA above, with the addition of habitats, otter, invertebrates and plant species for which the Ramsar Site is designated. Qualifying bird species may be dependent upon some of these features however, in which case the impacts on these features remain applicable to the Ramsar Site.

The potential effects arising during construction are discussed below:

- Non-physical disturbance – visual presences, noise (airborne), vibration and light disturbances. Construction works could cause noise, vibration and visual disturbances which may affect qualifying species of this site when they are foraging. These potential effects may

jeopardise adult fitness, survival and breeding success by displacing birds from preferred foraging grounds.

- Toxic contamination – water quality degradation from potential pollution events. During construction of wells/galleries, desalination plant and pipeline there is a risk of oil/chemical release into waterbodies during construction activities which could have the potential for toxic contamination on qualifying birds and otter through direct ingestion or indirect effect on their prey species or supporting habitat. Otters can occupy very large ranges (around 32km for males and 20km for females) and can be adversely affected by pollution events leading to a reduction in their food supply (e.g. as a result of fish mortality). Habitats close to the option, located beyond the Ramsar Site boundary, may be used by otters as feeding grounds, acting as functionally linked habitat and providing an important role for maintaining or restoring the population of these qualifying species at favourable conservation status.
- Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition. Construction of the wells/galleries, desalination plant and pipeline may lead to changes in water quality, including increased turbidity and sedimentation, which can have negative effects on the life cycle of the qualifying bird species.
- Biological disturbances – changes in habitat quality and availability; potential for bird and otter populations to be displaced from current foraging areas. This may include changes to availability of breeding and foraging habitats, habitat avoidance due to changes in water quality, disturbances or introduction of invasive species, and changes to habitat natural succession. These may lead to changes in bird species distribution, while the effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site. These may also lead to reduced productivity and growth of the vegetation that conforms the habitats supporting snail populations; otters can also be affected by increased sedimentation altering ecosystem processes and food webs that they or their prey rely on.

Mitigation measures proposed for the Outer Thames Estuary SPA are applicable for mitigating the effects discussed. Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features.

12.3.2.5 The Broads SAC (UK0013577) (approximately 0.05km west)

The site has been selected for the following qualifying features:

- H3140. Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.; Calcium-rich nutrient-poor lakes, lochs and pools
- H3150. Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation; Naturally nutrient-rich lakes or lochs which are often dominated by pondweed
- H6410. *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*); Purple moor-grass meadows
- H7140. Transition mires and quaking bogs; Very wet mires often identified by an unstable `quaking` surface
- H7210. Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*; Calcium-rich fen dominated by great fen sedge (saw sedge)*
- H7230. Alkaline fens; Calcium-rich spring water-fed fens
- H91E0. Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*); Alder woodland on floodplains*

- S1016. *Vertigo moulinsiana*; Desmoulin's whorl snail
- S1355. *Lutra lutra*; Otter
- S1903. *Liparis loeselii*; Fen orchid
- S4056. *Anisus vorticulus*; Little whirlpool ram's-horn snail
- (* denotes a priority natural habitats or species)

Construction effects

This SAC is located approximately 0.05km west of the option footprint (from the closest point) and is designated for supporting a variety of species, such as plants and invertebrates, in addition to highly mobile species such as waterbirds and otter. The geographical range of this site is the same as the Broadland Ramsar Site. The impact pathways and potential significant effects on this site during construction are the same as described for the Broadland Ramsar Site above.

Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features.

12.3.2.6 Breydon Water SPA (UK9009181) (approximately 3km north)

The site has been selected for the following qualifying features:

- A037 *Cygnus columbianus bewickii*; Bewick's swan (Non-breeding)
- A132 *Recurvirostra avosetta*; Pied avocet (Non-breeding)
- A140 *Pluvialis apricaria*; European golden plover (Non-breeding)
- A142 *Vanellus vanellus*; Northern lapwing (Non-breeding)
- A151 *Philomachus pugnax*; Ruff (Non-breeding)
- A193 *Sterna hirundo*; Common tern (Breeding)

The conservation objectives set for this Habitats Site is similar to that for Outer Thames Estuary SPA, to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive.

Construction effects

The site is reasonably within the foraging range of the qualifying bird species. The intertidal area where the proposed works will situate may act as functionally linked habitat for the qualifying bird species to forage, although the site is upstream of the proposed works and distant that no noise or visual disturbances are expected. Impact pathways identified due to construction works include toxic and non-toxic contamination and biological disturbance. The potential effects arising during construction are discussed below:

- Toxic contamination – water quality degradation from potential pollution events. During construction of wells/galleries, desalination plant and pipeline there is a risk of oil/chemical spills into waterbodies which could have the potential for toxic contamination on qualifying birds through direct ingestion or indirect effect on their prey species or supporting habitats.
- Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition. Construction of the wells/galleries, desalination plant and pipeline may lead to

changes in water quality, including increased turbidity and sedimentation, which can have negative effects on the life cycle of the qualifying bird species.

- Biological disturbances – changes in habitat quality and availability; potential for bird populations to be displaced from current foraging areas. This may include changes to availability of breeding and foraging habitats, habitat avoidance due to changes in water quality, and disturbances or introduction of invasive species.

Mitigation measures proposed for the Outer Thames Estuary SPA are applicable for mitigating the effects discussed. Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features.

12.3.2.7 Breydon Water Ramsar Site (UK11008) (approximately 3km north)

The site has been selected for the following fixed criteria:

Ramsar Site Criterion 5: Assemblages of international importance: 68,175 waterfowl, non-breeding season (5 year peak mean 1998/99-2002/2003)

Ramsar Site Criterion 6: Species/populations occurring at levels of international importance Species with peak counts in winter:

- Tundra swan, Cygnus columbianus bewickii, NW Europe
- Northern lapwing, *Vanellus vanellus*, Europe – breeding
- Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK
- Eurasian wigeon, *Anas penelope*, NW Europe
- Northern shoveler, *Anas clypeata*, NW & C Europe
- European golden plover, *Pluvialis apricaria apricaria*, *Pluvialis apricaria altifrons* Iceland & Faroes/E Atlantic
- Black-tailed godwit, *Limosa limosa islandica*, Iceland/W Europe

Conservation objectives are not produced for Ramsar Sites. With the reference to the relevant qualifying interest features of the Ramsar Site, the conservation advice package produced by Natural England for the overlapping SPA designation (i.e., Breydon Water SPA) will be, in most cases, sufficient to support the management of the Ramsar Site interests.

Construction effects

Breydon Water Ramsar Site is within the geographical range of Breydon Water SPA. The impact pathways and potential significant effects on this site during construction are the same as described for the Breydon Water SPA above.

Following assessment, during the construction phase it can be concluded that all potential effects on integrity can be fully mitigated, and the site's conservation objectives will not be adversely affected.

Operation effects

No pathways have been identified during the operation of this option that could lead to LSE on this Habitats Site and its qualifying features.

12.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible

12.3.4 Monitoring

It is recommended that breeding and wintering bird surveys are undertaken within the construction footprint with an additional 500m buffer to determine if functionally linked habitat is present within the ZoI. In addition, a desk-based noise assessment should be undertaken once more information is provided on the construction methodology to determine the extent of elevated noise disturbance above ambient conditions. The distribution of qualifying bird species could then be overlayed with noise contours to determine potential adverse effects from anthropogenic disturbance and appropriate mitigation measures.

Phase I Biotope Mapping and Phase II sampling are also recommended within the construction footprint with an additional 500m buffer to determine the biotopes and species present that will be potentially lost or affected during construction and operation of the beach wells/infiltration galleries.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 12.2: Option ESW-DES-008 (Corton beach well desalination) - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Outer Thames Estuary SPA (0km)	All	This option may have the following effects on the SPA during the construction and operation phases: **During construction** • Physical loss and/or damage – temporary loss/damage to habitat resulting from construction of the wells and transfer pipelines. • Non-physical disturbance – visual presences, noise (airborne and underwater), vibration and light disturbances. • Toxic contamination – water quality degradation from potential pollution events. • Non-toxic contamination – changes in turbidity. • Biological disturbances – changes to habitat quality and availability of breeding and foraging habitats, habitat avoidance due to changes in water quality and disturbances and changes to habitat natural succession. **During operation** • Physical loss and/or damage – loss of intertidal habitat where wells/galleries and pipelines are installed. • Non-toxic contamination – changes in water quality (salinity levels) due to brine discharge.	For construction phase, the following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites), 'Guidance Notes for the Reduction of Obtrusive Light'. • Due regard will be had to implementing the TIDE Toolbox: Guiding Estuarine Management • Biosecurity measures to ensure appropriate removal and/or management control of Invasive Non-Native Species (INNS) at source. • Trenchless techniques in the near shore/ intertidal zone. • Works in the vicinity or within this site should be either accompanied by a noise assessment and noise thresholds agreed with Natural England. • Specific mitigation for night works and artificial lighting will incorporate lighting hoods to minimise the light spill. • Specific mitigation to reduce elevated turbidity/sedimentation and silt deposition downstream of the proposed works should include silt screening around the area of works to limit the movement and redeposition of material.	No adverse effects.

			• Consideration to critical seasonal periods for bird species must be given (winter and breeding seasons). • Development of a Construction and Environmental Management Plan (CEMP) which will include all the above proposed mitigation measures and any further measures identified at the project stage. For operation, the following mitigation measures are proposed to mitigate the operation effects identified: • Installation of a salinity and residual chemical diffuser on the discharge point. This will increase mixing and enhance rapid initial dilution of the concentrate, minimising increases in local salinity and its influence on the coastal habitat. • Methods for brine discharge or processing that will remove the need to discharge into the sea. This could include alternatively, discharge of the brine could be made to discharge lagoons on land removing potential effects. If this option were to be pursued then the use and harvesting of salt or highly concentrated brine for use as refrigerating fluid, water softening and purification and de-icing should be considered. • Further brine dilution with cooling water (this will also be mitigated by permits governing the temperature of discharged water)	
Southern North Sea Special Area of Conservation (SAC) (UK0030395) (0km)	All	This option may have the following effects on the SAC during the construction phase: **During construction** • Non-physical disturbance – noise (underwater), vibration and light disturbance. • Toxic contamination – water quality degradation from potential pollution events.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA, except the following: • Consideration to seasonal periods for Harbour porpoise must be given (winter periods when Harbour porpoises are expected closer to the south).	No adverse effects.

		• Biological disturbances – changes to habitat quality and availability of breeding and foraging habitats, habitat avoidance due to changes in water quality and disturbances and changes to habitat natural succession. No adverse effects are anticipated during the operation phase.		
Broadland SPA (UK9009253) (approx. 0.05km west)	All	This option may have the following effects on the SPA during the construction phase: **During construction** • Non-physical disturbance – visual presences, noise (airborne), vibration and light disturbances. • Toxic contamination – water quality degradation from potential pollution events. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition. • Biological disturbances – changes to habitat quality and availability; potential for bird populations to be displaced from current foraging areas. No adverse effects are anticipated during the operation phase.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA.	No adverse effects.
Broadland Ramsar (UK11010) (approx. 0.05km west)	All	This option may have the following effects on the Ramsar site during the construction phase: **During construction** • Non-physical disturbance – visual presences, noise (airborne), vibration and light disturbances. • Toxic contamination – water quality degradation from potential pollution events. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA.	No adverse effects.

		• Biological disturbances – changes to habitat quality and availability; potential for bird and otter populations to be displaced from current foraging areas. No adverse effects are anticipated during the operation phase.		
The Broads SAC (UK0013577) (approx. 0.05km west)	All	The potential adverse effects on the Ramsar site are the same as detailed above for Broadland Ramsar.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA.	No adverse effects.
Breydon Water SPA (UK9009181) (approx. 3km north)	All	This option may have the following effects on the SPA during the construction phase: **During construction** • Toxic contamination – water quality degradation from potential pollution events. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition. • Biological disturbances – changes to habitat quality and availability; potential for bird populations to be displaced from current foraging areas. No adverse effects are anticipated during the operation phase.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA.	No adverse effects.
Breydon Water Ramsar (UK11008) (approx. 3km north)	All	The potential adverse effects on the Ramsar site are the same as detailed above for Breydon Water SPA.	The proposed mitigation measures for construction phase to avoid and/or alleviate adverse effects on this Site is the same as detailed above for Outer Thames Estuary SPA.	No adverse effects.

12.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is considered that with adherence to the proposed mitigation, the works associated with the option ESW-DES-008 (Corton beach well desalination) will not have any adverse effects on the integrity of the Outer Thames Estuary SPA, Southern North Sea SAC, Broadland SPA, Broadland Ramsar Site, The Broads SAC, Breydon Water SPA or Breydon Water Ramsar Site during the construction and operation phases.

Breeding and wintering bird surveys as well as Phase I Biotope Mapping and Phase II sampling are recommended within the construction footprint with an additional 500m buffer. Desk-based noise assessment is also recommended once more information is provided on the construction methodology.

It is recommended that if any changes are made to the design or location of this option, the HRA is revised and this document amended accordingly.

12.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

13 Langford EDR Nitrate Removal + Pipeline (ESW-NIT-005)

Option ID: (ESW-NIT-005)

13.1 Option Description

This option proposes an electrodialysis reversal (EDR) treatment to be positioned within the existing Lanford water treatment works (WTW) site boundary. It will be located downstream of the existing Granular Activated Carbon (GAC) treatment, and upstream of the WTW's chlorine contact tanks.

The option also includes a waste stream discharge (brine) pipeline to Anglian Water's Maldon sewage treatment works (STW) on Osea Road. The pipeline is approximately 6.7km long, with a nominal diameter of 200mm. It is to be laid in road for the entirety of the pipeline route.

There will be no increase in deployable output as a result of this option. The option will allow Langford WTW to continue to operate in times of high nitrate, whereas currently when the nitrate concentration in the raw water is too high, the WTW has to cease production.

13.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified five Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for three of these sites (Table 13.1).

Option NIT-005 therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA).

Table 13.1: NIT-005 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Blackwater Estuary Ramsar Site (UK11007) (approximately 0.08km southeast)	Crouch & Roach Estuaries SPA (UK9009244) (approximately 10km south)
Essex Estuaries SAC (UK0013690) (approximately 0.08km southeast)	Crouch & Roach Estuaries Ramsar Site (UK11058) (approximately 10km south)
Blackwater Estuary SPA (UK9009245) (approximately .08km southeast)	

13.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 13.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects
- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

13.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Blackwater Estuary Ramsar Site (UK11007)
- Essex Estuaries SAC (UK0013690)
- Blackwater Estuary SPA (UK9009245)

13.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 13.2.

13.3.2.1 Blackwater Estuary Ramsar Site (UK11007) (approximately 0.08km southeast)

The Blackwater Estuary is the largest Essex estuary north of the Thames, and is one of the largest estuarine complexes in East Anglia. It is situated between the Dengie peninsula and Mersea Island on the Essex coast. The Ramsar Site covers a total area of 4,395.15 hectares, and is coincident with Blackwater Estuary Site of Special Scientific Interest (SSSI).

The estuary contains mudflats which are fringed by saltmarsh on their upper shores. Other habitats within the site include shingle and shell banks, offshore islands, a sea wall, ancient grazing marsh and associated fleet and ditch systems, as well as semi-improved grassland. The site's saltmarsh habitat triggers Ramsar Site Criterion 1, and the sequences of saltmarsh plant communities present are designated under Ramsar Site Criterion 3. These features are all of high conservation interest, as the mosaic of habitats supports nationally scarce plants and rare invertebrate assemblages (16 British Red Data Book species and 94 local and notable species). The 16 British Red Data Book species are as follows: the endangered water beetle (*Paracymus aeneus*); the vulnerable damselfly (*Lestes dryas*), the flies (*Aedes flavescens, Erioptera bivittata, Hybomitra expollicata*) the spiders (*Heliophanus auratus* and *Trichopterna cito*); the rare beetles (*Baris scolopacea, Philonthus punctus, Graptodytes bilineatus* and *Malachius vulneratus*), the flies (*Campsicemus magius* and *Myopites eximia*), the moths (*Idaea ochrata* and *Malacosoma castrensis*) and the spider (*Euophrys*).

Internationally and nationally important numbers of overwintering waterfowl are also supported by this site. Bird species are designated for this site under Ramsar Site Criteria 5 and 6. In winter, 105061 waterfowl are supported by this site, an assemblage of international importance. This includes populations of the following species: dark-bellied brent goose (*Branta bernicla bernicla*), grey plover (*Pluvialis squatarola*), dunlin (*Calidris alpina alpina*), black-trailed godwit (*Limosa limosa islandica*), common shelduck (*Tadorna tadorna*), European golden plover (*Pluvialis apricaria apricaria*) and common redshank (*Tringa totanus totanus*).

Construction effects

There is potential for adverse effects during construction due to direct impacts on the Ramsar Site, which is located in close proximity to the option. There is the possibility of noise, visual, vibration and light disturbance on qualifying species, as well as dust and air pollution. The pipeline is to be laid entirely within roads, therefore no physical loss of supporting habitats is expected. At Langford it is assumed that no works other than deliveries of nitrate to site will occur during the construction phase, as all facilities already exist.

The landscape within 500m of the pipeline includes the Ramsar Site, so construction-related impacts cannot be ruled out at this stage. The pipeline crosses two waterbodies which feed into the Ramsar Site (Spickets Brook and the River Blackwater), and both the Option and the Site are within the Essex Gravels Water Body (GB40503G000400). Due to this hydrological connectivity, it is possible that any pollution events, toxic (chemical) or non-toxic (sedimentation/siltation) could be transferred downstream to the site and impact qualifying features. Habitats which are designated under Criterion 1 such as saltmarshes (and those which support the qualifying animal species), may be degraded through pollution. Reduced water quality may adversely affect the aquatic flora and fauna for which qualifying features rely; these food resources may be lost and result in changes to the population sizes and distribution of qualifying features within or from the site. There is also the potential for dust produced during construction works to enter these waterbodies via run-off or deposition), adding to the suspended sediment load in the river. Potential changes in water quality during pipeline installation have also been identified due to pollution incidents and increases in suspended sediment from vibration disturbance which could cause habitat degradation and changes to habitat availability for qualifying birds. In addition, construction works may lead to the introduction and/or spread of INNS.

Therefore, the construction of this Option could have direct effects on the feeding and/or roosting behaviours of qualifying birds, increasing energy expenditure due to more frequent flights, potential abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site. Effects on other qualifying features, including habitat alterations, changes to natural plant succession, and impacts on invertebrate populations may also occur. As well as this, the WFD assessment has identified the Essex Gravels Water Body as requiring further assessment in order to inform likely future changes in abstraction patterns.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

No significant effects during operation are anticipated. The purpose of the option is to add a nitrate stage to the existing WTW, which will result in improved drinking water quality, which can in turn lead to improved environmental water quality. It is unknown if this will result in noticeable improvements within the Ramsar Site, but the improvements in water quality may increased food availability and improve the habitat quality for qualifying features. Flow and water quality are not identified as a threat or pressure on this site within the Site Improvement Plan (SIP)[26].

13.3.2.2 Essex Estuaries SAC (UK0013690) (approximately 0.08km southeast)

Essex Estuaries is the second largest estuarine site on the east coast of England. It contributes to the essential range and variation of estuaries in the United Kingdom (UK) as the best example of a coastal plain estuary system on the British North Sea coast.

This Habitats Site is designated for supporting a coastal plain estuarine system with open coast mudflats and sandflats not covered by seawater at low tide, sandbanks, *Salicornia* and other annuals colonising mud and sand, spartina swards (*Spartinion maritimae*), Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and Mediterranean and hermos-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*).

Construction effects

[26] Natural England (2015). Site Improvement Plan: Essex Estuaries (online) available at: Site Improvement Plan: Essex Estuaries - SIP077 (naturalengland.org.uk)

The Essex Estuaries SAC boundary within 10km of the option is identical to that of the Blackwater Estuary Ramsar Site designation, with the exception of the SAC including the waters of the River Blackwater, whereas the Ramsar Site borders the river, covering only the terrestrial components.

Therefore, the impact pathways and potential significant effects on this site during construction are the same as described for Blackwater Estuary Ramsar Site above, although estuarine habitats and saltmarsh plants are the only qualifying features within this site, which will act as receptors of the effects of pollution events.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The operation effects on the Essex Estuaries SAC and specifically qualifying habitats will be similar to the ones listed above for the Blackwater Estuary Ramsar Site, as both sites follow the same boundary within 10km of the option.

13.3.2.3 Blackwater Estuary SPA (UK9009245) (approximately 0.08km southeast)

The extent of Blackwater Estuary SPA is identical to that of the corresponding Ramsar Site designation. The SPA is designated for the following waterbird species: black-tailed godwit (*Limosa limosa islandica*), dark-bellied brent goose (*Branta bernicla bernicla*), dunlin (*Calidris alpina alpina*), grey plover (*Pluvialis squatarola*), hen harrier (*Circus cyaneus*), little tern (*Sternula albifrons*), pochard (*Aythya ferina*), and ringed plover (*Charadrius hiaticula*) as well as being designated for waterbird assemblages.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for Blackwater Estuary Ramsar Site above, although waterbird populations are the only qualifying features within this site, which will act as receptors of the effects of pollution events.

Operation effects

The operation effects on the Blackwater Estuary SPA and specifically qualifying waterbirds will be similar to the ones listed above for the Blackwater Estuary Ramsar Site, as both sites follow the same boundary.

13.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible

13.3.4 Monitoring

Monitoring of pollutants immediately downstream of the restoration and improvement areas should be undertaken to ensure that significant levels of contaminants are not being transferred into the Blackwater Estuary.

Specific monitoring of qualifying features within the Habitats Sites is recommended, due to the proximity between the sites and the option, as well as the presence of functionally linked habitats

(waterbodies such as streams and ponds) that mobile qualifying species (waterbirds) could utilise, between the sites and the option. The presence of these habitats means it is likely that qualifying bird species will be present within or adjacent to the works.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 13.2: Option NIT-005 – Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Blackwater Estuary Ramsar (approximately 0.08km southeast)	All	This option may have the following permanent or temporary effects on the Ramsar during the construction phase: • Physical damage – habitat degradation as a result of water quality changes in case of pollution events and increases in suspended sediment loading that may affect bird nesting/feeding grounds and functionally linked land. • Toxic contamination – chemical pollution in the upstream River Blackwater and/or Spickets Brook during construction works which could be transferred downstream to within the Ramsar boundary and damage qualifying habitats and plants and reduce prey availability for qualifying animals (waterbirds and insects). • Non-toxic contamination – additional sedimentation or siltation during construction works within or adjacent to the River Blackwater and/or Spickets Brook, leading to degradation or smothering of qualifying or supporting habitats downstream within the Ramsar. • Physical loss/damage – significant localised habitat loss and/or degradation from pollution, both toxic and non-toxic. • Biological disturbances – potential introduction of INNS, reductions in the prey availability and/or extent of habitats (qualifying or those which support qualifying species), anthropogenic disturbances, and habitat avoidance, all of which may subsequently lead to displacement of qualifying features within or from the site, as a result of the above impact pathways. No adverse effects will arise during operation.	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. Specific mitigation to reduce increased sedimentation and silt deposition downstream include: • Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. • Planning silt screening around the area of works to limit the movement and redeposition of material. • Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport. • Development of a Construction and Environmental Management Plan (CEMP) which will include all the above proposed mitigation measures and any further measures identified at the project stage. • Additional working methods which will reduce disturbance to overwintering birds during construction include:	No adverse effects.

			- A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; - All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. With this in place, adverse effects on the Habitats Site will be alleviated during construction. Monitoring of pollution downstream of the works areas will enable early detection of any changes during construction which may have a significant effect on the site downstream.	
Essex Estuaries SAC (approximately 0.08km southeast)	All	The potential adverse effects on the SAC are the same as detailed above for the Blackwater Estuary Ramsar.	The proposed mitigation to avoid and/or alleviate adverse effects on the Ramsar is the same as detailed above for the Blackwater Estuary Ramsar.	No adverse effects.
Blackwater Estuary SPA (approximately 0.08km southeast)	All	The potential adverse effects on the SPA are the same as detailed above for the Blackwater Estuary Ramsar.	The proposed mitigation to avoid and/or alleviate adverse effects on the SPA is the same as detailed above for the Blackwater Estuary Ramsar, with the addition of the following measures: • If construction works are undertaken during the wintering period (September – March inclusive), pre-construction hen harrier surveys will be required to determine presence/absence and the number of individuals (if present). • These works will only be permitted if the population present at risk of disturbance is <1% of the cited SPA population and works will be supervised by an Ecological Clerk of Works (ECoW). Where >1% of the qualifying species	No adverse effects.

		are present, directional drilling pipeline installation will be considered to avoid the loss of potentially functionally linked habitat and/or the construction works will be completed via a staged process whereby habitat is reinstated upon completion and suitable (undisturbed) supporting habitat is present for hen harrier to use if displaced temporarily by the works. • During construction works an ECoW will be required to maintain a sufficient buffer (200m minimum). If a qualifying species is present within the ZoI, works must cease until they have moved outside of the ZoI. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats.

13.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is ascertained that with adherence to the proposed mitigation, the works associated with the option NIT-005 will not have any adverse effects on the integrity of the Blackwater Estuary Ramsar Site, Essex Estuaries SAC, or Blackwater Estuary SPA during the construction phase.

During construction, continuous pollution (toxic and non-toxic) monitoring is recommended immediately downstream of the pipeline construction works area in order to identify, at the earliest stage, changes which may result in adverse effects downstream at the Habitats Sites.

It is recommended that if any changes are made to the design or location of this option, the HRA is revised and this document amended accordingly.

13.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

14 Langham EDR Nitrate Removal (ESW-NIT-006)

Option ID: (ESW-NIT-006)

14.1 Option Description

This option proposes a nitrate electrodialysis reversal (EDR) to be positioned within the existing Langham Water Treatment Works (WTW) site boundary. It will be located downstream of the existing Granular Activated Carbon (GAC) treatment and upstream of the WTW's chlorine contact tanks.

The option includes a waste stream discharge pipeline to Anglian Water's Colchester sewage treatment works (STW). The pipeline is approximately 14.523km long, with a nominal diameter of 200mm.

14.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified nine Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for three of these sites (Table 14.1).

Option NIT-006 therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA).

Table 14.1: NIT-006 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Colne Estuary Ramsar Site (UK11015) (approximately 3.5km south)	Stour and Orwell Estuaries Ramsar Site (UK11067) (approximately 5.8km east)
Colne Estuary SPA (UK9009243) (approximately 3.5km south)	Stour and Orwell Estuaries SPA (UK9009121) (approximately 5.8km east)
Essex Estuaries SAC (UK0013690) (approximately 3.5km south)	Abberton Reservoir Ramsar Site (UK11001) (approximately 5km southwest)
	Abberton Reservoir SPA (UK9009141) (approximately 5km southwest)
	Blackwater Estuary SPA (UK9009245) (approximately 7.5km southwest)
	Blackwater Estuary Ramsar Site (UK11007) (approximately 7.5km southwest)

14.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 14.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects
- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

14.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Colne Estuary Ramsar Site (UK10015)
- Colne Estuary SPA (UK9009243)
- Essex Estuaries SAC (UK0013690)

14.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 14.2.

14.3.2.1 Colne Estuary Ramsar Site (UK11015) (approximately 3.5km south)

The Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site is important due to the extent and diversity of saltmarsh present. This site, and the four other sites in the Mid-Essex Coast complex, includes a total of 3,237ha that represent 70% of the saltmarsh habitat in Essex and 7% of the total saltmarsh in Britain. The Ramsar Site also supports internationally important wintering waterbird assemblages (peak counts of 32041 waterfowl – 5 year peak mean 1998/99 – 2002/2003); as well as species of nationally scarce plants and invertebrates.

The wetland invertebrate assemblages include 38 British Red Data–Book invertebrate species; the rarest of these include the endangered ground beetle species (*Dyschirius extensus)* and the moth species (*Coleophora fuscicornis)* and (*Ethmia terminella)*. The wetland plant assemblages includes 12 species of nationally scarce plants such as slender hare's-ear (*Bupleurum tenuissimum*), divided sedge (*Carex divisa*), common sea heath (*Frankenia laevis*), sea barely (*Hordeum marinum*), golden samphire (*Inula crithmoides*), rock sea-lavender (*Limonium binervosum*), perennial glasswort (*Salicornia perennis*), one-flowered glasswort (*Salicornia pusilla*), small cordgrass (*Spartina maritima*), shrubby seablite (*Suaeda vera*), common eelgrass (*Zostera marina)* and dwarf eelgrass (*Zostera noltii*). Over winter, the site also supports internationally important populations of dark-bellied brent goose (*Branta bernicla bernicla)* and common redshank (*Tringa tetanus*).

Construction effects

This site is hydrologically connected to the option with the proposed pipeline running adjacent to and crossing the River Colne approximately 3.5km upstream. Further hydrological connections exist as both the Option and the Habitats Site are within the Essex Gravels Water Body catchment (GB40503G000400).

Due to this hydrological connectivity, it is possible that any pollution events (toxic or non-toxic) could be transferred downstream to the Ramsar Site and impact habitats (such as saltmarsh and floodplain grazing marsh), which support its qualifying species. Therefore, construction-related impacts cannot be ruled out at this stage. The wetland flora and fauna which qualifying bird species rely on may also be affected by any pollution events. These food resources may be lost and result in changes to the population sizes and distribution of qualifying species found within the site.

There is potential for dust produced during pipeline construction works upstream to enter the River Colne (via run-off or deposition), adding to the suspended sediment load in the river. Potential changes in water quality during pipeline installation have also been identified due to pollution incidents which could cause habitat degradation of wetland assemblages from exposure to toxic substances, reduction in dissolved oxygen levels, and increased turbidity. The impact pathways identified could result in changes to qualifying species distributions and extents, as well as changes to habitat availability and wetland invertebrate community assemblages. In addition, construction works may lead to the introduction and/or spread of invasive non-native species (INNS), negatively impacting on the extent of qualifying habitats and supporting habitat availability and suitability for qualifying invertebrates.

The proposed works are considered sufficiently distant from the Ramsar Site so that other direct construction-related impacts (such as adverse air pollution effects arising from construction vehicle emissions) are not anticipated. However, the landscape within 500m of the proposed pipeline footprint does include some supporting wetland habitat which may be used as functionally linked habitat supporting the Ramsar Site's qualifying bird species while foraging.

Possible indirect effects to the integrity of the SPA site resulting from construction activities might include noise, visual and artificial light disturbances which could impact upon qualifying bird species. Disturbance can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, desertion of nesting sites, eggs and/or chicks, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise breeding success, adult fitness, and survival by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

In the absence of up-to-date species records or survey data at this stage, and due to the proximity of these functionally linked habitats to construction activities, it is not possible to rule out significant effects on this Habitats Site from construction.

No other impact pathways are anticipated during construction.

The adverse effects described can be mitigated using best practice measures and the preparation and implementation of a Construction Environmental Management Plan (CEMP). These measures are listed in Table 14.3. After mitigation no adverse effects on the site integrity is anticipated.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate treatment stage. The option also proposes the transfer of treated water from Langham WTW to Colchester STW via a new pipeline, with no discharges on any waterbodies. Therefore, no significant effects are anticipated during the operation phase.

14.3.2.2 Colne Estuary SPA (UK9009243) (approximately 3.5km south)

Colne Estuary is a short and branching estuary, with five tidal arms which flow into the main river channel. The estuary has a narrow intertidal zone predominantly composed of flats of fine silt with mudflat communities typical of south-eastern estuaries.

The Colne Estuary is of high ornithological importance for wintering waterfowl, providing good quality feeding areas for an excellent diversity of bird species. The site also regularly supports internationally important numbers of wintering dark-bellied brent goose and common redshank, as well as nationally important wintering populations of the following: cormorant (*Phalacrocorax carbo*), mute swan (*Cygnus olor*), shelduck (*Tadorna tadorna*), common goldeneye (*Bucephala*

clangula), ringed plover (*Charadrius hiaticula*), grey plover (*Pluvialis squatarola*), sanderling (*Calidris alba*), dunlin (*Calidris alpina*), black-tailed godwit (*Limosa limosa*) and curlew (*Numenius arquata*). The Colne Estuary also regularly supports nationally important wintering populations of hen harrier (*Circus cyaneus*). This species is habitat specific, strongly associated with wetland areas, especially those rich in common reed (*Phragmites australis*) and occupies large ranges.

During severe winter weather the Blackwater Estuary (and the whole Mid-Essex Coast) can assume even greater national and international importance as wildfowl and waders from many other areas arrive, attracted by the relatively mild climate and the abundant food resources available in this SPA.

In summer, the site supports nationally important breeding populations of little tern (*Sternula albifrons*) and two regularly occurring migratory species: common pochard (*Aythya ferina*) and ringed plover (*Chararius hiaticula*).

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described above for the Colne Estuary Ramsar Site, as both of these Habitats Sites share the same boundary.

No significant direct effects are anticipated on breeding little tern due to the lack of suitable nesting habitat within the ZoI. Little tern nest exclusively on the coast on sand and shingle beaches, spits or inshore islets, and are unlikely to use the short sward floodplain grazing marsh habitat associated with the proposed development footprint for nesting. Similarly, no direct effects are anticipated on breeding common pochard and ringed plover due to the lack of suitable nesting habitat within the ZoI.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate treatment stage. The option also proposes the transfer of treated water from Langham WTW to Colchester STW via a new pipeline, with no discharges on any waterbodies. Therefore, no significant effects are anticipated during the operation phase.

14.3.2.3 Essex Estuaries SAC (UK0013690) (approximately 3.5km south)

Essex Estuaries is the second largest estuarine site on the east coast of England. It contributes to the essential range and variation of estuaries in the United Kingdom (UK) as the best example of a coastal plain estuary system on the British North Sea coast. The site comprises the major estuaries of the Colne, Blackwater, Crouch and Roach rivers.

This Habitats Site is designated for supporting a coastal plain estuarine system with open coast mudflats and sandflats not covered by seawater at low tide, sandbanks, *Salicornia* and other annuals colonising mud and sand, Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and Mediterranean and 177hermos-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). The area of pioneer marsh located at Foulness Point includes gradation into extensive cordgrass (*Spartina spp.*) swards, including the most extensive remaining stand of the native small cordgrass (*Spartina maritima*) in the UK and possibly in Europe.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described above for the Colne Estuary Ramsar Site, with Annex 1 habitats and protected vascular plant species being the main receptors of the effects of disturbance from construction activities.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate treatment stage. The option also proposes the transfer of treated water from Langham WTW to Colchester STW via a new pipeline, with no discharges on any waterbodies. Therefore, no significant effects are anticipated during the operation phase.

14.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible

14.3.4 Monitoring

Monitoring of pollutants, such as chemicals, construction dust, loose soil, or spilled fluids from construction sites immediately downstream of the proposed development areas should be undertaken to ensure that significant levels of contaminants are not being transferred into the Colne Estuary.

On a precautionary basis and to inform a future project level HRA, it is also recommended that the following monitoring is included in a survey plan, shown in Table 14.2.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 14.2: Qualifying features of the Habitats Sites and their recommended monitoring plan.

Habitats Sites	Qualifying features	Monitoring Guidelines
Colne Estuary Ramsar	Birds (wintering)	Birds Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online).
	Wetland invertebrate assemblage.	English Nature (2005). Organising surveys to determine site quality for invertebrates, A framework guide for ecologists. English Nature, 1 – 20. Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27. Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough.
Colne Estuary SPA	Birds (breeding and wintering)	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough.

		Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf
Essex Estuaries SAC	Supporting habitats for qualifying species.	Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27.

Source: Mott MacDonald, 2023.

Table 14.3: Option NIT-006 - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Colne Estuary Ramsar (approximately 3.5km south)	**Ramsar criterion 1** The site is important due to the extent and diversity of saltmarsh present.	This option is sufficiently distant from the Habitats Site boundary (>3km) to exclude adverse effects from air pollution. However, the following temporary and permanent effects on qualifying habitats during construction have been identified: • Toxic contamination – chemical pollution in the upstream river Colne during construction works which could be transferred downstream to within the Ramsar boundary and damage supporting habitats and reduce prey availability for qualifying features. • Non-toxic contamination – additional sedimentation or siltation during construction works within or adjacent to the river Colne, leading to degradation or smothering of supporting habitats downstream within the Ramsar site. • Physical loss/damage – significant localised habitat loss and/or degradation from pollution, both toxic and non-toxic. • Biological disturbances – reductions in the prey availability and/or extent of habitats which support qualifying species, both of which may subsequently lead to displacement of qualifying features within or from the site, as a result of the above impact pathways. • Biological disturbances: Accidental introduction of INNS to the site.	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Specific mitigation to reduce increased sedimentation and silt deposition downstream include: - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. - Planning silt screening around the area of works to limit the movement and redeposition of material. - Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport. • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • The development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	No adverse effects.

			With this in place, adverse effects on the Habitats Site will be alleviated during construction. Monitoring of pollution downstream of the works areas will enable early detection of any changes during construction which may have a significant effect on the site downstream.	
	Ramsar criterion 2 The site supports 12 species of nationally scarce plants and at least 38 British Red Data Book invertebrate species.	• Physical damage – habitat degradation as a result of water quality changes in case of pollution events and increases in suspended sediment loading. • Toxic contamination – pollution incidents causing changes to water quality (degradation) and mortality of qualifying invertebrates and vascular plant species if present. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of qualifying habitats impacting on the suitability to support qualifying invertebrates. • Biological disturbances – potential introduction of INNS, changes in habitat distribution and extent and habitat avoidance by qualifying invertebrates.	The proposed mitigation to avoid and/or alleviate adverse effects on these qualifying species is the same as detailed above for saltmarsh habitats.	No adverse effects.
	Ramsar criterion 3 This site supports a full and representative sequences of saltmarsh plant communities.	See “Possible adverse effects before mitigation” listed above for Ramsar criterion 1.	See “Indicative mitigation measures” listed above for Ramsar criterion 1.	No adverse effects.
	Ramsar criterion 5 Assemblages of waterfowl of international importance	In addition to the adverse effects listed above for the other qualifying features of this Ramsar site, this option may have the following permanent or temporary effects on wintering waterfowl during the construction phase: • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement from preferred foraging or roosting areas and ultimately a reduction in breeding success.	• Sensitive timing of construction works to avoid the breeding period for bird species detailed in the Broadland SPA supplementary advice note during April to August inclusive. Any works which are undertaken outside of this period may disturb or displace overwintering species from suitable functional land, details of which are provided below. • If construction works are undertaken during the wintering period (September – March	No adverse effects.

	• Biological disturbances – reductions in the prey availability and/or extent of habitats which support qualifying species, both of which may subsequently lead to displacement of qualifying species within or from the site, as a result of the above impact pathways. • Biological disturbances – anthropogenic disturbance within potential functionally linked habitat, changes in habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas. No adverse effects will arise during operation.	inclusive), pre-construction wintering bird surveys will be required to determine presence/absence and the number of individuals (if present). • These works will only be permitted if the population present at risk of disturbance is <1% of the cited SPA population and works will be supervised by an Ecological Clerk of Works (ECoW). The ECoW will deliver a toolbox talk to all relevant contractors on the potential presence of wintering birds within the ZoI and the appropriate procedures to be followed. • During construction works an ECoW will be required to maintain a sufficient buffer (200m minimum) from any functionally linked habitats. If a qualifying species is present within the ZoI, works must cease until they have moved outside of the ZoI. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Additional working methods which will reduce disturbance to overwintering birds during construction include: - All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'.

			• The development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	
	Ramsar criterion 6 Species/populations occurring at levels of international importance. Dark-bellied brent goose and common redshank.	See "Possible adverse effects before mitigation" listed above for wintering waterfowl.	See "Indicative mitigation measures" listed above for wintering waterfowl.	No adverse effects
Colne Estuary SPA (approximately 3.5km south)	Overwintering bird species	See "Possible adverse effects before mitigation" listed above under Colne Estuary Ramsar Criterion 5 for wintering waterfowl.	See "Indicative mitigation measures" listed above under Colne Estuary Ramsar Criterion 5 for wintering waterfowl.	No adverse effects.
Essex Estuaries SAC (approximately 3.5km south)	Coastal plain estuarine system with open coast mudflats and sandbank and associated vegetation.	See "Possible adverse effects before mitigation" listed above under Colne Estuary Ramsar Criterion 1 for saltmarsh.	See "Indicative mitigation measures" listed above under Colne Estuary Ramsar Criterion 1 for saltmarsh.	No adverse effects.

Source: Mott MacDonald, 2023

14.3.5 Stage 2 outcomes

Following this HRA AA and ensuring the implementation of the proposed mitigation measures during construction, it is concluded that no adverse effects are anticipated on the Essex Estuaries SAC, Colne Estuary (Mid Essex Coast Phase 2) SPA and Ramsar Site, and that the integrity of these sites will not be affected by the proposed works. Mitigation measures include pre-construction surveys, timing restrictions, staged construction works, toolbox talks and presence of an ECoW.

No impact pathways during the operational phase of the option have been identified on Habitats Sites and associated qualifying features.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for the construction phases only at all sites, since no adverse effects from the operation stage were identified. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Desk based noise assessment to determine an accurate extent of the ZoI once more information is available on construction methodology.
- A desk-based hydro-geological assessment is required when more information is available to ensure that the pipeline installation proposed does not cause subsidence of the riverbed on the River Colne.
- River condition assessments to assess the condition of the River Colne prior to construction, to determine the presence (or likely absence) of qualifying features and supporting habitat within the ZoI. This will allow a better estimation of construction impacts and potential degradation in site condition.
- Adapted river habitat surveys of the River Colne to determine if suitable spawning habitat is present for brook lamprey, bullhead and white-clawed crayfish (mapping of silt beds, gravel, riffles, glides, runs, shelter etc.) within the ZoI.
- A detailed review of the baseline ecological data for qualifying birds and invertebrates to inform the requirement for additional monitoring and to determine more targeted mitigation measures. This is likely to include breeding and wintering bird, otter, Desmoulin's whorl snail and wetland invertebrate surveys.

The CEMP will be prepared and implemented including relevant mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time, and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

14.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

15 Abberton Raw Water Pumping Station (ESW-PMP-001A)

Option ID: (ESW-PMP-001A)

15.1 Option Description

This option has two distinct elements. Firstly, the replacement to enable an enhanced pumping capacity of two existing pumps, motors and controls at Abberton Reservoir Raw Water Pumping Station (RWPS). The new pumps will have duty points of 43Ml/d at 51m head.

Secondly, the treatment at Langford WTW is proposed to be upgraded to accommodate the introduction of source water from Abberton raw water reservoir. The requirement is to sustain the maximum capacity of the WTW (57Ml/d), of which up to 50Ml/d could be Abberton Reservoir raw water.

15.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified nine Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for seven of these sites (Table 15.1).

Option PMP-001A therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA).

Table 15.1: PMP-001A Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Abberton Reservoir SPA (UK9009141) (0km)	Dengie (Mid-Essex Coast Phase 1) Ramsar Site (UK11018) (approximately 9.5km south)
Abberton Reservoir Ramsar Site (UK11001) (0km)	Dengie (Mid-Essex Coast Phase 1) SPA (UK9009242) (approximately 9.5km south)
Essex Estuaries SAC (UK0013690) (approximately 2.2km east)	
Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (UK9009245) (approximately 2.2km southeast)	
Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar Site (UK11007) (approximately 2.2km southeast)	
Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site (UK11015) (approximately 3km southeast)	
Colne Estuary (Mid-Essex Coast Phase 2) SPA (UK9009243) (approximately 3km southeast)	

15.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 15.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects

- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

15.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Abberton Reservoir SPA (UK9009141)
- Abberton Reservoir Ramsar Site (UK11001)
- Essex Estuaries SAC (UK0013690)
- Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (UK9009245)
- Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar Site (UK11007)
- Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site (UK11015)
- Colne Estuary ((Mid-Essex Coast Phase 2) SPA (UK9009243)

15.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 15.2.

15.3.2.1 Abberton Reservoir SPA (UK9009141) (0km)

Abberton Reservoir is a large storage reservoir approximately four miles south of Colchester. It is the largest freshwater body in Essex, and one of the most important British reservoirs for wildfowl. An estimated 30,000 birds visit the site annually, including internationally important numbers of one species, and nationally important numbers of 12 species. The site is co incident with Abberton Reservoir Site of Special Scientific Interest (SSSI).

The site regularly supports a nationally important breeding population (5% of the British breeding population) of cormorant (*Phalacrocorax carbo*). This is unusual in Great Britain, as the birds are nesting in inland trees rather than coastal cliffs or rocky islets.

In addition to this, over winter, the area regularly supports Northern shoveler (*Anas clypeata*), Eurasian teal (*Anas crecca*), Eurasian wigeon (*Anas penelope*), gadwall (*Anas strepera*), common pochard (*Aythya ferina*), tufted duck (*Aythya fuligula*), common goldeneye (*Bucephla clangula*), mute swan (*Cygnus olor*), common coot (*Fulica atra*), and great crested grebe (*Podiceps cristatus*).

The site also supports an internationally important assemblage of birds, with 39,763 waterfowl individuals wintering here.

Construction effects

Abberton Reservoir is entirely congruent with the boundary of the SPA, therefore the option is hydrologically connected to the Habitats Site. Due to this hydrological connectivity, it is possible that any pollution events, toxic (chemical) or non-toxic (sedimentation/siltation) could be transferred to the reservoir, impacting qualifying bird species, and degrading their supporting habitats. Reduced habitat availability or degraded habitats may lead to habitat avoidance by the

designated bird species, which may result in rapid population fluctuations. Reduced water quality may adversely affect the aquatic flora and fauna for which qualifying birds rely; these food resources may be lost and result in changes to the population sizes and distribution of qualifying features within or from the site. Air pollution, dust, noise, visual, vibration and light disturbance may also have adverse effects on the site and its qualifying species.

Therefore, the construction of this Option could have direct effects on the feeding and/or roosting behaviours of qualifying birds, increasing energy expenditure due to more frequent flights, potential abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

The upgrade at Langford WTW is not hydrologically connected to the SPA, and is sufficiently distant that no construction effects are expected to arise due to this element of the option.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

There will be abstraction of 43Ml/d from the reservoir during the operation phase. This has the potential to lead to hydrological changes within the waterbody, which may in turn disrupt the habitat that the qualifying bird species are dependent upon. Roosting and foraging areas adjacent to the reservoir may also be impacted, resulting in decreases in the availability of these habitats. Water quality could also be affected as a result of the disruptions to the hydrological environment. These effects could result in direct mortality, rapid population fluctuations of waterbirds, as well as changes to the natural succession of habitats within the SPA.

Therefore, the operation of this Option could have direct effects on the qualifying bird species (as described under the construction effects section above), due to physical damage, water quality changes, and biological disturbances caused by increased abstraction.

The upgrade at Langford WTW is not hydrologically connected to the SPA, and is sufficiently distant that no construction effects are expected to arise due to this element of the option.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

15.3.2.2 Abberton Reservoir Ramsar Site (UK11001) (0km)

The Abberton Reservoir Ramsar Site extent is identical to that of the corresponding SPA designation. The site is designated for waterfowl assemblages of international importance (peak counts in winter of 23,787 birds) and avifaunal populations of international importance. This includes: gadwall, northern shoveler, Eurasian wigeon, mute swan and common pochard. All of these species are designated under the SPA too.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Abberton Reservoir SPA above.

Operation effects

The impact pathways and potential significant effects on this site during operation are the same as described for the Abberton Reservoir SPA above.

15.3.2.3 Essex Estuaries SAC (UK0013690) (approximately 2.2km east)

Essex Estuaries is the second largest estuarine site on the east coast of England. It contributes to the essential range and variation of estuaries in the United Kingdom (UK) as the best example of a coastal plain estuary system on the British North Sea coast.

This Habitats Site is designated for supporting a coastal plain estuarine system with open coast mudflats and sandflats not covered by seawater at low tide, sandbanks, *Salicornia* and other annuals colonising mud and sand, spartina swards (*Spartinion maritimae*), Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*).

Construction effects

This site is hydrologically connected to the option, approximately 7km downstream of the pump replacement, via the Layer Brook, Roman River and River Colne. The Langford WTW element of the option is also hydrologically connected to the site (approximately 2.5km away), through the River Blackwater, the River Chelmer, and small surface watercourses surrounding the WTW. Due to this hydrological connectivity, it is possible that any pollution events, toxic (chemical) or non-toxic (sedimentation/siltation) could be transferred downstream to the site and impact qualifying features. Pollution events could result in the loss or degradation of qualifying Annex I habitats within the site. Hydrological changes resulting from the construction works could also result in physical damage, reducing habitat availability within the SAC.

Due to this distance between the proposed construction works and the SAC, no other impact pathways have been identified during construction. Given that all of the qualifying features are habitats or plants and are therefore stationary, there is no concern about disturbance to functionally linked habitats beyond the SAC boundary.

Operation effects

There will be abstraction of 43Ml/d from the reservoir during the operation phase. This has the potential to lead to hydrological changes (such as flow reductions) within the SAC, which could potentially result in the loss or degradation of qualifying habitats and plant species for which the site is designated. Water quality could also be altered, leading to the same impacts of loss and degradation. These effects will be continuous throughout operation of the works.

Therefore, the operation of this Option could have direct effects on the qualifying habitats and plant species due to physical damage, water quality changes, water table availability changes and biological disturbances caused by increased abstraction.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

15.3.2.4 Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar Site (UK11007) (approximately 2.2km southeast)

The Blackwater Estuary is the largest Essex estuary north of the Thames, and is one of the largest estuarine complexes in East Anglia. It is situated between the Dengie peninsula and Mersea Island on the Essex coast. The Ramsar Site covers a total area of 4,395.15 hectares, and is coincident with Blackwater Estuary Site of Special Scientific Interest (SSSI).

The estuary contains mudflats which are fringed by saltmarsh on their upper shores. Other habitats within the site include shingle and shell banks, offshore islands, a sea wall, ancient grazing marsh and associated fleet and ditch systems, as well as semi-improved grassland. The site's saltmarsh habitat triggers Ramsar Site Criterion 1, and the sequences of saltmarsh plant communities present are designated under Ramsar Site Criterion 3. These features are all of high conservation interest, as the mosaic of habitats supports nationally scarce plants and rare

invertebrate assemblages (16 British Red Data Book species and 94 local and notable species). The 16 British Red Data Book species are as follows: the endangered water beetle (*Paracymus aeneus*); the vulnerable damselfly (*Lestes dryas*), the flies (*Aedes flavescens, Erioptera bivittata, Hybomitra expollicata*) the spiders (*Heliophanus auratus* and *Trichopterna cito*); the rare beetles (*Baris scolopacea, Philonthus punctus, Graptodytes bilineatus* and *Malachius vulneratus*), the flies (*Campsicemus magius* and *Myopites eximia*), the moths (*Idaea ochrata* and *Malacosoma castrensis*) and the spider (*Euophrys*).

Internationally and nationally important numbers of overwintering waterfowl are also supported by this site. Bird species are designated for this site under Ramsar Site Criteria 5 and 6. In winter, 105061 waterfowl are supported by this site, an assemblage of international importance. This includes populations of the following species: dark-bellied brent goose (*Branta bernicla bernicla*), grey plover (*Pluvialis squatarola*), dunlin (*Calidris alpina alpina*), black-trailed godwit (*Limosa limosa islandica*), common shelduck (*Tadorna tadorna*), European golden plover (*Pluvialis apricaria apricaria*) and common redshank (*Tringa totanus totanus*).

Construction effects

The Langford WTW are hydrologically connected to the Ramsar Site (approximately 2.5km away) through the Rivers Blackwater and Chelmer, and through small surface watercourses surrounding the WTW. Due to this hydrological connectivity, it is possible that any pollution events, toxic (chemical) or non-toxic (sedimentation/siltation) could be transferred downstream to the site and impact qualifying features. Pollution events could result in the loss or degradation of designated habitats, as well as those habitats on which qualifying species depend. The landscape within 500m of the works includes wetland habitats (grazing marsh, ponds, reservoirs) which qualifying bird species may use as functionally linked habitat for foraging activities. Visual and noise disturbance to species using this habitat is therefore possible; this disturbance could displace these waterbirds from the Reservoir.

The pump replacement at Abberton Reservoir is sufficiently distant from, and not hydrologically connected to the Ramsar Site, that no construction effects are expected to arise due to this element of the option. The Reservoir may provide functionally linked habitat for some of the Ramsar Site qualifying features (like overwintering waterbirds), therefore there is the potential for visual and noise disturbance, habitat loss and habitat damage for the qualifying features. These effects could ultimately result in the displacement of these bird species from the Ramsar Site.

Operation effects

No significant effects on this Habitats Site during operation are anticipated.

15.3.2.5 Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (UK9009245) (approximately 2.2km southeast)

The extent of Blackwater Estuary SPA is identical to that of the corresponding Ramsar Site designation. The SPA is designated for the following waterbird species: black-tailed godwit (*Limosa limosa islandica*), dark-bellied brent goose (*Branta bernicla bernicla*), dunlin (*Calidris alpina alpina*), grey plover (*Pluvialis squatarola*), hen harrier (*Circus cyaneus*), little tern (*Sternula albifrons*), pochard (*Aythya ferina*), and ringed plover (*Charadrius hiaticula*) as well as being designated for waterbird assemblages.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Blackwater Estuary Ramsar Site above, with the exception of habitats, invertebrates and plant species for which the Ramsar Site is designated. SPA-qualifying bird species may be dependent upon some of these features however, in which case the impacts on these features remain applicable to the SPA.

Operation effects

No significant effects on this Habitats Site during operation are anticipated.

15.3.2.6 Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site (UK11015) (approximately 3km southeast)

The Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site supports internationally important populations of wintering dark-bellied brent goose and common redshank, wintering waterbird assemblages (peak counts in winter of 32041 waterfowl (5 year peak mean 1998/99 – 2002/2003), saltmarsh, wetland invertebrate assemblages and wetland plant assemblages.

The wetland invertebrate assemblages include 38 British Red Data Book invertebrate species; rarest of these include the endangered ground beetle species (*Dyschirius extensus)* and the moth species (*Coleophora fuscicornis)* and (*Ethmia terminella)*. The wetland plant assemblages includes 12 species of nationally scarce plants such as slender hare's-ear (*Bupleurum tenuissimum*), divided sedge (*Carex divisa*), common sea heath (*Frankenia laevis*), sea barely (*Hordeum marinum*), golden samphire (*Inula crithmoides*), rock sea-lavender (*Limonium binervosum*), perennial glasswort (*Salicornia perennis*), one-flowered glasswort (*Salicornia pusilla*), small cordgrass (*Spartina maritima*), shrubby seablite (*Suaeda vera*), common eelgrass (*Zostera marina)* and dwarf eelgrass *(Zostera noltii*).

Construction effects

The Langford WTW are hydrologically connected to the Ramsar Site, but they are sufficiently distant (approximately 20km away) that any pollution events occurring due to the works are not considered likely to have a significant effect on the integrity of the Ramsar Site. The landscape within 500m of the works however does include wetland habitats (grazing marsh, ponds, reservoirs) which qualifying bird species may use as functionally linked habitat for foraging activities. Visual and noise disturbance to species using this habitat is therefore possible; this disturbance could displace these waterbirds from the Reservoir.

The Colne Estuary Ramsar Site is also hydrologically connected to Abberton Reservoir via Layer Brook, the Roman River and the River Colne. Due to this hydrological connectivity, it is possible that any pollution events, toxic (chemical) or non-toxic (sedimentation/siltation) could be transferred downstream to the site and impact qualifying features. Pollution events it´s likely to result in the loss or degradation of qualifying habitats within the site, and habitats on which the other qualifying species depend. Hydrological changes resulting from the construction works it's likely to also result in physical damage, reducing habitat availability within the Ramsar Site. Abberton Reservoir may also constitute functionally linked habitat for some of the waterfowl for which the Ramsar Site is designated: visual and noise disturbance here may displace species from the Ramsar Site.

Operation effects

There will be abstraction of 43Ml/d from the reservoir during the operation phase. This alteration has the potential to lead to hydrological changes (such as flow reductions) within the Ramsar Site, which could potentially result in the loss or degradation of qualifying habitats, plant and bird species for which the site is designated. Water quality could also be altered, leading to the same impacts of loss and degradation. These effects will be continuous throughout operation of the works.

Therefore, the operation of this Option could have direct effects on the qualifying habitats, plant and bird species due to physical damage, water quality changes, water table availability changes and biological disturbances caused by increased abstraction.

Mitigation measures must be implemented to prevent adverse effects on site integrity. With the implementation of mitigation measures, no adverse effects are anticipated.

15.3.2.7 Colne Estuary (Mid-Essex Coast Phase 2) SPA (UK9009243) (approximately 3km southeast)

Colne Estuary is a short and branching estuary, with five tidal arms which flow into the main river channel. The estuary has a narrow intertidal zone predominantly composed of flats of fine silt with mudflat communities typical of south-eastern estuaries.

Over winter, the site regularly supports hen harrier (*Circus cyaneus*). This species is habitat specific, strongly associated with wetland areas, especially those rich in common reed (*Phragmites australis*) and occupies large ranges. The site also regularly supports internationally important numbers of wintering dark-bellied brent goose (*Branta bernicla*) and common redshank (*Tringa totanus*), as well as nationally important wintering populations of the following: cormorant (*Phalacrocorax carbo*), mute swan (*Cygnus olor*), shelduck (*Tadorna tadorna*), common goldeneye (*Bucephala clangula*), ringed plover (*Charadrius hiaticula*), grey plover (*Pluvialis squatarola*), sanderling (*Calidris alba*), dunlin (*Calidris alpina*), black-tailed godwit (*Limosa limosa*) and curlew (*Numenius arquata*).

In summer, the site supports nationally important breeding populations of little tern (*Sternula albifrons*) and two regularly occurring migratory species: common pochard (*Aythya ferina*) and ringed plover.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Colne Estuary Ramsar Site above, with the exception of habitats, invertebrates and plant species for which the Ramsar Site is designated. SPA-qualifying bird species may be dependent upon some of these features however, in which case the impacts on these features remain applicable to the SPA.

Operation effects

There will be abstraction of 43Ml/d from the reservoir during the operation phase. This has the potential to lead to hydrological changes (such as flow reductions) within the SPA, which could potentially result in the loss or degradation of habitats that qualifying bird species are dependent upon for feeding and roosting purposes. Water quality could also be altered, leading to the same impacts of loss and degradation. These effects will be continuous throughout operation of the works.

Therefore, the operation of this Option it´s likely to have direct effects on the qualifying bird species and the habitats they utilise, due to physical damage, water quality changes, water table availability changes, and biological disturbances caused by increased abstraction.

15.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

15.3.4 Monitoring

Monitoring of pollutants, such as chemicals, construction dust, loose soil, or spilled fluids from construction sites, immediately downstream of the two elements of the works (the pumping enhancement at Abberton and the upgrades at Langford WTW) should be undertaken to ensure that significant levels of contaminants are not being transferred into Abberton Reservoir or any of the adjacent waterbodies at Langford.

It is considered necessary to undertake monitoring specifically for the qualifying features within Abberton Reservoir SPA and Abberton Reservoir Ramsar, due to the direct overlap of the Option with these Habitats Sites. It is not considered necessary to undertake monitoring for the qualifying features of any other Habitats Sites, due to their distance from the Option elements.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 15.2: Option PMP-001A - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Abberton Reservoir SPA (0km)	All	This option may have the following permanent or temporary effects on the SPA during the construction phase: **During construction** • Physical loss – direct loss and degradation of suitable habitat due to construction works, and hydrological changes resulting in reduced habitat availability within the Reservoir. Also, habitat degradation as a result of water quality changes in case of pollution events and increases in suspended sediment loading that may affect bird nesting/feeding grounds and functionally linked land. • Toxic contamination – pollution incidents causing changes to water quality (degradation). • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of supporting habitats. • Biological disturbances – anthropogenic disturbance, changes in habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas. Also, potential population fluctuations as a result of these effects. The effects of toxic and non-toxic contamination could result in permanent impacts but are likely to be localised due to the nature of the option, i.e. small scale improvement works. **During operation** • Water table/ availability – changes to surface water levels and flows and drying of suitable wetland habitats utilised by birds.	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Specific mitigation to reduce increased sedimentation and silt deposition downstream include[1]: - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. - Planning silt screening around the area of works to limit the movement and redeposition of material. - Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport. • Development of a Construction and Environmental Management Plan (CEMP) which will include all the above proposed mitigation measures and any further mitigation measures identified at the Project stage. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats	No adverse effects.

		• Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of habitats. • Biological disturbances – changes in habitat availability as a result of abstraction; habitat avoidance and potential for qualifying birds to be displaced from current foraging areas. • Physical damage – hydrological changes may lead to habitat degradation causing reduced habitat availability for qualifying species	Site, or there is visual line of sight between construction activities and these habitats. • Additional working methods which will reduce disturbance to overwintering birds during construction include: - All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and - All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. Monitoring of pollution within the reservoir will enable early detection of any changes during construction which may have a significant effect on the site downstream.	
Abberton Reservoir Ramsar (0km)	All	The potential adverse effects on the Ramsar are the same as detailed above for Abberton Reservoir SPA.	The proposed mitigation to avoid and/or alleviate adverse effects on the Ramsar is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.
Essex Estuaries SAC (approximately 2.2km east)	All	This option may have the following permanent or temporary effects on the SAC during the construction phase: **During construction** • Physical loss –hydrological changes resulting in reduced habitat availability within the SAC. • Toxic contamination – pollution incidents causing changes to water quality (degradation). • Non-toxic contamination – changes in turbidity leading to changes in sediment	The proposed mitigation to avoid and/or alleviate adverse effects on the SAC is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.

		loading and silt deposition which may lead to smothering of habitats. The effects of toxic and non-toxic contamination could result in permanent impacts but are likely to be localised due to the nature of the option, i.e. small scale improvement works. **During operation** • Water table/ availability – reduced flows could reduce habitat extents within the SAC. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of habitats. • Biological disturbances – changes in habitat availability • Physical damage – hydrological changes may lead to habitat degradation causing reduced habitat availability		
Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (approximately 2.2km southeast)	All	This option may have the following permanent or temporary effects on the SAC during the construction phase: **During construction** • Physical loss –hydrological changes resulting in reduced habitat availability within the SPA. • Toxic contamination – pollution incidents causing changes to water quality (degradation). • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of habitats.	The proposed mitigation to avoid and/or alleviate adverse effects on the SPA is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.

		• Non-physical disturbance –noise and light localised disturbance on functionally linked habitats • Biological disturbance – anthropogenic disturbance, changes in functionally linked habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas. Also, potential population fluctuations as a result of these effects The effects of toxic and non-toxic contamination could result in permanent impacts but are likely to be localised due to the nature of the option, i.e. small scale improvement works. No adverse effects will arise during operation.		
Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar (approximately 2.2km southeast)	All	The potential adverse effects on the Ramsar are the same as detailed above for Blackwater Estuary SPA.	The proposed mitigation to avoid and/or alleviate adverse effects on the Ramsar is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.
Colne Estuary (Mid-Essex Coast Phase 2) Ramsar (approximately 3km southeast)	All	The potential adverse effects on the Colne Estuary Ramsar are the same as detailed above for Abberton Reservoir SPA.	The proposed mitigation to avoid and/or alleviate adverse effects on the Colne Estuary Ramsar is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.
Colne Estuary (Mid-Essex Coast Phase 2) SPA (approximately 3km southeast)	All	The potential adverse effects on the Colne Estuary SPA are the same as detailed above for Abberton Reservoir SPA.	The proposed mitigation to avoid and/or alleviate adverse effects on the Colne Estuary SPA is the same as detailed above for Abberton Reservoir SPA.	No adverse effects.

Source: Mott MacDonald, 2023

15.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is ascertained that with adherence to the proposed mitigation, the works associated with the option PMP-001A will not have any adverse effects on the integrity of the Abberton Reservoir SPA, Abberton Reservoir Ramsar Site, Essex Estuaries SAC, Blackwater Estuary (Mid-Essex Coast Phase 4) SPA, Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar Site, Colne Estuary (Mid-Essex Coast Phase 2) Ramsar Site, or Colne Estuary (Mid-Essex Coast Phase 2) SPA during the construction phase.

During construction, continuous pollution (toxic and non-toxic) monitoring is recommended within Abberton Reservoir and immediately downstream of the Langford WTW area in order to identify, at the earliest stage, changes which may result in adverse effects downstream at the Habitats Sites.

It is recommended that if any changes are made to the design or location of this option, the HRA is revised and this document amended accordingly.

15.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

16 North Suffolk Winter Storage Reservoir (ESW-RES-002C1)

Option ID: (ESW-RES-002C1)

16.1 Option Description

This option proposes the building of a new winter storage reservoir. The intake would come from the River Waveney when there is no spare capacity at Barsham water treatment works (WTW). When supplies are short at Barsham WTW, water will be taken from the reservoir and transferred to the WTW.

Two transfer pipelines are required; from the River Waveney to the reservoir (2.32km long) and from the reservoir to Barsham WTW (3.52km). There are three potential flow rates for both transfer pipelines: 16.2 Megalitres per day (Ml/d), 18.5 Ml/d, or 19.9 Ml/d. There is also a potential transfer for this option from the River Hundred but confirmation of this requires further engagement with the regulator, and has not been subject to detailed design and therefore not included in our environmental assessment

The option also includes additional treatment capacity provided by a 16Ml/d extension at the Barsham WTW.

16.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified seven Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for any of these sites (Table 16.1).

Option RES-002C1 therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA).

Table 16.1: RES-002C1 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approximately 1.1km north / 1.7km downstream)	Outer Thames Estuary SPA (UK9020309) (approximately 12.7km east / 23km downstream)
Broadland Ramsar Site (UK11010) (approximately 1.1km north / 1.7km downstream)	Southern North Sea SAC (UK0030395) (approximately 12.7km east / 23km downstream)
The Broads SAC (UK0013577) (approximately 1.1km north / 1.7km downstream)	
Breydon Water Ramsar Site (UK11008) (approximately 12.5km north / 34km downstream)	
Breydon Water SPA (UK9009181) (approximately 12.5km north / 34km downstream)	

16.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 16.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects

- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

16.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Broadland SPA (UK9009253)
- Broadland Ramsar Site (UK11010)
- The Broads SAC (UK0013577)
- Breydon Water Ramsar Site (UK11008)
- Breydon Water SPA (UK9009181)

16.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 16.2.

16.3.2.1 Broadland SPA (UK9009253) (approximately 1.1km north / 1.7km downstream)

The Broadland SPA is a low-lying wetland complex connecting the boundaries between east Norfolk and northern Suffolk. The area includes the river valley systems of the Bure, Yare and Waveney and their major tributaries. This distinctive open landscape comprises a complex and interlinked mosaic of wetland habitats including open water, reedbeds, woodland, grazing marsh, and fen meadow, forming one of the finest marshland complexes in the UK. Its qualifying features are non-breeding Bewick's swan (*Cygnus columbianus bewickii*), gadwall (*Anas strepera*), hen harrier (*Circus cyaneus*), ruff (*Calidris pugnax*), Northern shoveler (*Anas clypeata*), whooper swan (*Cygnus cygnus*) and wigeon (*Anas penelope*), as well as breeding bittern (*Botaurus stellaris*) and marsh harrier (*Circus aeruginosus*).

Construction effects

The Broadland SPA is hydrologically connected to the option, with the proposed abstraction point on the River Waveney located approximately 1.1km upstream. Further hydrological connections exist as the proposed pipeline and reservoir footprint also covers several dikes and canals which link to all of the different components of the SPA further downstream. This SPA has been identified as a groundwater-dependent terrestrial ecosystem (GWDTE) meaning that it is ecologically sensitive to changes in groundwater levels and chemistry.

Due to this hydrological connectivity, it is possible that any pollution events (toxic or non-toxic) could be transferred to the site and impact habitats (such as reedbeds and floodplain grazing marsh) which support its qualifying species. Potential changes in water quality arising from pipeline installation, particularly when crossing upstream watercourses, have also been identified as surface water pathways for pollution transfer to within the SPA. This could cause habitat degradation of wetland assemblages from exposure to toxic substances, reduction in dissolved oxygen levels, and increased turbidity from sedimentation, transferred both through the surface and groundwater catchments. Therefore, construction-related impacts cannot be ruled out at this stage. The wetland flora and fauna which qualifying bird species rely on may also be affected by

any pollution events. These food resources may be lost and result in changes to the population sizes and distribution of qualifying species found within the site.

In addition, construction works may lead to the introduction and/or spread of invasive non-native species (INNS), negatively impacting on the extent of supporting habitat availability and suitability for qualifying species.

Adverse effects on the SPA from pollution events during construction are only anticipated on the underpinning Geldeston Meadows SSSI and Stanley and Alder Carr, Aldeby SSSI. These are the only hydrologically connected components of the SPA which are within 10km downstream of the option. Additionally, SSSI components are connected downstream, but at a distance at which the effects of pollution, if such events were to occur, are not anticipated to be significant.

The proposed works are considered sufficiently distant from the SPA site so that other direct construction-related impacts (such as adverse air pollution effects arising from construction vehicle emissions) are not anticipated. However, the landscape within 500m of the proposed pipeline footprint does include wetland habitat which may be used as functionally linked habitat supporting the SPA's qualifying bird species while foraging.

The proposed works footprint also includes areas of agricultural land and grassland which are suitable functionally linked habitats that support foraging overwintering bird species; Bewick's swan, whooper swan marsh harrier and hen harrier. Swans will typically forage in agricultural land during the day and return to roosting sites within the SPA at night. There may be permanent or temporary loss of these foraging habitats; it is not anticipated that the proposed pipeline footprint and its narrow area will cause any long-term impacts on the overall ability of the surrounding functional land to support the Habitat Site's populations. However, the construction of a new reservoir will result in the permanent loss of a large area of functionally linked foraging habitat which may result in a shift to the area which is used by qualifying features of the Broadland SPA. Other possible indirect effects to the integrity of the SPA site resulting from construction activities might include noise, visual and artificial light disturbances which could impact upon qualifying bird species. Disturbance can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, desertion of nesting sites, eggs and/or chicks, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise breeding success, adult fitness, and winter survival rates by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site. The easternmost construction area is close to, but outside of Natural England's *Goose & Swan Functional Land Impact Risk Zone (IRZ)*, which represents confirmed functionally linked land outside of Habitat's Sites boundaries. Given the proximity to this area, the precautionary approach assumes that both Bewick's swan and whooper swan regularly use this area and are therefore potentially disturbed by construction activities whilst foraging.

Hen harrier and marsh harrier are both species with wide foraging ranges, so may be disturbed by construction activities associated with the construction of the River Waveney intake and pipeline transfer to the new reservoir. Disturbance to marsh harrier is not anticipated outside of the Broads, but hen harrier may still forage over the agricultural land which comprises the majority of the option footprint.

Disturbance effects are not anticipated on breeding bittern, and overwintering gadwall, wigeon, shoveler and ruff, as these species' foraging ranges are typically within the SPA boundary and immediately adjacent habitats, and or depend on habitats which are not within the ZoI for disturbance (i.e. reed beds for breeding bittern).

In the absence of up-to-date species records or survey data at this stage, and due to the proximity of these functionally linked habitats to construction activities, it is not possible to rule out significant effects on this Habitats Site from construction.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 16.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

During the operational phase, it is assumed that there will be an increase in abstraction from the River Waveney, which could cause changes to flow velocity. Changes in flow volume and velocity could change sedimentation patterns and hydromorphology of the river downstream of this option. Disruption of a stable hydrological environment may result in reduced water quality as natural sedimentation, siltation and erosion process are changed with increased abstraction. These may be permanent effects throughout the duration of operation.

Alterations to the abstraction regime may result in hydrological changes downstream within the SPA boundary and functionally linked habitats, potentially causing disruption to the supporting habitats and prey availability for which qualifying features rely upon.

The creation of the new reservoir is likely to create a new alternative swan roost capable of supporting populations of both Bewick's swan and whooper swan. This new roost location could result in the reduction in the number of these species using the SPA boundary and may also cause a shift in the area of land that is functionally linked to the Broadland SPA. Consequently, this may bring these species into increased conflict with exiting land uses, resulting in additional disturbance effects which could lead to reduced winter survival rates and jeopardise future population viability and distribution within the Broadland SPA and functionally linked habitat.

It is also possible that the water transfer from the River Waveney results in the spread of INNS to the new reservoir, potentially resulting in the degradation of new functionally linked roosting habitat for qualifying swan species of the SPA. The presence of a new large waterbody creates conditions for which INNS can colonise, as detailed within the INNS level 2 assessment.

No other impact pathways are anticipated during operation.

The Water Framework Directive (WFD) level 2 assessment identified potential impacts on the River Waveney, from changes in flow and water quality during increased abstraction. The impacts, when taken on their own, have the potential to lead to a widespread or prolonged effect on the quality of the water environment that may result in the temporary reduction in WFD status.

The above potential hydrological changes could disrupt qualifying habitats through habitat degradation, loss or damage, resulting in changes to overall distribution and extent within the SPA and functionally linked land. There is potential for adverse effects on site integrity during operation of the option and further studies are required to inform this AA.

16.3.2.2 Broadland Ramsar Site (UK11010) (approximately 1.1km north / 1.7km downstream)

A low-lying wetland complex composed of the Bure, Yare, Thurne, and Waveney River systems of the Norfolk Broads. The mosaic of wetland habitats includes open water, reedbeds, carr woodland, grazing marsh, and fen meadow, with an extensive complex of flooded medieval peat diggings. Outstanding assemblages of rare plants and invertebrates occur at the site, where 136 British Red Data Book invertebrate species have been recorded. Amongst this rich insect fauna are nationally rare dragonflies, spiders, moths, and butterflies. The area is also a stronghold for

the swallowtail butterfly (*Papilio machaon brittanicus,* for which this is the only known breeding location in Britain) as well as a number of nationally rare breeding birds and otter. Several species of waterbirds winter there and include internationally important numbers of Bewick's swan, wigeon, gadwall and shoveler. Pink-footed goose (*Anser brachyrhynchus*) and greylag goose (*Anser anser*) are species with peak counts in winter which have been identified for possible future consideration under criterion 6.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Broadland SPA above, with the addition of qualifying Annex 1 habitats, vascular plant species, otter (*Lutra lutra*) and invertebrates as receptors of the effects of pollution events, where present within the ZoI. The effects of pollution may result in the loss and/or degradation of qualifying Annex I habitats, and those habitats which support qualifying features and/or their preferred prey items. This may ultimately lead to displacement of qualifying features from within the Ramsar Site boundary into sub-optimal habitats.

As mentioned above for the Broadland SPA, the only underpinning SSSI components present within the ZoI for pollution events during construction are the Geldeston Meadows SSSI and Stanley and Alder Carrs, Aldeby SSSI. Annex I habitats which are present within these SSSIs, and therefore potentially at risk of adverse effects are: 'natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*', and 'alluvial woodlands with alder and ash'. Annex II species present in these locations include otter and Desmoulin's whorl snail (*Vertigo moulinsiana*). Other qualifying features of Ramsar Site criterion 1 are not monitored features of these SSSIs and are therefore not anticipated to be adversely affected by pollution events, if they were to occur during construction.

Otters can occupy large ranges (around 32km for males and 20km for females) and use a wide range of habitats including rivers, marshes and estuaries. A such, the River Waveney, and connected watercourses and wetland habitats, are assumed to be suitable functionally linked habitats for otter outside of the Ramsar Site boundary. Otter populations associated with the Ramsar Site may use areas within the construction footprint for foraging, commuting, resting and/or breeding. In addition to the degradation of suitable habitats and/or prey availability from pollution events during construction, loss and/or disturbance of resting sites and foraging habitats may occur. If otters are present during the works, temporary disturbance and displacement from a breeding site or resting place could occur. As a European Protected Species, it is an offence to disturb an otter resting place or breeding site (natal den: subterranean dens/holts and above ground/couches). Resting places are typically located in dense bank vegetation and areas of reed. Breeding sites are located in hollow tree trunks and piles of timber[27]. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 16.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The potential adverse effects on the Ramsar Site during operation are the same as described for the Broadland SPA above. Changes in flow and water quality may have adverse effects within

[27] Kruuk, H. 2006. Otters: ecology, behaviour and conservation: ecology, behaviour and conservation, OUP Oxford.

downstream components of the Ramsar Site, resulting in degradation of qualifying Annex I habitats and/or habitats which support qualifying features both within the site boundary and functionally linked land, the latter specifically for overwintering bird species and otter.

Specific adverse effects from the creation of the reservoir, and its potential to become new functionally linked roosting habitat for geese and swan species, is detailed above for the Broadland SPA. Whooper swan is not a qualifying feature of the Ramsar Site, so is not considered in this respect. However, both pink-footed goose and greylag goose may also utilise the new reservoir for roosting and thus these effects apply to the additional species.

No other impact pathways are anticipated during operation.

There is potential for adverse effects on site integrity during operation of the option and further studies are required to inform this AA.

16.3.2.3 The Broads SAC (UK0013577) (approximately 1.1km north / 1.7km downstream)

The Broads SAC contains a variety of habitats including naturally nutrient-rich lakes that support a diversity of relict vegetation and aquatic invertebrate assemblages, rich areas of stoneworts, large blocks of alder (*Alnus glutinosa*) woodland, calcareous fens and wet heath.

Qualifying features of The Broads SAC include hard oligo-mesotrophic waters with benthic vegetation of *Chara* species, natural eutrophic lakes with *Magnopotamion* or *Hydrocharition,* Molinia meadows on calcareous, peat or clay-silt soil, transition mires and quaking bogs, calcareous fens with great fen-sedge (*Cladium mariscus*) and species of *Caricion davallianae* (calcium-rich fen dominated by great fen-sedge), alkaline fens, alluvial woods with black alder and European ash (*Fraxinus excelsior*), fen orchid (*Liparis loeselii*), ram's-horn snail (*Anisus vorticulus*), Desmoulin's whorl snail, and otter.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Broadland Ramsar Site above. Only qualifying Annex I habitats which are present within the ZoI (monitored features of Geldeston Meadows SSSI and Stanley and Alder Carr, Aldeby SSSI) are anticipated to be adversely affected by pollution events, if they were to occur during construction. Due to the distance between the option and the SAC (>1km) no other impact pathways are anticipated on qualifying Annex I habitats during construction.

The potential adverse effects on Desmoulin's whorl snail and otter are described within for the Broadland Ramsar Site above. No adverse effects are anticipated on fen orchid or ram's-horn snail, as they are not anticipated to be present within the ZoI.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 16.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The potential adverse effects on the SAC during operation are the same as described for the Broadland Ramsar Site above. Changes in flow and water quality may have adverse effects within downstream components of the Ramsar Site, resulting in degradation of qualifying Annex I habitats and/or habitats which support qualifying features both within the site boundary and functionally linked land, the latter specifically for otter which have a wide home range. Effects on otter are likely to be indirect, through loss of suitable prey items and therefore displacement from optimal foraging and commuting areas.

No other impact pathways are anticipated during operation.

There is potential for adverse effects on site integrity during operation of the option and further studies are required to inform this AA.

16.3.2.4 Breydon Water Ramsar Site (UK11008) (approximately 12.5km north / 34km downstream)

This site is an inland tidal estuary at the mouth of the River Yare and its confluence with the Rivers Bure and Waveney and an adjacent area of drained floodplain. The site holds extensive areas of mudflats that are exposed at low tide (which form the only tidal flats on the east coast of Norfolk), as well as a large area of lowland wet grassland. Breydon Water is internationally important for the populations of wintering waterfowl that it supports, notably of Bewick's swan and lapwing (*Vanellus vanellus*) which are the two qualifying species identified under criterion 6. Pink-footed goose, wigeon, shoveler, golden plover (*Pluvialis* apricaria) and black-tailed godwit (*Limosa limosa islandica*) are species with peak counts in winter which have been identified for possible future consideration under criterion 6.

Construction effects

While the same hydrological connections with the proposed as described above exist (via the River Waveney), this Habitats Site is sufficiently distance from the proposed works (34km downstream) that any pollution events, if they were to occur during construction, are unlikely to have a significant effect within the Ramsar Site boundary. There are, however, habitats within and in close proximity to the construction areas which could be functionally linked to this Ramsar Site and support qualifying bird species (namely Bewick's swan) for foraging. As such, there is the potential for direct loss and damage to these habitats, as well as anthropogenic disturbance of the site's qualifying bird species as a result of the proposed works. Potential disturbance pathways and effects on overwintering birds whilst foraging are detailed above for the Broadland SPA. Bewick's swan and pink-footed goose are the only qualifying features which are anticipated to use habitats surrounding the option for foraging.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 16.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

During the operational phase, it is assumed that there will be an increase in abstraction from the River Waveney. Alterations to the abstraction regime may result in hydrological changes within the Ramsar Site downstream, as well as functionally linked habitats outside of the site boundary. This may potentially cause disruption to the habitats that the qualifying features rely upon. Disruption of a stable hydrological environment may also alter the water quality within the Ramsar Site. These effects will be continuous throughout operation of the reservoir.

No other impact pathways are anticipated during operation.

There is potential for adverse effects on site integrity during operation of the option and further studies are required to inform this AA.

16.3.2.5 Breydon Water SPA (UK9009181) (approximately 12.5km north / 34km downstream)

Breydon Water SPA consists of an inland tidal estuary with extensive areas of mud flats that are exposed during low tide forming the only intertidal flats occurring on the east coast of Norfolk. The mosaic of small areas of saltmarsh, reedbeds and brackish water communities in the surrounding borrow dykes have considerable botanical and invertebrate rich interest.

Breydon Water supports internationally important wintering populations of Berwick's swan, avocet (*Recurvirostra avosetta*), golden plover and ruff and an internationally important breeding population of common tern (*Sterna hirundo).* The Site also regularly supports over 20,000 waterfowl in any season and over 1% of the biogeographic population of Lapwing.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described above for the Breydon Water Ramsar Site. Bewick's swan is the only qualifying feature which is anticipated to use habitats surrounding the option for foraging.

No other impact pathways are anticipated during construction.

The adverse effects described above can be mitigated using industry-wide best practice, to be detailed within a Construction Environmental Management Plan (CEMP) produced at the project stage. These measures are listed in Table 16.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

The potential adverse effects on the SPA during operation are the same as described for the Breydon Water Ramsar Site above. Changes in flow and water quality may have adverse effects within downstream components of the Ramsar Site, resulting in degradation of habitats which support qualifying features both within the site boundary and functionally linked land. No adverse effects are anticipated on breeding common tern, which breed on artificial platforms within the SPA, and forage primarily within the marine environment of the Outer Thames Estuary SPA. It is therefore unlikely that any changes in flow affect their breeding habitat or food resources.

No other impact pathways are anticipated during operation.

There is potential for adverse effects on site integrity during operation of the option and further studies are required to inform this AA.

16.3.3 Assumptions and mitigation measures

16.3.3.1 Assumptions

Based on the current level of information a number of assumptions have been made, relating to principles and established mitigation measures, which will be followed during option development at the project level.

The assumption, in the absence of detailed design or recent survey data, is that the land required for the construction of the infrastructure associated with this option constitutes functionally linked habitat for the qualifying species of The Broadland SPA, Broadland Ramsar Site, Breydon Water SPA and Breydon Water Ramsar Site (bird species only, specific species detailed above) and The Broads SAC (otter only); significant proportions of the overall Habitats Sites' populations regularly use areas either within or directly adjacent to the construction footprint and are therefore likely to be present during their peak seasons.

The plan level measures will be delivered at the project level using the principles set out below:

- An engagement plan will set out the expectations and timescales of consultation so that stakeholders can provide advice during the design and consenting processes.
- Option design and the development of measures to safeguard the Habitats Sites will be informed by further research (listed within the conclusion below).
- In planning the location of infrastructure, the emphasis should be on avoiding Habitats Sites. If this is not possible, adverse effects must be minimised through design, so they are no longer significant.
- Where it is necessary to minimise adverse effects of infrastructure at the project level, appropriate measures should ideally be agreed with statutory stakeholders and be capable of being secured within project design and/or consents. Mitigation measures will also need to be acceptable to competent authorities.
- 'Best available techniques' (BAT) for preventing or minimising impacts on the environment. Consideration of BAT will include the use of technology, design as well as construction, operation, maintenance and decommissioning methods.
- Current best practice environmental considerations, guidance and advice from statutory nature conservation bodies (e.g. Natural England) will be taken into account during the detailed design process.
- Planning of infrastructure should be undertaken in consultation with key stakeholders (e.g. Natural England and, where appropriate, JNCC). Other non-statutory consultees should also be included in the consultation (e.g. RSPB).

If avoidance is not possible then this must be clearly justified, including reasons why alternative locations, either inside or outside the Habitats Site, is unsuitable. If mitigation is included in the design this must be capable of being secured in the project's consents. For example, there may be a number of locations where existing built infrastructure is located on the banks of the River Waveney and therefore opportunities to reinstate decommissioned Environment Agency assets.

The application of the above principles, and the targeted mitigation and industry-wide best practice (within Table 16.3 below), can be relied upon in the plan-level assessment to conclude no adverse effect on site integrity during the construction phase.

Whilst it is not possible for the WRMP24 assessment to reasonably predict the effects on the Habitats Sites in a detailed way, as a lower tier plan to the Anglian river basin district (RBD) River Basin Management Plan (RBMP), which is the principal safeguard related to river basin management, the WRMP24 contains measures that would ensure compliance with the policies of the RBMP. The operational limits of surface water abstraction associated with the Habitats Sites will be constrained by the updated RBMP. With respect to water quality, the river basin management plan aims to sustain geomorphological processes, meet the hydro-ecological requirements of the constituent species and dilute contaminants. The environmental objectives in the RBMP are legally binding once the plan is approved by Secretary of State for Environment, Food and Rural Affairs. All public bodies (e.g. Northumbrian Water Limited) must have regard to these objectives when making decisions that could affect the quality of the water environment. The environmental objectives of the RBMP include, inter alia: preventing deterioration of the status of surface waters and groundwater; achieving objectives and standards for protected areas; and aiming to achieve good status for all water bodies.

The Water Framework Directive (WFD) assessment to inform the WRMP24 concluded, in relation to this option and the 'Waveney (Ellingham Mill - Burgh St. Peter)', the potential for a widespread or prolonged effect on the quality of the water environment that may result in the temporary reduction in WFD status and the potential to prevent target WFD objectives from being achieved. The WFD assessment concluded the confidence in the screening outcome is low, due to the insufficient detail on the receiving environment and the construction and operation of this option. Any water transfer from the River Waveney must be incorporated into

the RBMP and the implications of future design changes on the conservation objectives of the Broadland SPA, Broadland Ramsar Site, The Broads SAC, Breydon Water SPA and Breydon Water Ramsar Site should be assessed in accordance with the Habitats Regulations.

16.3.3.2 Mitigation

The specific mitigation within Table 16.3 below includes industry-wide best practice measures and mitigation which have all been implemented on consented nationally significant infrastructure projects (NSIPs) to address common risks in the construction and development sectors. Therefore, there is practical certainty they can be implemented and in place at the relevant time when the project level HRA is undertaken. The full implementation of these measures, together with any site-specific efficacy research, will be secured and enforced as it has on other projects, in the project planning process.

Mitigation for the permanent loss of functionally linked habitat for overwintering geese and swans, associated with the reservoir construction, must consider the potential shift in functionally linked habitat and its usage together with potential land use conflicts when selecting both the location and the total area of the provision. At this time, there is not enough information to provide details on the extent or location of any compensatory habitat creation and/or management which may be required, only that it should be considered at the project level and guided by further studies. With the understanding that these considerations are made at the project stage, no adverse effect on site integrity is reasonably foreseeable at the plan-level assessment.

A Construction and Environmental Management Plan (CEMP) will be developed, which will include relevant measures described in the best practice guidance outlined within the rdWRMP. The design of the measures within the CEMP will be based on the anticipated site conditions and construction methods whilst also allowing for a precautionary margin of error to account for extreme events, such as unprecedented rainfall which could increases the risk of flooding and pollution. The efficacy of the mitigation measures will be monitored and evaluated by the construction site environmental manager during the construction phase to inform adaptive management.

16.3.4 Monitoring

During construction, monitoring of pollutants is recommended immediately downstream of the proposed location for the installation of the new abstraction pipeline on the river Waveney in order to identify, at the earliest stage, changes which may result in adverse effects at the Habitats Sites.

On a precautionary basis and to inform a future project level HRA, It is also recommended that the following qualifying species and habitats are monitored and included in a survey plan as shown in Table 16.2.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 16.2: Qualifying features of the Habitats Sites and their recommended monitoring plan.

Habitats Sites	Qualifying features	Monitoring Guidelines

The Broads SAC	Desmoulin's whorl snail Otter	Killeen, I.J and Moorkens, E.A (2003). Monitoring Desmoulin's Whorl Snail, *Vertigo moulinsiana*. Conserving Natura 2000 Rivers Monitoring Series No. 6, English Nature, Peterborough. Chanin, P. (2003). Monitoring the Otter *Lutra*. Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough.
Broadland SPA	Birds (breeding and wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf
Broadland Ramsar	Wetland invertebrate assemblage. Birds (wintering bird surveys)	English Nature (2005). Organising surveys to determine site quality for invertebrates, A framework guide for ecologists. English Nature, 1 – 20. Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27. Same monitoring guidance as proposed above for Broadland SPA
Breydon Water Ramsar	Birds (wintering bird surveys)	Same monitoring guidance as proposed above for Broadland SPA
Breydon Water SPA	Birds (wintering bird surveys).	Same monitoring guidance as proposed above for Broadland SPA

Table 16.3: Option RES-002C1 - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Broadland SPA (approximately 1.1km north / 1.7km downstream)	Marsh harrier (Breeding) Bittern (breeding) Overwintering species: Hen harrier Bewick's swan Whooper swan Gadwall Ruff Shoveler Wigeon	This option may have the following permanent or temporary effects on the SPA during the construction phase: • Toxic contamination – chemical pollution in the upstream River Waveney during construction works which could be transferred downstream to the SPA boundary, causing water quality degradation and damage to habitats which support qualifying species. • Non-toxic contamination – additional sedimentation or siltation during construction works of the upstream River Waveney, causing changes in turbidity leading to changes in sediment loading and silt deposition which may lead to the degradation of habitats supporting qualifying species. • Biological disturbance – potential introduction/ spread of INNS. • • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement from preferred foraging or roosting areas and ultimately a reduction in breeding success. • Biological disturbance – reductions in the prey availability and/or extent of habitats which support	The following mitigation and best practice measures will be implemented at the project stage to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works, this should include silt screening around the area of works to limit the movement and redeposition of material. • Directional drilling, or other no-dig techniques, should be used within the riparian zone, where proposed infrastructure interacts with the watercourse and functionally linked wetland habitats. The pipeline will also be installed to a depth that does not cause vibration disturbance or subsidence of the riverbed neat the intake or bankside. This will reduce construction related disturbance to qualifying features of the Ramsar in functionally linked habitats. • Sensitive timing of construction works to avoid the breeding period for bird	No adverse effects are anticipated

	qualifying species, both of which may subsequently lead to displacement of qualifying species within or from the site, as a result of the above impact pathways. • Biological disturbance – anthropogenic disturbance within potential functionally linked habitat, changes in habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas. This option may have the following permanent effects on the SPA during the operation phase: • Water table availability - reduced flow downstream of the option within the SPA boundary may result in reductions in the extent of habitats which support qualifying species. • Physical damage – Hydrological changes may lead to habitat degradation causing reduction of habitat availability/habitat loss for this site. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to changes in hydrology resulting in habitat loss or damage. • Biological disturbance – reductions in the distribution and extent of supporting habitats, both within and outside of the SPA, from the above pathways. A shift in functionally linked habitat from the creation of a new reservoir, a potential roost site for some qualifying features which could draw these species away from the SPA. Transfer of INNS to the new reservoir, thus degrading what could be functionally linked habitat. • The identified effects have the potential to reduce the distribution, extent and population sizes of qualifying species.	species detailed in the Broadland SPA supplementary advice note during April to August inclusive. Any works which are undertaken outside of this period may disturb or displace overwintering species from suitable functional land, details of which are provided below. • Given the sensitivity of the qualifying species at this site, it is strongly recommended that construction works avoid the sensitive period stated above (April to August inclusive). However, if this cannot be avoided, additional mitigation will be required. This should be informed by additional monitoring and assessment, but may involve the following as a guideline, which will be applicable outside of this period to safeguard overwintering bird species: • Additional working methods which will reduce disturbance to breeding birds during construction include: A slow construction start allowing plant engines to idle for five minutes to allow acclimatisation to additional noise. Plant machinery to be painted/camouflaged to be less conspicuous; it is unlikely that all plant will be effectively screened by barriers due to size. The use of netting or colours in dark greens, grey or black will blend into the background when moving. All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances

			in technology will be utilised, including the use of electric and hybrid alternatives. All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. The development of a Construction and Environmental Management Plan will include all the above proposed mitigation measures and any further measures identified from additional studies at the project stage. Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction. Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed abstraction and transfer from the River Waveney to the new reservoir and WTW. The operational limits of the abstraction and transfer from the River Waveney to the new reservoir and WTW that will be imposed by the updated Thames RDB RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity during operation.	
Broadland Ramsar (approximately 1.1km north / 1.7km downstream)	Qualifying Annex 1 Habitats (criterion 1) which are present within the ZoI.	This option may have the following permanent or temporary effects on the Ramsar during the construction phase: • Toxic contamination – chemical pollution in the upstream River Waveney during construction works which could be transferred downstream to the Ramsar	The following mitigation and best practice measures will be implemented at the project stage to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites).	No adverse effects.

boundary, causing water quality degradation and damage to qualifying Annex I habitats.

- Non-toxic contamination – additional sedimentation or siltation during construction works of the upstream River Waveney, causing changes in turbidity leading to changes in sediment loading and silt deposition which may lead to the degradation of qualifying Annex I habitats.
- Biological disturbance – potential introduction/ spread of INNS.

The effects of toxic and non-toxic contamination could result in permanent effects on qualifying habitats but are likely to be localised due to the nature of the option.

This option may have the following permanent effects on the Ramsar during the operation phase:

- Water table availability - reduced flow downstream of the option within the Ramsar boundary may result in changes to qualifying habitats which rely on the current hydrological regime.
- Physical damage – Hydrological changes may lead to habitat degradation causing reduction and extent of qualifying habitats.
- Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to changes in hydrology resulting in habitat loss or damage.

The identified effects have the potential to reduce the distribution and extent of qualifying habitats.

- Biosecurity measures to ensure appropriate removal and/or management control of INNS at source.
- Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works, this should include silt screening around the area of works to limit the movement and redeposition of material.
- Directional drilling, or other no-dig techniques, should be used within the riparian zone, where proposed infrastructure interacts with the watercourse The pipeline will also be installed to a depth that does not cause vibration disturbance or subsidence of the riverbed near the intake or bankside. This will reduce construction related sedimentation and silt deposition upstream of the Ramsar.

The development of a Construction and Environmental Management Plan will include all the above proposed mitigation measures and any further measures identified from additional studies at the project stage.

Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction.

Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed abstraction and transfer from the River Waveney to the new reservoir and WTW.

The operational limits of the abstraction and transfer from the River Waveney to the new reservoir and WTW that will be imposed by the updated Thames RDB RBMP are a sufficient safeguard for this plan-level assessment to

		conclude no adverse effect on site integrity during operation.
Desmoulin`s whorl snail. RDB invertebrate species Fen orchid RBD plant species	See “Possible adverse effects before mitigation” listed above for qualifying Annex I habitats for the Broadland Ramsar.	See “Mitigation measures” listed above for qualifying Annex I habitats for the Broadland Ramsar.
Otter	In addition to the effects listed above for qualifying Annex I habitats, the following temporary or permanent effects are applicable to otter during construction: • Non-physical disturbance – visual, noise and vibration disturbance close to otter foraging, commuting and resting sites during construction may result in changes to breeding behaviours. Otters may be foraging in the River Waveney and other water courses within the proposed pipe footprint, and therefore disturbance can change regular behaviours and use of preferred areas. • Biological disturbances – disturbance to qualifying species which may subsequently lead to their displacement within or from the site, as a result of the above impact pathway. This option may have the following permanent effects on the Ramsar otter population during the operation phase: • Water table availability - reduced flow downstream of the option within the Ramsar boundary and	In addition to the mitigation detailed for qualifying Annex I habitats above, the following mitigation measures should be implemented at the project stage to safeguard otter: • Scottish Environment Protection Agency’s (SEPA) good practice guide for intakes and outfalls (WAT-SG-28). • Environment Agency’s best practice guide for screening intakes and outfalls (Science report SC030231). - Intake heads should be designed for slow suction velocity to further reduce impingement of freshwater biota against the intake screen. Heads should be fitted orthogonal to downstream currents to reduce forcing against the screens, thus minimising velocity of approach for prey species. Intake locations should avoid the spawning grounds of otter prey species. • Maintain commuting routes during construction, with no physical barriers to movement within the watercourse and adjacent suitable habitat. • Sensitive timing of construction works to avoid the periods of greatest otter activity, i.e. no night-time working.

	functionally linked habitat may result in reductions in the extent of habitats and prey availability which support qualifying species. • Physical damage – Hydrological changes may lead to habitat degradation causing reduction of habitat and prey availability for otter. • Non-toxic contamination – temporary changes in turbidity, sedimentation and/or silting associated to changes in hydrology resulting in habitat loss or damage. • Biological disturbance – reductions in the distribution and extent of supporting habitats, both within and outside of the Ramsar, from the above pathways. Changes to the populations of preferred prey as a result of reduced water quality from increased abstraction. Transfer of INNS to the new reservoir, thus degrading what could be functionally linked habitat. The identified effects have the potential to reduce the distribution, extent and population sizes of qualifying species.	• Best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011) to avoid significant effects due to increased light (if works are programmed at night) • Retain bankside habitat cover and other suitable adjacent habitats where possible. • Pre-commencement otter survey to ensure that no breeding or resting sites are present within the Zone of Influence (ZoI) of the works. • Potential resting sites should be monitored using cameras (requires Natural England licence). A 30m protection zone around confirmed resting sites is required during construction. This distance is extended to 150m for confirmed breeding sites. • If holts require closure and destruction to facilitate construction, artificial replacements will be required on the same watercourse away from the works area. These must be in-situ before construction starts. This work, if necessary, will require a Natural England licence. The development of a Construction and Environmental Management Plan will include all the above proposed mitigation measures and any further measures identified from additional studies at the project stage.

			Following the principles outlined within the 'Assumptions' section above, and the implementation of industry-wide best practice measures, no adverse effects are anticipated during construction. Appropriate mitigation measures for features during operation will be informed by completion of further assessments, including hydrological modelling of the proposed abstraction and transfer from the River Waveney to the new reservoir and WTW. The operational limits of the abstraction and transfer from the River Waveney to the new reservoir and WTW that will be imposed by the updated Thames RDB RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity during operation.	
	Bewick's swan Pink-footed goose Greylag goose Wigeon Gadwall Shoveler	See "Possible adverse effects before mitigation" listed above for qualifying features of the Broadland SPA.	See "Mitigation measures" listed above for qualifying features of the Broadland SPA. Although the seasonality for peak numbers of qualifying breeding birds is different to that of the overwintering assemblage, the impact pathways are the same. Qualifying bird species of the Ramsar overwinter at the site, from November to March inclusive. When it comes to avoidance of sensitive periods, April to August inclusive should be avoided to reduce disturbance effects on qualifying breeding bird species of the Broadland SPA. Avoidance of breeding birds should be prioritised, as they are also protected by the Wildlife and Countryside Act 1981 (as amended).	
The Broads SAC (approximately 1.1km north / 1.7km downstream)	Qualifying Annex 1 Habitats Desmoulin's whorl snail	See "Possible adverse effects before mitigation" listed above for qualifying Annex I habitats for the Broadland Ramsar.	See "Mitigation measures" listed above qualifying Annex I habitats for the Broadland Ramsar.	No adverse effects

	Ram's-horn snail Fen orchid			
	Otter	See "Possible adverse effects before mitigation" listed above for otter for the Broadland Ramsar.	See "Mitigation measures" listed above for otter for the Broadland Ramsar.	
Breydon Water Ramsar (approximately 12.5km north / 34km downstream)	Overwintering populations of: Bewick's swan. Pink-footed goose Lapwing Wigeon Shoveler Golden plover Black-tailed godwit	See "Possible adverse effects before mitigation" listed above for qualifying features of the Broadland SPA. Adverse effects from disturbance during construction are only anticipated for Bewick's swan and Pink-footed goose.	See "Mitigation measures" listed above for qualifying features of the Broadland SPA. Although the seasonality for peak numbers of qualifying breeding birds is different to that of the overwintering assemblage, the impact pathways are the same. Qualifying bird species of the Ramsar overwinter at the site, from October to March inclusive. When it comes to avoidance of sensitive periods, April to August inclusive should be avoided to reduce disturbance effects on qualifying breeding bird species of the Broadland SPA. Avoidance of breeding birds should be prioritised, as they are also protected by the Wildlife and Countryside Act 1981 (as amended).	No adverse effects
Breydon Water SPA (approximately 12.5km north / 34km downstream)	Ruff (Passage) Overwintering populations of: Bewick's swan Avocet Lapwing Golden plover	See "Possible adverse effects before mitigation" listed above for qualifying features of the Broadland SPA.	See "Mitigation measures" listed above for qualifying features of the Broadland SPA. Although the seasonality for peak numbers of qualifying breeding birds is different to that of the overwintering assemblage, the impact pathways are the same. Details of the seasonality of qualifying features of the SPA are provided within the Natural England conservation advice page. When it comes to avoidance of sensitive periods, April to August inclusive should be avoided to reduce disturbance effects on qualifying breeding bird species of the Broadland SPA. Avoidance of breeding birds should be prioritised, as they are	No adverse effects.

		also protected by the Wildlife and Countryside Act 1981 (as amended).
Common tern (breeding)	No impact pathways present.	None required.

16.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is considered that with adherence to the proposed mitigation, the works associated with the option RES-002C1 is not expected to have any adverse effects on the integrity of the Broadland SPA, Broadland Ramsar Site, The Broads SAC, Breydon Water Ramsar Site and Breydon Water SPA during the construction phase. Mitigation measures which may be progressed at the project stage could include pre-construction surveys, timing restrictions, habitat avoidance, habitat reinstatement, staged construction works, toolbox talks and presence of an ECoW.

No adverse effect on site integrity can be concluded for during operation, on the understanding that further research identified in the conclusion of this Appropriate Assessment on the potential environmental effects of future design iterations (including the use of alternative water transfer operating procedures or water sources), will lead to a final project that will operate in compliance with the legally binding environmental objectives set out in the RBMP. The operational limits that will be imposed by the RBMP are a sufficient safeguard for this plan-level assessment to conclude no adverse effect on site integrity.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for construction phases at all sites. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Hydrodynamic modelling of flows to identify whether the changes in the water levels and flows as a result of the new abstraction point on the River Waveney would have an adverse effect on the quality and quantity of water required to maintain the integrity of Habitats Sites downstream of the option and their qualifying features.
- Water quality monitoring and modelling to determine the potential adverse effects of water quality changes on qualifying habitats present downstream of the proposed works on the River Waveney.
- A detailed review of the baseline ecological data for qualifying bird species, invertebrates and otter to inform the requirement for additional monitoring and to determine more targeted mitigation measures.
- Finally, the adverse effects identified through this HRA may be compounded through the more frequent and intense effects of climate change, including heat waves, droughts, floods, and rising sea levels. Therefore, a climate change scenario analysis is also recommended to account for mid and long-term effects on the Habitats Sites.

It is also recommended that a CEMP be put in place that would include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

16.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

17 Broome to Barsham Transfer (ESW-TRA-023)

Option ID: (ESW-TRA-023)

17.1 Option Description

This option proposes the transfer of raw water from Broome WTW to Barsham WTW - connecting to a new service reservoir. The transfer pipeline is approximately 6.04km long and has an outside diameter of 225mm.

17.2 Stage 1 Screening – Review

The Stage 1 screening carried out in July 2023 identified three Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for any of these sites (Table 17.1).

This option has proceeded to the next HRA stage – AA. The full HRA screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 17.1: TRA-023 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approx. 1.5km north)	
Broadland Ramsar Site (UK110100) (approx. 1.5km north)	
The Broads SAC (UK0013577) (approx. 1.5km north)	

17.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 17.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects
- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

17.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Broadland SPA (UK9009253)
- Broadland Ramsar Site (UK110100)
- The Broads SAC (UK0013577)

17.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 17.2.

17.3.2.1 Broadland SPA (UK9009253) (approx. 1.5km north)

The Broadland SPA is a low-lying wetland complex connecting the boundaries between east Norfolk and northern Suffolk. The area includes the river valley systems of the Bure, Yare and Waveney and their major tributaries. This distinctive open landscape comprises a complex and interlinked mosaic of wetland habitats including open water, reedbeds, woodland, grazing marsh, and fen meadow, forming one of the finest marshland complexes in the UK. Its qualifying features are non-breeding Bewick's swan (*Cygnus columbianus bewickii*), gadwall (*Anas strepera*), hen harrier (*Circus cyaneus*), ruff (*Calidris pugnax*), Northern shoveler (*Anas clypeata*), whooper swan (*Cygnus cygnus*) and wigeon (*Anas penelope*), as well as breeding bittern (*Botaurus stellaris*) and marsh harrier (*Circus aeruginosus*).

Construction effects

The Broadland SPA is hydrologically connected to the option with the proposed pipeline crossing the River Waveney approximately 1.5km upstream. Further hydrological connections exist as the proposed pipeline also crosses several dikes and canals which link to all of the SSSI components of the SAC further downstream. This Site has been identified as a groundwater-dependent terrestrial ecosystem (GWDTE) meaning that it is ecologically sensitive to changes in groundwater levels and chemistry.

Due to this hydrological connectivity, it is possible that any pollution events (toxic or non-toxic) could be transferred to the site and impact habitats (such as reedbeds and floodplain grazing marsh), which support its qualifying species. The wetland flora and fauna which qualifying bird species rely on may also be affected by any pollution events. These food resources may be lost and result in changes to the population sizes and distribution of qualifying species found within the site.

Other temporary impact pathways that could lead to adverse effects on qualifying species include an increased exposure to air pollution (dust and nitrogen oxides associated with construction vehicles). Direct exposure to dangerous concentrations of air pollutants as a result of the proposed works is unlikely due to the highly mobile nature of the qualifying bird species. Therefore, no adverse effects from air pollution are anticipated on qualifying species themselves.

No significant direct effects are anticipated on breeding bittern due to the lack of suitable supporting habitat within the ZoI. Bittern are associated with reedbed habitat and are unlikely to be present in the short sward floodplain grazing marsh habitat associated with the proposed pipeline footprint. No reedbed habitat has been identified within the wider ZoI of the pipeline. Similarly, marsh harrier primarily breed in reedbed habitat. However, the wider impacted area could provide foraging habitat for marsh harrier. For example, the pipeline overlaps with coastal and floodplain grazing marsh priority habitat. Therefore, there is potential for loss of functionally linked supporting habitat and anthropogenic disturbance during construction works.

The proposed works also pass through areas of agricultural land and grassland which are suitable functionally linked habitats that support foraging overwintering bird species; Bewick's swan, whooper swan, wigeon and hen harrier. Swans will typically forage in agricultural land during the day and return to roosting sites within the SPA at night. There may be permanent or temporary loss of these foraging habitats, however it is not anticipated that the proposed pipeline footprint and its narrow area will cause any long-term impacts on the overall ability of the surrounding functional land to support the Habitat Site's populations.

During construction there may also be indirect effects to the integrity of the SPA through disturbance (namely noise, visual disturbance and artificial light) which could impact upon qualifying bird species. Disturbance can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, desertion of nesting sites, eggs and/or chicks, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise breeding success, adult fitness, and survival by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

In the absence of up-to-date species records or survey data at this stage, it is not possible to rule out significant effects on this Habitats Site from construction.

No other impact pathways are anticipated during construction.

The adverse effects described can be mitigated using best practice measures and the preparation and implementation of a Construction Environmental Management Plan (CEMP). These measures are listed in Table 17.3. After mitigation no adverse effects on the site integrity is anticipated.

Operation effects

No adverse effects from the operation of this option have been identified on the Broadlands SPA and its qualifying features.

17.3.2.2 Broadland Ramsar Site (UK110100) (approx. 1.5km north)

A low-lying wetland complex composed of the Bure, Yare, Thurne, and Waveney River systems of the Norfolk Broads. The mosaic of wetland habitats includes open water, reedbeds, carr woodland, grazing marsh, and fen meadow, with an extensive complex of flooded medieval peat diggings. Outstanding assemblages of rare plants and invertebrates occur at the site, where 136 British Red Data Book invertebrate species have been recorded. Amongst this rich insect fauna are nationally rare dragonflies, spiders, moths, and butterflies. The area is also a stronghold for the swallowtail butterfly (*Papilio machaon brittanicus,* for which this is the only known breeding location in Britain) as well as a number of nationally rare breeding birds. Several species of waterbirds winter there and include internationally important numbers of Bewick's swan.

Construction effects

The hydrological connection between the option and this site is the same as described above for Broadland SPA. Qualifying Annex I habitats (such as calcareous fens and alluvial woods) may be degraded through pollution and sedimentation, as could other habitats, flora and fauna for which qualifying features such as Otter and wetland invertebrates rely on. The loss or degradation of these habitats, food resources and refuges through pollution events would reduce the suitability of the site to support qualifying species, resulting in changes to their population sizes and distribution within or from the site.

The construction effects on breeding and non-breeding qualifying birds will be similar to the ones listed above for the Broadlands SPA, as both sites follow the same boundary.

Other temporary impact pathways that could lead to adverse effects on qualifying species include exposure to noise, visual and vibration disturbance and increased exposure to air pollution (dust and nitrogen oxides associated with construction vehicles). Direct exposure to dangerous concentrations of air pollutants as a result of the proposed works is less likely to affect qualifying bird species due to their highly mobile nature. Therefore, no adverse effects from air pollution are anticipated on these qualifying species themselves. However, invertebrates (such as the swallow tail butterfly or Desmoulin`s whorl snail) are less mobile and known to be affected by exposure to common air pollutants[28]. Qualifying invertebrate species and communities might therefore, if present within the ZoI, be impacted by increased levels of air pollutants due to the presence of construction vehicles and other machinery use.

No other impact pathways are anticipated during construction.

The adverse effects described can be mitigated using best practice measures and the preparation and implementation of a CEMP. These measures are listed in Table 17.3. After mitigation no adverse effects on the site integrity is anticipated.

Operation effects

No adverse effects from the operation of this option have been identified on the Broadland Ramsar Site and its qualifying features.

17.3.2.3 The Broads SAC (UK0013577) (approx. 1.5km north)

The Broads SAC contains a variety of habitats including naturally nutrient-rich lakes that support a diversity of relict vegetation and aquatic invertebrate assemblages, rich areas of stoneworts, large blocks of alder (*Alnus glutinosa*) woodland, calcareous fens and wet heath.

Qualifying features of The Broads SAC include hard oligo-mesotrophic waters with benthic vegetation of *Chara* species, natural eutrophic lakes with *Magnopotamion* or *Hydrocharition,* Molinia meadows on calcareous, peat or clay-silt soil, transition mires and quaking bogs, calcareous fens with great fen-sedge (*Cladium mariscus*) and species of *Caricion davallianae* (calcium-rich fen dominated by great fen-sedge), alkaline fens, alluvial woods with black alder and European ash (*Fraxinus excelsior*), fen orchid (*Liparis loeselii*), ram's-horn snail (*Anisus vorticulus*), Desmoulin's whorl snail, and otter (*Lutra lutra*).

Construction effects

The hydrological connection between the option and this site is the same as described above for the Broadlands SPA and Ramsar Site. The construction effects on qualifying habitats of the Broads SAC will be similar to the ones listed above for the Broadlands Ramsar Site, as both sites follow the same boundary. The construction effects on breeding and non-breeding qualifying birds will be similar to the ones listed above for the Broadlands SPA, as both sites follow the same boundary. The effects of other temporary impact pathways on qualifying species (including exposure to noise, visual and vibration disturbance and increased exposure to air pollution) will be the same as described above for the Broadlands SPA and Ramsar Site.

Otters can occupy large ranges (around 32km for males and 20km for females) and use a wide range of habitats including rivers, marshes and estuaries. If otters are present during the works, temporary disturbance and displacement from a breeding site or resting place could occur. As a European Protected Species, it is an offence to disturb an otter resting place or breeding site (natal dens, subterranean dens/holts and above ground/couches). Resting places are typically located in dense bank vegetation and areas of reed. Breeding sites are located in hollow tree

[28] Ryalls, J.M.W et al. (2022). Anthropogenic air pollutants reduce insect-mediated pollination services. *Environmental Pollution*

trunks and piles of timber[29]. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

Pollution incidents and sedimentation could also impact on the successful growth of qualifying habitats, cause habitat degradation and therefore, reduce the suitability of the site to support qualifying species including the Desmoulin's snail, ram's-horn snail and otter. There is potential for adverse effects on calcareous fens with swamp sawgrass and species of *Caricion davallianae*, alluvial woods with black alder and ash, Desmoulin's whorl snail, ramshorn snail and otter.

No impact pathways that could lead to an adverse effect have been identified for natural eutrophic lakes with *Magnopotamion* or *Hydrocharition,* Molinia meadows on calcareous peat or clay-silt soil, transition mires and quaking bogs, hard oligo-mesotrophic waters with benthic vegetation of *Chara* species, alkaline fens and fen orchids. These qualifying habitats are not present within the proposed pipeline footprint, and the other components of the SAC are distant enough from the option footprint that no significant effects are anticipated.

No other impact pathways are anticipated during construction.

The adverse effects described can be mitigated using best practice measures and the preparation of a CEMP. These measures are listed in Table 17.3. After mitigation no adverse effects on the site integrity is anticipated.

Operation effects

No adverse effects from the operation of this option have been identified on the Broadland Ramsar Site and its qualifying features.

17.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

17.3.4 Monitoring

During construction, continuous pollution (toxic and non-toxic) monitoring is recommended immediately downstream of the proposed works area in order to identify, at the earliest stage, changes which may result in adverse effects downstream at the Habitats Sites.

It is also recommended that the following qualifying habitats and species are monitored and included in a survey plan shown in Table 17.2.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

[29] Kruuk, H. 2006. Otters: ecology, behaviour and conservation: ecology, behaviour and conservation, OUP Oxford.

Table 17.2: Qualifying features of the Habitats Sites and their recommended monitoring plan.

Habitats Sites	Qualifying features	Monitoring Guidelines
The Broads SAC	Desmoulin's whorl snail and ramshorn whirlpool snail (combined as no guidance available for latter species).	Killeen, I.J and Moorkens, E.A (2003). Monitoring Desmoulin's Whorl Snail, *Vertigo moulinsiana*. Conserving Natura 2000 Rivers Monitoring Series No. 6, English Nature, Peterborough.
	Otter	Chanin, P. (2003). Monitoring the Otter *Lutra*. Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough.
	Supporting habitats for qualifying species.	Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27.
Broadland SPA	Birds (breeding and wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf
Broadland Ramsar	Wetland invertebrate assemblage.	English Nature (2005). Organising surveys to determine site quality for invertebrates, A framework guide for ecologists. English Nature, 1 – 20. Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27.
	Birds (wintering bird surveys)	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf

Table 17.3: Option TRA-023 - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Broadland SPA (approx. 1.5km north)	Marsh harrier	This option may have the following permanent or temporary effects on the SPA during the construction phase: • Toxic contamination – pollution incidents and exposure to air pollution (dust and nitrogen oxides) that could lead to degradation of functionally linked foraging habitat. • Non-toxic contamination - habitat degradation via changes in water quality caused by increased suspended sediment and turbidity from associated run-off. This could lead to increased silt deposition, particularly when groundwater levels are high, and the site is susceptible to flooding. • Physical loss/damage – significant localised habitat loss and/or degradation from pollution of functionally linked foraging habitat for qualifying species. • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Directional drilling, or other no-dig techniques, should be used to cross watercourses over 3m wide, where proposed pipeline alignments bisect them. This includes a 10m buffer distance either side of the watercourse to limit impact pathways into the watercourse. The pipeline will also be installed to a depth that does not cause vibration disturbance or subsidence of the riverbed. This will reduce impacts to main watercourses and reduce the likelihood of pollution events downstream within the Habitats Site. • Sensitive timing of construction works to avoid the breeding period for qualifying bird species detailed in the Broadland SPA supplementary advice note during April to August inclusive. Any works which are undertaken outside of this period may disturb or displace overwintering	No adverse effects.

	from preferred foraging or roosting areas and ultimately a reduction in breeding success. • Biological disturbances – disturbance to qualifying features and reductions in the extent of habitats which support qualifying species, both of which may subsequently lead to changes in distribution and extent of qualifying features, as a result of the above impact pathways. Accidental introduction of invasive non-native species (INNS) to the site. The effects of toxic pollution and physical loss/damage of habitat could result in permanent impacts but are likely to be localised due to the nature of the option (i.e., narrow pipeline corridors during directional drilling). The identified effects have the potential to reduce the distribution, extent and population sizes of qualifying species. No adverse effects are anticipated during operation.	species from suitable functional land, details of which are provided below. The development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	
Overwintering species: Hen harrier Bewick's swan Whooper swan Gadwall Ruff Shoveler	In addition to the effects listed above for marsh harrier, the following temporary effects are applicable to overwintering bird species during construction: • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement from preferred foraging or roosting	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • Assuming that works will take place during the winter period to avoid effects on breeding marsh harrier, these works will only be permitted if the population present at risk of disturbance is less than 1% of the cited SPA population, and works will	No adverse effects.

Wigeon	areas and ultimately a reduction in winter survival rates. No additional adverse effects are anticipated during operation.	be supervised by an ornithological watching brief. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Night works will be avoided for the construction of the proposed pipeline adjacent, as qualifying bird species may be roosting within the site and/or immediately adjacent habitats. • Additional working methods which will reduce disturbance to overwintering birds during construction include: A slow construction start allowing plant engines to idle for five minutes to allow acclimatisation to additional noise. Plant machinery to be painted/camouflaged to be less conspicuous; it is unlikely that all plant will be effectively screened by barriers due to size. The use of netting or colours in dark greens, grey or black will blend into the background when moving. All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives. All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. Overwintering populations of some qualifying species, e.g. Bewick's swan, whooper swan, hen harrier and wigeon, roost within the Habitats Sites' boundary itself and only use surrounding agricultural land for foraging. Therefore, specific mitigation measures for temporary artificial lighting

		during night works are not required for the pipeline construction. However, there is currently not enough information available to propose mitigation for the potential operational effects on the Habitats Site. As a result, there is still the potential for adverse effects.	
Bittern	Due to the lack of reed habitat within the proposed pipeline area, bittern is not likely present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects identified.

Broadland Ramsar (approx. 1.5km north)	H7210 Calcareous fens with great fen-sedge and species of the *Caricion davallianae.* H91E0 Alluvial forests with common alder and European ash (*Alno-Padion, Alnion incanae, Salicion albae*). Desmoulin`s whorl snail. Ramshorn snail.	This option may have the following permanent or temporary effects on the Ramsar Site and its qualifying features during the construction phase: • Toxic contamination – pollution incidents and exposure to air pollution (dust and nitrogen oxides) that could lead to habitat degradation and displacement of qualifying invertebrate species. • Non-toxic contamination - habitat degradation via changes in water quality caused by increased suspended sediment and turbidity from associated run-off. This could lead to increased silt deposition, particularly when groundwater levels are high, and the site is susceptible to flooding. • Loss of functionally linked terrestrial habitat for qualifying Annex II species. Potential for direct mortality of Desmoulin's whorl snail and ramshorn snail during construction. • Biological disturbances – disturbance to qualifying features and reductions in the extent of habitats which support qualifying species, both of which may subsequently lead to changes in distribution and extent of qualifying features, as a result of the above	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Directional drilling, or other no-dig techniques, should be used to cross watercourses over 3m wide, where proposed pipeline alignments bisect them. This includes a 10m buffer distance either side of the watercourse to limit impact pathways into the watercourse. The pipeline will also be installed to a depth that does not cause vibration disturbance or subsidence of the riverbed. This will reduce direct impacts on the Habitat Site. • Specific mitigation to reduce increased sedimentation and silt deposition downstream include: - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. - Planning silt screening around the area of works to limit the movement and redeposition of material. - Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport. The development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	No adverse effects.

	impact pathways. Introduction of INNS to the site.	
	The effects of toxic pollution and physical loss/damage of habitat could result in permanent impacts but are likely to be localised due to the nature of the option (i.e., narrowpipeline corridors during directional drilling). The identified effects have the potential to reduce the extent and distribution of the qualifying Annex I habitat, and distribution, extent and population sizes of qualifying Annex II species. No adverse effects are anticipated during operation.	

Otter.	In addition to the effects listed above, the following temporary effects are applicable to otters during construction: • Non-physical disturbance – visual, noise and vibration disturbance close to otter resting sites during construction may result in changes to breeding behaviours. Otters may be foraging in the River Waveney and other water courses within the proposed pipe footprint, and therefore disturbance can change regular behaviours and use of preferred areas. • Biological disturbances – disturbance to qualifying species which may subsequently lead to their displacement within or from the site, as a result of the above impact pathway. No additional effects are anticipated on otter during operation.	In addition to the above, the following mitigation measures should be implemented: • Maintain commuting routes during construction, with no physical barriers to movement within the watercourse and adjacent suitable habitat. • Sensitive timing of construction works to avoid the periods of greatest otter activity, i.e. no night-time working. • Best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011) to avoid significant effects due to increased light (if works are programmed at night) • Retain bankside habitat cover and other suitable adjacent habitats where possible. • Pre-commencement otter survey to ensure that no breeding or resting sites are present within the Zone of Influence (ZoI) of the works. • Potential resting sites should be monitored using cameras (requires Natural England licence). A 30m protection zone around confirmed resting sites is required during construction. This distance is extended to 150m for confirmed breeding sites.	No adverse effects.

			If holts require closure and destruction to facilitate construction, artificial replacements will be required on the same watercourse away from the works area. These must be in-situ before construction starts. This work will require a Natural England licence.	
	Bewick's swan. Wigeon. Gadwall. Northern shoveler.	See "Possible adverse effects before mitigation" listed above for overwintering species for Broadland SPA.	See "Indicative mitigation measures" listed above for overwintering species for Broadland SPA.	No adverse effects.
	H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.* H3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition type vegetation. H7140 Transition mires and quaking bogs. H7230 Alkaline fens. H6410 Molinia meadows on calcareous, peat or clay-silt soil. Fen orchid.	Based on the extent of the proposed pipeline footprint, these qualifying habitats and species are not thought to be present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects.
The Broads SAC (approx. 1.5km north)	H7210 Calcareous fens with great fen-sedge and species of the *Caricion davallianae.* H91E0 Alluvial forests with common alder and European ash (*Alno-Padion, Alnion incanae, Salicion albae*).	See "Possible adverse effects before mitigation" listed above for calcareous fens and alluvial forests for Broadland Ramsar.	See "Indicative mitigation measures" listed above for calcareous fens and alluvial forests for Broadland Ramsar.	No adverse effects.

Desmoulin`s whorl snail. Ramshorn snail.	See “Possible adverse effects before mitigation” listed above for Desmoulin's whorl snail and ramshorn snail for Broadland Ramsar.	See “Indicative mitigation measures” listed above for listed above for Desmoulin's whorl snail and ramshorn snail for Broadland Ramsar.	No adverse effects.
Otter.	See “Possible adverse effects before mitigation” listed above for otter for Broadland Ramsar.	See “Indicative mitigation measures” listed above for otter for Broadland Ramsar.	No adverse effects.
Bewick’s swan. Wigeon. Gadwall. Northern shoveler.	See “Possible adverse effects before mitigation” listed above for overwintering species for Broadland SPA.	See “Indicative mitigation measures” listed above for overwintering species for Broadland SPA.	No adverse effects.
H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.* H3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition type vegetation. H7140 Transition mires and quaking bogs. H7230 Alkaline fens. H6410 Molinia meadows on calcareous, peat or clay-silt soil. Fen orchid.	Based on the extent of the proposed pipeline footprint, these qualifying habitats and species are not thought to be present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects.

Source: Mott MacDonald, 2023

17.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is considered that with adherence to the proposed mitigation measures and implementation of a CEMP, the works associated with option TRA-023 are not expected to have any adverse effects on the integrity of the Broads SAC, Broadland SPA and Broadland Ramsar Site during the construction phase. Proposed mitigation measures include pre-construction surveys, timing restrictions, habitat avoidance via directional drilling, habitat reinstatement, stage construction works, toolbox talks, habitat management, presence of an ECoW and if required, and a Natural England derogation licence for otter.

No impact pathways during the operational phase of the option have been identified on Habitats Sites and associated qualifying features.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for the construction phases only at all sites, since no adverse effects from the operation stage were identified. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Desk based noise assessment to determine an accurate extent of the ZoI once more information is available on construction methodology.
- A desk-based hydro-geological assessment is required when more information is available to ensure that the pipeline installation proposed does not cause subsidence of the riverbed on the River Waveney.
- Groundwater monitoring is required to understand groundwater levels and how they interact with the proposed pipeline.
- River condition assessments to assess the condition of the River Waveney prior to construction, to determine the presence (or likely absence) of qualifying features and supporting habitat within the ZoI. This will allow a better estimation of construction impacts and potential degradation in site condition.
- Adapted river habitat surveys of the River Waveney to determine if suitable spawning habitat is present for brook lamprey, bullhead and white-clawed crayfish (mapping of silt beds, gravel, riffles, glides, runs, shelter etc.) within the ZoI.
- A detailed review of the baseline ecological data for qualifying birds and invertebrates to inform the requirement for additional monitoring and to determine more targeted mitigation measures. This is likely to include breeding and wintering bird, otter, Desmoulin's whorl snail and wetland invertebrate surveys.

It is also recommended that a CEMP is put in place, which would include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time, and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

17.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

18 Langford UV – Crypto (ESW-UVC-001)

Option ID: (ESW-UVC-001)

18.1 Option Description

This option proposes the installation of additional ultraviolet treatment infrastructure at the existing Langford WTW to treat for cryptosporidium for the plant's full flow capacity of 57Ml/d. These are to be located on the outlet from the Granular Activated Contactors, prior to the clean water storage tanks.

The option assumes the need for inline pumping, on site power supply and transformer, additional standby power generation, and fuel storage.

18.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified two Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for either of these sites: Essex Estuaries SAC, Blackwater Estuary Ramsar and Blackwater Estuary SPA. The screening review is summarised in This option has proceeded to the next HRA stage – AA. The full HRA screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 188.1 below.

This option has proceeded to the next HRA stage – AA. The full HRA screening review is presented in Appendix F.2. Information on the Habitats Sites is provided in Appendix F.3, including qualifying features, conservation objectives, and threats and pressures to site integrity.

Table 188.1: UVC-001 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Essex Estuaries SAC (UK0013690) (approx. 2.5km southeast)	None
Blackwater Estuary Ramsar Site (UK11007) (approx. 2.5km southeast)	
Blackwater Estuary SPA (UK9009245) (approx. 2.5km southeast)	

18.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 18.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects
- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

18.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Essex Estuaries SAC (UK0013690)
- Blackwater Estuary Ramsar Site (UK11007)
- Blackwater Estuary SPA (UK9009245)

18.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 18.2.

18.3.2.1 Essex Estuaries SAC (UK0013690) (approx. 2.5km)

Essex Estuaries is the second largest estuarine site on the east coast of England. It contributes to the essential range and variation of estuaries in the United Kingdom (UK) as the best example of a coastal plain estuary system on the British North Sea coast. The site comprises the major estuaries of the Colne, Blackwater, Crouch and Roach rivers.

This Habitats Site is designated for supporting a coastal plain estuarine system with open coast mudflats and sandflats not covered by seawater at low tide, sandbanks, *Salicornia* and other annuals colonising mud and sand, Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). The area of pioneer marsh located at Foulness Point includes gradation into extensive cordgrass (*Spartina spp*) swards, including the most extensive remaining stand of the native small cordgrass (*Spartina maritima*) in the UK and possibly in Europe.

Construction effects

Partial hydrological connections exist between this option's footprint and the SAC through the rivers Chelmer and Blackwater. Although these rivers are not in direct hydrological connection with the option, they lay within 500m and flow into the SAC approximately 2.5km downstream. Some hydrological connection also exists through the Essex Gravels groundwater water body (WFD ID GB40503G000400). Therefore, it is possible that unpredictable pollution events could occur, which may have significant effects downstream within the SAC. However, the proposed works are considered significantly distant from the SAC site so that direct construction-related impacts are not anticipated.

The Essex Estuaries SAC is designated for a variety of Annex I habitats which are highly vulnerable to pollution events. Construction works are proposed outside of the Habitats Site's boundary and sufficiently distant to exclude potential adverse effects from air pollution (nitrogen oxides and sulphur dioxide from construction vehicles). However, there is potential for dust produced during construction works to enter the rivers Chelmer or Blackwater (via run-off or deposition), adding to the suspended sediment load in the river.

In addition, there is potential for adverse effects during construction due to changes in water quality from pollution incidents, increases in suspended sediment and subsequent loading downstream and the introduction and/or spread of invasive non-native species (INNS) as a result

of the proposed works. This is due to the partial hydrological connectivity with qualifying habitats present downstream. The impact pathways identified could cause habitat degradation from exposure to toxic substances, reductions in dissolved oxygen levels, and increased turbidity, resulting in changes to species distribution and extent, as well as changes to invertebrate community assemblages.

The adverse effects described above can be mitigated using best practice mitigation measures and the preparation and implementation of a Construction Environmental Management Plan (CEMP). These measures are listed in Table 18.3. With the implementation of mitigation measures, no adverse effects are anticipated.

Operation effects

During the operational phase, all water will be treated as per the baseline conditions, with the addition of an ultraviolet treatment stage. Given that the Option and the Habitats Site are not directly hydrologically connected, no operational impacts are expected to occur.

18.3.2.2 Blackwater Estuary Ramsar Site (UK11007) (approx. 2.5km southeast)

The site, one of the largest estuarine complexes in East Anglia, consists of intertidal mudflats fringed by saltmarsh, shingle and shell banks, and offshore islands. Surrounding terrestrial habitats include a sea wall, grassland, ancient grazing marsh and associated fleet and ditch system. This rich mosaic of habitats is of international importance due to its outstanding assemblage of saltmarsh plant communities. Twenty-two nationally scarce plant species are present, including *Bupleurum tenuissimum, Carex divisa, Ceratophyllum submersum, Chenopodium botryodes* and *Euphorbia paralias.*

The invertebrate fauna is also well represented and includes at least 16 Red Data Book species. Among these are the endangered water beetle (*Paracymus aeneus)* and the vulnerable damselfly (*Lestes dryas)*, and vulnerable flies (*Aedes flavescens, Erioptera bivittata*, and *Hybomirra expollicata)*. Notable also are nationally important numbers of breeding waterbirds, including Common pochard (*Aythya farina)*, Little tern (*Sterna albifrons)* and Common ringed plover (*Charadrius hiaticula)*; as well as nationally important wintering numbers of Great cormorant (*Phalacrocorax carbo)*, Common shelduck (*Tadorna tadorna)*, Gadwall (*Anas strepera),* Eurasian teal (*Anas crecca*), Common goldeneye (*Bucephala clangula),* Eurasian curlew (*Numenius arquata*) and Common redshank (*Tringa totanus)*.

Construction effects

Although the proposed works are sufficiently distant from the Ramsar Site to rule out direct construction-related impacts, the landscape within 500m from the works does include some wetland habitats (grazing marsh, ponds and reservoirs) which may be used as functionally linked habitat supporting qualifying species of wetland birds whilst foraging. Possible indirect effects to the integrity of the Ramsar Site resulting from construction activities might include noise, visual and artificial light disturbances which could impact upon qualifying bird species. Disturbance can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, desertion of nesting sites, eggs and/or chicks, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise breeding success, adult fitness, and survival by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

In the absence of up-to-date species records or survey data at this stage, and due to the proximity of these functionally linked habitats to construction activities, it is not possible to rule out significant effects on this Habitats Site from construction.

The same partial hydrological connections exist between the proposed development footprint and the Ramsar Site as described above for Essex Estuaries SAC. Therefore, it is possible that

unpredictable pollution events could occur, which may have significant effects downstream within the Habitat Site.

The potential impact pathways and effects identified are the same as described above for the Essex Estuaries SAC. Qualifying Annex I habitats may be degraded through pollution and sedimentation, as could other habitats, flora and fauna for which qualifying species such as wetland birds and invertebrates rely on. These food resources and refuges may be lost and result in changes to the population sizes and distribution of qualifying features within or from the site.

The adverse effects described can be mitigated using best practice mitigation measures and the preparation of a CEMP. These measures are listed in section 4.4.4. With the implementation of mitigation measures, no adverse effects are anticipated at this stage.

Operation effects

During the operational phase, all water will be treated as per the baseline conditions, with the addition of an ultraviolet treatment stage. Given that the Option and the Habitats Site are not directly hydrologically connected, no operational impacts are expected to occur.

18.3.2.3 Blackwater Estuary SPA (UK9009245) (approx. 2.5km southeast)

The Blackwater Estuary SPA extends from Youghal New Bridge to the Ferry Point peninsula and follows the boundaries of five SSSIs: the Colne Estuary, the Blackwater Estuary, Dengie, the River Crouch Marshes and Foulness. At low tide, intertidal flats are exposed on both sides of the channel. Salt marshes fringe the estuarine channels, especially in the sheltered creeks. The Blackwater Estuary is of high ornithological importance for wintering waterfowl, providing good quality feeding areas for an excellent diversity of bird species. The site supports an internationally important population of black-tailed godwit (*Limosa limosa*) and has a further seven species with nationally important populations: wigeon (*Anas penelope*), golden plover (*Pluvialis apricaria*), lapwing (*Vanellus vanellus*), dunlin (*Calidris alpina*), bar-tailed godwit (*Limosa lapponica*), curlew and redshank. The Blackwater Estuary also regularly supports nationally important wintering populations of hen harrier (*Circus cyaneus*). This species is habitat specific, strongly associated with wetland areas, especially those rich in common reed (*Phragmites australis*) and occupies large ranges.

During severe winter weather the Blackwater Estuary (and the whole Mid-Essex Coast) can assume even greater national and international importance as wildfowl and waders from many other areas arrive, attracted by the relatively mild climate and the abundant food resources available in this SPA.

During the summer months, The Blackwater Estuary supports nationally important breeding populations of little tern as well as regularly supporting breeding pochard and ringed plover.

Construction effects

Although the proposed works are sufficiently distant from the SPA to rule out direct construction-related impacts, the landscape within 500m from the works does include some wetland habitats (grazing marsh, ponds and reservoirs) which may be used as functionally linked habitat supporting qualifying species of wetland birds whilst foraging. The potential impact pathways and effects on qualifying bird species as a result of disturbances caused by construction works are the same as described above for the Blackwater Estuary Ramsar Site.

In the absence of up-to-date species records or survey data at this stage, and due to the proximity of these functionally linked habitats to construction activities, it is not possible to rule out significant effects on this Habitats Site from construction.

No significant direct effects are anticipated on breeding little tern due to the lack of suitable nesting habitat within the ZoI. Little tern nest exclusively on the coast on sand and shingle beaches, spits or inshore islets, and are unlikely to use the short sward floodplain grazing marsh habitat associated with the proposed development footprint for nesting.

The same partial hydrological connections exist between the proposed development footprint and the SAC as described above for Essex Estuaries SAC. Therefore, it is possible that unpredictable pollution events could occur, which may have significant effects downstream within the Habitat Site.

The potential impact pathways and effects identified are the same as described above for the Essex Estuaries SAC. It is possible that any pollution events (toxic or non-toxic) could be transferred to the SAC and impact habitats (such mudflats and salt marshes), which support its qualifying species. The wetland flora and fauna which qualifying bird species rely on may also be affected by any pollution events. These food resources may be lost and result in changes to the population sizes and distribution of qualifying species found within the SAC.

The adverse effects described can be mitigated using best practice mitigation measures and the preparation of a (CEMP). These measures are listed in Table 18.3. With the implementation of mitigation measures, no adverse effects are anticipated at this stage of the plan.

Operation effects

During the operational phase, all water will be treated as per the baseline conditions, with the addition of an ultraviolet treatment stage. Given that the Option and the Habitats Site are not directly hydrologically connected, no operational impacts are expected to occur.

18.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

18.3.4 Monitoring

Monitoring of pollutants immediately downstream of the proposed development areas should be undertaken to ensure that significant levels of contaminants are not being transferred into the Blackwater Estuary.

On a precautionary basis and to inform a future project level HRA, it is also recommended that the following monitoring is included in a survey plan, shown in Table 2.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 18.2: Qualifying features of the Habitats Sites and their recommended monitoring plan.

Habitats Sites	Qualifying features	Monitoring Guidelines

Blackwater Estuary Ramsar Site	Birds (wintering)	Birds Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online).
Blackwater Estuary SPA	Birds (breeding and wintering)	Birds Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online).

Source: Mott MacDonald, 2023.

Table 18.3: Option UVC-001- Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Essex Estuaries SAC (UK0013690) (approx. 2.5km southeast)	Coastal plain estuarine system with open coast mudflats and sandbank and associated vegetation. 1130 Estuaries 1140 Mudflats and sandflats not covered by seawater at low tide 1310 Salicornia and other annuals colonising mud and sand 1320 Spartina swards 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) 1420 Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*) 1110 Sandbanks which are slightly covered by sea water all the time.	This option is sufficiently distant from the Habitats Site boundary (~2.5km) to exclude adverse effects from air pollution. However, the following temporary and permanent effects on qualifying habitats during construction phase have been identified: • Physical damage – habitat degradation as a result of water quality changes in case of pollution events that may affect the saltmarsh vegetation. • Toxic contamination – chemical pollution in the upstream rivers Chelmer and Blackwater during construction works which could be transferred downstream to the SAC boundary, causing water quality degradation and damage to qualifying habitats. • Non-toxic contamination – additional sedimentation or siltation during construction works of the upstream rivers Chelmer and Blackwater, causing to changes in turbidity leading to changes in sediment loading and silt deposition which may lead to the	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Specific mitigation to reduce increased sedimentation and silt deposition downstream include: - Planning site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. - Planning silt screening around the area of works to limit the movement and redeposition of material. - Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport. • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage. With this in place, adverse effects on the Habitats Site will be alleviated during construction. Monitoring of pollution downstream of the works areas will enable early detection of any changes during construction which may have a significant effect on the site downstream.	No adverse effects.

		degradation of qualifying habitats downstream within the SAC. • Biological disturbances – potential introduction/ spread of INNS. • No adverse effects will arise during operation.		
Blackwater Estuary Ramsar (UK11007) (approx. 2.5km southeast)	**Ramsar Criterion 1** Qualifies by the extent and diversity of saltmarsh habitat present.	The potential adverse effects on the Ramsar are the same as detailed above for Essex Estuaries SAC	The proposed mitigation to avoid and/or alleviate adverse effects on the Ramsar is the same as detailed above for Essex Estuaries SAC	No adverse effects.
	Ramsar criterion 2 The site supports species of nationally scarce plants and a well-represented invertebrate fauna which includes at least 16 British Red Data Book species	This option is sufficiently distant from the Habitats Site boundary (~2.5km) to exclude adverse effects from air pollution. However, the following temporary and permanent effects on qualifying plants and invertebrates during construction have been identified: • Physical damage – habitat degradation as a result of water quality changes in case of pollution events and increases in suspended sediment loading. • Toxic contamination – pollution incidents causing changes to water quality (degradation) and mortality of qualifying invertebrates if present. • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of qualifying habitats impacting on the	Standard best practice procedures should be followed during construction to limit construction-related habitat degradation. These include: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites), 'Guidance Notes for the Reduction of Obtrusive Light'. • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works should include silt screening around the area of works to limit the movement and redeposition of material. • Development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	No adverse effects.

	suitability to support qualifying invertebrates. • Biological disturbances – potential introduction of INNS, changes in habitat distribution and extent and habitat avoidance by qualifying invertebrates.		
Ramsar criterion 3 This site supports a full and representative sequences of saltmarsh plant communities covering the range variation in Britain.	See "Possible adverse effects before mitigation" listed above for Ramsar criterion 1.	See "Indicative mitigation measures" listed above for Ramsar criterion 1.	No adverse effects
Ramsar criterion 5 Assemblages of over wintering waterfowl of international importance	This option is sufficiently distant from the Habitats Site boundary (~2.5km) to exclude adverse effects from air pollution. However, the following temporary and permanent effects on qualifying birds during construction have been identified: • Physical damage – habitat degradation as a result of water quality changes in case of pollution events and increases in suspended sediment loading that may affect bird nesting/feeding grounds and functionally linked land. • Toxic contamination – pollution incidents causing changes to water quality (degradation). • Non-toxic contamination – changes in turbidity leading to changes in sediment loading and silt deposition which may lead to smothering of supporting habitats. • Biological disturbances – reductions in the prey availability and/or extent of habitats which support qualifying	Standard best practice procedures should be followed during construction to limit construction-related habitat degradation. These include: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites), 'Guidance Notes for the Reduction of Obtrusive Light'. • Biosecurity measures to ensure appropriate removal and/or management control of INNS at source. • Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works, this should include silt screening around the area of works to limit the movement and redeposition of material. • Development of a Construction and Environmental Management Plan (CEMP) which will include all the above proposed mitigation measures and any further measures identified at the project stage. • If construction works are undertaken during the wintering period (September – March inclusive), pre-construction wintering bird surveys will be required to determine presence/absence and the number of individuals (if present).	No adverse effects

	species, both of which may subsequently lead to displacement of qualifying species within or from the site, as a result of the above impact pathways. • Biological disturbances – potential introduction of INNS, anthropogenic disturbance within potential functionally linked habitat, changes in habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas.	• These works will only be permitted if the population present at risk of disturbance is <1% of the cited SPA population and works will be supervised by an Ecological Clerk of Works (ECoW). The ECoW will deliver a toolbox talk to all relevant contractors on the potential presence of wintering birds within the ZoI and the appropriate procedures to be followed. • During construction works an ECoW will be required to maintain a sufficient buffer (200m minimum). If a qualifying species is present within the ZoI, works must cease until they have moved outside of the ZoI. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. • Additional working methods which will reduce disturbance to overwintering birds during construction include: 1. A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; 2. Plant machinery to be painted/ camouflaged to be less conspicuous; it is unlikely that all plant will be effectively screened by barriers due to size. The use of netting or colours in dark greens, grey or black will blend into the background when moving; 3. All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and 4. All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'.	
Ramsar criterion 6 Species / populations occurring at levels of international importance. Species with peak counts in winter:	See "Possible adverse effects before mitigation" listed above for Ramsar criterion 5.	See "Indicative mitigation measures" listed above for Ramsar criterion 5.	No adverse effects

	dark-bellied brent goose, grey plover, dunlin and black-tailed godwit			
Blackwater Estuary SPA (UK9009245) (approx. 2.5km southeast)	**Article 4.1 Qualification** During the breeding season the area regularly supports: Little tern. Over winter the area regularly supports: Hen harrier	See “Possible adverse effects before mitigation” listed above for Ramsar criterion 5.	See “Indicative mitigation measures” listed above for Ramsar criterion 5.	No adverse effects
	Article 4.1 Qualification During the breeding season the area regularly supports: Common pochard and ringed plover. Over winter the area regularly supports an internationally important assemblage of birds	See “Possible adverse effects before mitigation” listed above for Ramsar criterion 5.	See “Indicative mitigation measures” listed above for Ramsar criterion 5.	No adverse effects

Source: Mott MacDonald, 2023

18.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is considered that with adherence to the proposed mitigation, the works associated with the option UVC-001 are not expected to have any adverse effects on the integrity of the Essex Estuaries SAC, Blackwater Estuary Ramsar Site, or Blackwater Estuary SPA during the construction phase. Mitigation measures include pre-construction surveys, timing restrictions, staged construction works, toolbox talks and presence of an ECoW. No impact pathways during the operational phase of the option have been identified on Habitats Sites and associated qualifying features.

During construction, continuous pollution (toxic and non-toxic) monitoring is recommended immediately downstream of the works area in order to identify, at the earliest stage, changes which may result in adverse effects downstream at the Habitats Sites.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for both construction and operation phases at all sites. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Water quality monitoring and modelling to determine the potential adverse effects of water quality changes on qualifying habitats present downstream of Langford WTW on the rivers Chelmer and Blackwater.
- A detailed review of the baseline ecological data for qualifying birds to inform the requirement for additional monitoring and to determine more targeted mitigation measures. This will include:
  - Breeding (common pochard and ringed plover) and wintering bird surveys on suitable habitats within 500m of the proposed works.

It is also recommended that a CEMP be put in place that would include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

The information in this document will be presented to Natural England during consultation. Where the Stage 2 AA concludes that there would be residual adverse effects on any of the Habitats Sites, the HRA must proceed to the next stage.

18.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

19 Barsham EDR Nitrate Removal and Pipeline (ESW-NIT-004)

Option ID: (ESW-NIT-004)

19.1 Option Description

This option proposes a nitrate electrodialysis reversal (EDR) treatment extension within Barsham WTW's existing site boundary. The intake is from the existing water treatment works (WTW) granular activated carbon (GAC), and the discharge is to the existing WTW's chlorine contact tanks.

Barsham River WTW source water has high nitrate concentrations at certain times of the year, particularly during the winter months, which can if too high stop water production. This option would allow the WTW to continue to operate throughout the year.

This option will provide nitrate treatment via electrodialysis reversal (EDR) for a proportion of the 28Ml/d river works WTW capacity, when blended with borehole water.

The option also includes a brine waste discharge pipeline to Beccles sewage treatment works (STW). This pipeline is approximately 5.4km long, with a diameter of 150mm. The pipeline is to be laid for the majority in road, with 1.1km laid in fields.

19.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified seven Habitats Sites within the ZoI of this option. LSE could not be ruled out for three of these sites (Table 19.1).

Option NIT-004 therefore needs progressing to Stage 2: HRA AA.

Table 19.1: NIT-004 Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approximately 2km east)	Benacre to Easton Bavents Lagoons SAC (UK0013104) (approximately 9km southeast)
Broadland Ramsar (UK110100) (approximately 2km east)	Benacre to Easton Bavents SPA (UK9009291) (approximately 9km southeast)
The Broads SAC (UK0013577) (approximately 2km east)	Outer Thames Estuary SPA (UK9020309) (approximately 9km east)
	Southern North Sea SAC (UK0030395) (approximately 9km east)

19.3 Stage 2 Appropriate Assessment

The Stage 2 AA provides an assessment to determine whether the construction and/or operation of this option will result in an adverse effect on the site integrity of the Habitats Sites identified at the screening stage with potential for LSE. At this stage, mitigation measures to prevent adverse effects can be included. For the purpose of these assessments, the use of widely used best practice measures constitute mitigation and are therefore included within Table 19.2.

The AA will result in one of three potential outcomes:

- Evidence is sufficient and demonstrates there will be no adverse effects
- Evidence is sufficient but indicates that there will be an adverse effect
- Insufficient evidence to determine the effects.

The information in this document will be presented to Natural England during consultation. Where the Stage 2 AA concludes that there would be residual adverse effects on any of the Habitats Sites, the HRA must proceed to the next stage.

19.3.1 Scope

The following sites were assessed at Stage 2 AA:

- Broadland SPA (UK9009253)
- Broadland Ramsar (UK110100)
- The Broads SAC (UK0013577)

19.3.2 Potential Effects on Habitat Sites

The potential effects of the construction and operation phases for the scheme are described below, considering the type, size, and scale of the element.

An assessment of each potential effect on the integrity of the Habitats Sites is made, in view of the sites' structure, function and conservation objectives. Where adverse effects are deemed significant, mitigation measures are also proposed in the following section.

At this stage, based on current information and in the absence of ecological assessment, a worst-case scenario is assumed. The potential adverse effects and recommended mitigation measures are outlined in Table 19.2.

19.3.2.1 Broadland SPA (UK9009253) (approximately 2km east)

The Broadland SPA is a low-lying wetland complex connecting the boundaries between east Norfolk and northern Suffolk. The area includes the river valley systems of the Bure, Yare and Waveney and their major tributaries. This distinctive open landscape comprises a complex and interlinked mosaic of wetland habitats including open water, reedbeds, woodland, grazing marsh, and fen meadow, forming one of the finest marshland complexes in the UK. Its qualifying features are non-breeding Bewick's swan (*Cygnus columbianus bewickii*), gadwall (*Anas strepera*), hen harrier (*Circus cyaneus*), ruff (*Calidris pugnax*), Northern shoveler (*Anas clypeata*), whooper swan (*Cygnus cygnus*) and wigeon (*Anas penelope*), as well as breeding bittern (*Botaurus stellaris*) and marsh harrier (*Circus aeruginosus*).

Construction effects

The option footprint is not in clear direct hydrological connection to the SPA - although this site sits in the same groundwater body of the option footprint (Broadland Rivers Chalk & Crag). Consequently, it is deemed unlikely that unpredictable pollution events arising from construction activities may have significant effects within the SAC. The proposed works are considered sufficiently distant from the SPA site so that direct construction-related impacts (such as

adverse air pollution effects arising from construction vehicle emissions) are not anticipated. However, the landscape within 500m of the pipeline does include some supporting wetland habitat which may be used as functionally linked habitat supporting the SPA site's qualifying bird species while foraging. Therefore, construction-related impacts cannot be ruled out at this stage.

Possible indirect effects to the integrity of the SPA site resulting from construction activities might include noise, visual and artificial light disturbances which could impact upon qualifying bird species. Disturbance can result in changes to feeding or roosting behaviours, increased energy expenditure due to more frequent flights, desertion of nesting sites, eggs and/or chicks, and desertion of supporting habitat. Disturbance to qualifying species when foraging may jeopardise breeding success, adult fitness, and survival by displacing birds from preferred feeding grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or from a site.

No significant direct effects are anticipated on breeding bittern due to the lack of suitable supporting habitat within the ZoI. Bittern are associated with reedbed habitat and are unlikely to be present in the short sward floodplain grazing marsh habitat associated with the proposed pipeline footprint. No reedbed habitat has been identified within the wider ZoI of the pipeline. Similarly, marsh harrier primarily breed in reedbed habitat. However, the wider impacted area could provide foraging habitat for marsh harrier. For example, the central section of the proposed pipeline comes within approximately 250m of an area of coastal and floodplain grazing marsh priority habitat. Therefore, there is potential for anthropogenic disturbance during construction works of this and other designated bird species which could be using functionally linked supporting habitats.

In the absence of up-to-date species records or survey data at this stage, and due to the proximity of these functionally linked habitats to construction activities, it is not possible to rule out significant effects on this Habitats Site from construction.

Due to the distance and lack of direct hydrological connectivity between the proposed works and the SPA, no other impact pathways have been identified during construction. The qualifying species are less likely to utilise other habitats within the proposed development footprint, which include urban and suburban areas, arable land, and deciduous woodlands. Under the current pipeline route (majority of which is to be laid under existing road, with approx. 1.1km laid in fields), no loss of functionally linked habitat is anticipated.

The adverse effects described can be mitigated using best practice measures and the preparation of a Construction Environmental Management Plan (CEMP). These measures are listed in Table 19.3. After mitigation no adverse effects on the site integrity is anticipated.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate stage. The option footprint is not in clear direct hydrological connection to the SPA (although it is in the same groundwater body of the option footprint). Therefore, no effects are anticipated during the operation phase.

19.3.2.2 Broadland Ramsar (UK110100) (approximately 2km east)

A low-lying wetland complex composed of the Bure, Yare, Thurne, and Waveney River systems of the Norfolk Broads. The mosaic of wetland habitats includes open water, reedbeds, carr woodland, grazing marsh, and fen meadow, with an extensive complex of flooded medieval peat diggings. Outstanding assemblages of rare plants and invertebrates occur at the site, where 136 British Red Data Book invertebrate species have been recorded. Amongst this rich insect fauna are nationally rare dragonflies, spiders, moths, and butterflies. The area is also a stronghold for the swallowtail butterfly (*Papilio machaon brittanicus,* for which this is the only known breeding

location in Britain) as well as a number of nationally rare breeding birds. Several species of waterbirds winter there and include internationally important numbers of Bewick's swan.

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Broadland SPA above, with the addition of qualifying invertebrate species and otter as receptors of the effects of disturbance from construction activities.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate stage. The option footprint is not in clear direct hydrological connection to the SPA (although it is in the same groundwater body of the option footprint). Therefore, no effects are anticipated during the operation phase.

19.3.2.3 The Broads SAC (UK0013577) (approximately 2km east)

The Broads SAC contains a variety of habitats including naturally nutrient-rich lakes that support a diversity of relict vegetation and aquatic invertebrate assemblages, rich areas of stoneworts, large blocks of alder (*Alnus glutinosa*) woodland, calcareous fens and wet heath.

Qualifying features of The Broads SAC include hard oligo-mesotrophic waters with benthic vegetation of *Chara* species, natural eutrophic lakes with *Magnopotamion* or *Hydrocharition,* Molinia meadows on calcareous, peat or clay-silt soil, transition mires and quaking bogs, calcareous fens with great fen-sedge (*Cladium mariscus*) and species of *Caricion davallianae* (calcium-rich fen dominated by great fen-sedge), alkaline fens, alluvial woods with black alder and European ash (*Fraxinus excelsior*), fen orchid (*Liparis loeselii*), ram's-horn snail (*Anisus vorticulus*), Desmoulin's whorl snail, and otter (*Lutra lutra*).

Construction effects

The impact pathways and potential significant effects on this site during construction are the same as described for the Broadland SPA above, with the addition of qualifying invertebrate species and otter as receptors of the effects of disturbance from construction activities.

Operation effects

During the operational phase all water will be treated as per the baseline conditions, with the addition of a nitrate stage. The option footprint is not in clear direct hydrological connection to the SPA (although it is in the same groundwater body of the option footprint). Therefore, no effects are anticipated during the operation phase.

19.3.3 Assumptions and Mitigation Measures

Based on the current level of information, assumed and established mitigation measures are proposed below that will need to be followed at project level to avoid or mitigate adverse effects on site integrity.

These measures are defined as industry-wide best practice measures to address common risks in the construction and development sectors and thus are proven to reduce the risk of the identified effects in so far as is reasonably possible.

19.3.4 Monitoring

It is recommended that the following qualifying species are monitored and included in a survey plan as shown in Table 19.2.

These are recommendations based on the level of assessment done to date using available information. This list should be revisited at a project level to confirm specific monitoring requirements.

Table 19.2: Qualifying features of the Habitats Sites and their recommended monitoring plan.

Habitats Sites	Qualifying features	Monitoring Guidelines
The Broads SAC	Desmoulin's whorl snail and ramshorn whirlpool snail (combined as no guidance available for latter species). Otter Supporting habitats for qualifying species.	Killeen, I.J and Moorkens, E.A (2003). Monitoring Desmoulin's Whorl Snail, *Vertigo moulinsiana*. Conserving Natura 2000 Rivers Monitoring Series No. 6, English Nature, Peterborough. Chanin, P. (2003). Monitoring the Otter *Lutra*. Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough. Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27.
Broadland SPA	Birds (breeding and wintering bird surveys).	Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf
Broadland Ramsar	Wetland invertebrate assemblage. Birds (wintering bird surveys)	English Nature (2005). Organising surveys to determine site quality for invertebrates, A framework guide for ecologists. English Nature, 1 – 20. Gurnell, A. M., England, J., Scott, S. J and Shuker, L. J. (2022). A guide to assessing river condition. Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric. River Modular Survey, 1 – 27. Joint Nature Conservation Committee (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough. Kirby *et al.* (2000). Key habitat attributes for birds and bird assemblages in England. English Nature Research Report No. 359. Peterborough, 45p. British Trust for Ornithology (BTO) (2017). Wetland Bird Survey (WeBS): Survey Methods, Analysis & Interpretation, (online), available at: https://www.bto.org/sites/default/files/webs_methods.pdf Austin *et al.* (2007). The UK Wintering Waterbird Indictor: New developments towards a more comprehensive assessment of trends in the wintering waterbird assemblage. BTO Research report No. 479, (online), available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2007/rr479.pdf

Table 19.3: Option NIT-004 - Potential adverse effects on the integrity of Habitat Sites

Habitat Sites	Qualifying features	Possible adverse effects before mitigation	Mitigation measures	Possible adverse effects after mitigation
Broadland SPA (approximately 2km east)	**Marsh harrier** **Overwintering species:** Hen harrier Bewick's swan Whooper swan Gadwall Ruff Shoveler Wigeon	This option may have the following permanent or temporary effects on the SPA during the construction phase: • Non-physical disturbance - increased energy expenditure by qualifying features in response to construction related noise and visual disturbance, possibly resulting in displacement from preferred foraging or roosting areas and ultimately a reduction in breeding success. • Biological disturbances – reductions in the prey availability and/or extent of habitats which support qualifying species, both of which may subsequently lead to displacement of qualifying species within or from the site, as a result of the above impact pathways. Biological disturbances – anthropogenic disturbance within potential functionally linked habitat, changes in habitat availability; habitat avoidance and potential for qualifying bird populations to be displaced from current foraging areas.	The following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • CIRIA C741 Environmental good practice on site guide. • Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites). • Sensitive timing of construction works to avoid the breeding period for bird species detailed in the Broadland SPA supplementary advice note during April to August inclusive. Any works which are undertaken outside of this period may disturb or displace overwintering species from suitable functional land, details of which are provided below. • If construction works are undertaken during the wintering period (September – March inclusive), pre-construction wintering bird surveys will be required to determine presence/absence and the number of individuals (if present). • These works will only be permitted if the population present at risk of disturbance is <1% of the cited SPA population and works will be supervised by an Ecological Clerk of Works (ECoW). The ECoW will deliver a toolbox talk to all relevant contractors on the potential presence of wintering birds within the ZoI and the appropriate procedures to be followed. • During construction works an ECoW will be required to maintain a sufficient buffer (200m minimum) from any functionally linked habitats. If a qualifying species is present within the ZoI, works must cease until they have moved outside of the ZoI. • Visual screening barriers should be erected around construction activities and plant movement routes, where works are taking place in or adjacent to habitats which may be considered functionally linked to the Habitats Site, or there is visual line of sight between construction activities and these habitats. Additional working methods which will reduce disturbance to overwintering birds during construction include:	No adverse effects.

		No adverse effects will arise during operation.	• A slow construction start, allowing plant engines to idle for five minutes to allow acclimatisation to additional noise; • Plant machinery to be painted/ camouflaged to be less conspicuous; it is unlikely that all plant will be effectively screened by barriers due to size. The use of netting or colours in dark greens, grey or black will blend into the background when moving; • All plant and equipment will be in good working order to reduce potential engine and machinery noise associated with older equipment. Advances in technology will be utilised, including the use of electric and hybrid alternatives; and • All flashing beacons will be removed to avoid visual disturbance unless safety critical. White noise reversing warnings will be used instead of typical 'beeps'. • The development of a CEMP which will include all the above proposed mitigation measures and any further measures identified at the project stage.	
	Bittern	Due to the lack of reed habitat within the proposed pipeline area, bittern is not likely present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects identified.
Broadland Ramsar (approximately 2km east)	H7210 Calcareous fens with great fen-sedge and species of the *Caricion davallianae.* H91E0 Alluvial forests with common alder and European ash (*Alno-Padion, Alnion incanae, Salicion albae*). H3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp. H3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* type vegetation. H7140 Transition mires and quaking bogs. H7230 Alkaline fens. H6410 Molinia meadows on calcareous, peat or clay-silt soil.	Based on the extent of the proposed pipeline footprint, and the lack of direct hydrological connection between the Ramsar site and the proposed works, these qualifying habitats and species are not thought to be present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects identified.

Fen orchid.		
Desmoulin`s whorl snail. Ramshorn snail	This option may have the following permanent or temporary effects on the Ramsar Site and these qualifying features during the construction phase: • Loss of functionally linked terrestrial habitat for qualifying Annex II species. Potential for direct mortality of Desmoulin's whorl snail and ramshorn snail during construction (if present within the proposed pipeline footprint). • Biological disturbances – disturbance to qualifying features and reductions in the extent of habitats which support qualifying species, both of which may subsequently lead to changes in distribution and extent of qualifying features, as a result of the above impact pathways. The identified effects have the potential to reduce the extent, population sizes and distribution of these qualifying Annex II species. No adverse effects are anticipated during operation.	In addition to the mitigation measures listed above for Broadland SPA, the following mitigation and best practice measures will be implemented to avoid or reduce adverse impacts: • Prior to the commencement of construction works, a suitably qualified ecologist should undertake monitoring on suitable habitat within the pipeline footprint (following the guidelines set out in Killeen, I.J and Moorkens, E.A (2003)) in order to determine the presence or likely absence of Desmoulin`s whorl and Ramshorn snail.
Otter.	In addition to the effects listed above, the following temporary effects are applicable to Otters during construction:	In addition to the above, the following mitigation measures should be implemented: • Maintain commuting routes during construction, with no physical barriers to movement within the watercourse and adjacent suitable habitat	No adverse effects.

		• Non-physical disturbance – visual, noise and vibration disturbance close to otter resting sites during construction may result in changes to breeding behaviours. Otters may be using functionally linked habitats to and other small water courses to the north of the proposed pipe footprint, and therefore disturbance can change regular behaviours and use of preferred areas. • Biological disturbances – disturbance to qualifying species which may subsequently lead to their displacement within or from the site, as a result of the above impact pathway. No additional effects are anticipated on otter during operation.	• Sensitive timing of construction works to avoid the periods of greatest otter activity, i.e. no night-time working • Best practice such as 'Guidance Notes for the Reduction of Obtrusive Light' (Institute of Lighting Professionals, 2011) to avoid significant effects due to increased light (if works are programmed at night) • Retain bankside habitat cover and other suitable adjacent habitats where possible. • Pre-commencement Otter survey to ensure that no breeding or resting sites are present within the Zone of Influence (ZoI) of the works. • Potential resting sites should be monitored using cameras (requires Natural England licence). A 30m protection zone around confirmed resting sites is required during construction. This distance is extended to 150m for confirmed breeding sites. If holts require closure and destruction to facilitate construction, artificial replacements will be required on the same watercourse away from the works area. These must be in-situ before construction starts. This work will require a Natural England licence.	
	Bewick's swan. Wigeon. Gadwall. Northern shoveler.	The potential adverse effects on these Ramsar qualifying species are the same as detailed above for Broadland SPA	The proposed mitigation to avoid and/or alleviate adverse effects on these Ramsar qualifying species is the same as detailed above for Broadland SPA	No adverse effects.
The Broads SAC (approximately 2km east)	H7210 Calcareous fens with great fen-sedge and species of the *Caricion davallianae*. H91E0 Alluvial forests with common alder and European ash (*Alno-Padion, Alnion incanae, Salicion albae*). H3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	Based on the extent of the proposed pipeline footprint, and the lack of direct hydrological connection between the Ramsar site and the proposed works, these qualifying habitats and species are not thought to be present within the ZoI of the pipeline installation. Therefore, no impact pathways have been identified.	None required.	No adverse effects identified.

	H3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* type vegetation. H7140 Transition mires and quaking bogs. H7230 Alkaline fens. H6410 Molinia meadows on calcareous, peat or clay-silt soil. Fen orchid.		
	Otter	The potential adverse effects on this SAC qualifying species are the same as detailed above for Broadland Ramsar	The proposed mitigation to avoid and/or alleviate adverse effects on this SAC qualifying species is the same as detailed above for Broadland Ramsar	No adverse effects.
	Desmoulin`s whorl snail. Ramshorn snail.	The potential adverse effects on these SAC qualifying species are the same as detailed above for Broadland Ramsar	The proposed mitigation to avoid and/or alleviate adverse effects on these SAC qualifying species is the same as detailed above for Broadland Ramsar	No adverse effects.

Source: Mott MacDonald, 2023

19.3.5 Stage 2 outcomes

Following this HRA Appropriate Assessment, it is considered that with adherence to the proposed mitigation measures and implementation of a CEMP, the works associated with option NIT-004 are not expected to have any adverse effects on the integrity of the Broads SAC, Broadland SPA and Broadland Ramsar during the construction phase. Proposed mitigation measures include pre-construction surveys, timing restrictions, habitat avoidance, habitat reinstatement, stage construction works, toolbox talks, habitat management, presence of an ECoW and if required, and a Natural England derogation licence for otter.

No impact pathways during the operational phase of the option have been identified on Habitats Sites and associated qualifying features.

In accordance with the National Planning Policy Framework, the development and implementation of the Option should promote the conservation, restoration and enhancement of the Habitats Sites identified within the ZoI and the protection and recovery of qualifying species as well as identify and pursue opportunities for securing measurable net gains for biodiversity.

The recommended mitigation measures detailed within this document assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for the construction phases only at all sites, since no adverse effects from the operation stage were identified. Nevertheless, further studies are recommended to propose more targeted mitigation measures and fulfil the regulatory requirements applicable at the project level, including:

- Desk based noise assessment to determine an accurate extent of the ZoI once more information is available on construction methodology.
- A detailed review of the baseline ecological data for qualifying birds and invertebrates to inform the requirement for additional monitoring and to determine more targeted mitigation measures. This is likely to include breeding and wintering bird, otter, Desmoulin's whorl snail and wetland invertebrate surveys.

It is also recommended that a CEMP is put in place, which would include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time, and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

19.3.6 Conclusions

Assuming that all proposed mitigation measures are implemented it is considered that there will not be a significant change in:

- The extent and distribution of qualifying species
- The structure and function of the habitats of qualifying species
- The supporting processes on which habitats of qualifying species rely.

As such it can be concluded that the proposed option would not give rise to effects on the integrity of any Habitats Sites.

20 California Beach Desalination (ESW-DES-004)

Option ID: (ESW-DES-004)

20.1 Option Description

This option proposes a seawater desalination plant. A service reservoir is proposed to be located off site. There will be two transfers required: Transfer 1 from beach infiltration galleries to desalination plant, length: 1.8km. Transfer 2 from desalination plant to Barsham WTW, length: approx. 37km. Tunnelling/trenchless techniques likely to be required.

20.2 Stage 1 Screening – Review

The Stage 1 screening carried out in June 2023 identified nine Habitats Sites within the Zone of Influence (ZoI) of this option. Likely significant effects (LSE) could not be ruled out for any nine sites (Table 20.1).

Option ESW-DES-004 therefore needs progressing to Stage 2: HRA Appropriate Assessment (AA). No Appropriate assessment has been undertaken for this option as it is not included in the BVP, OFWAT Core Plan, Best Environmental Plan or the adaptive programmes.

Table 20.1: Corton beach well desalination (ESW-DES-008) Stage 1 screening results

Potential for Significant Effects	No Likely Significant Effects
Broadland SPA (UK9009253) (approx. 0.05km)	
Broadland Ramsar (UK11010) (approx. 0.05km)	
The Broads SAC (UK0013577) (approx. 0.05km)	
Southern North Sea SAC (UK0030395) (approx. 0.0km)	
Greater Wash SPA (UK9020329) (approx. 0.0km)	
Outer Thames Estuary SPA (UK9020309) (approx. 0.0km)	
Breydon Water Ramsar (UK11008) (approx. 1.8km)	
Breydon Water SPA (UK9009181) (approx. 1.8km)	
Great Yarmouth North Denes SPA (UK9009271) (approx. 0km)	

21 In-combination effects

21.1 In Combination Assessment

This in combination assessment aims to identify where the rdWRMP24 is likely to interact with other plans and projects at a strategic scale and determined the degree to which such interaction may lead to adverse effects on Habitats Sites.

There is confidence that the measures detailed in this plan level assessment can avoid and mitigate for all potential effects and therefore bearing in mind these findings, adverse in combination effects are not anticipated.

GIS was used to identify any plans and strategic projects that interacted with receptors affected by one or more options included in the rdWRMP24.

In Suffolk there are 10 various development project or plans that likely to interact with the options. These projects consist of major urban developments (Strategic Employment Site Allocations, Regeneration areas, Strategic Employment Site Nacton Heath) among other projects including active and inactive landfill sites, quarries and waste management sites. The status of these projects and any construction activities related to these projects are not known at this stage. The nearest protected area is to the south of the option, Stour and Orwell Estuaries SPA and Ramsar. However, there are no pathways between the developments and the options within BESP, BVP and LCP that are likely to affect the integrity of the site and its qualifying species. Therefore, in combination effects within and out with the plan is ruled out.

In Essex there are 9 development project or sites consisting of major urban development including active and inactive landfill and waste management sites scattered around 5 districts; Brentwood District,), Basildon District, Chelmsford District, Rochford District, Castle Point District, Braintree District and Maldon District. Option ESW-EFR-001 passes through 4 of these districts. The nearest protected sites are to the south of the option, Crouch & Roach Estuaries (Mid-Essex Coast Phase 3) SPA and Ramsar and Benfleet and Southend Marshes SPA and Ramsar. However, there are no pathways between the development and the options. Therefore, in combination effects are ruled out.

The other Strategic plans and projects identified that may interact with the rdWRMP24 are:

- River Basin Management Plans (RBMPs)
- Marine plans
- Anglian Water's Drought Plan
- Anglian Water's Drainage and Waste Water Management Plans
- Other water company draft WRMPs
- Large existing and emerging Local Plan housing allocations
- NSIPs listed on the Planning Inspectorate's Website
- Hybrid Bills
- Transport and Works Act Orders for large-scale transport infrastructure
- Minerals and waste applications and energy from waste projects

In terms of the sustainable management of water quantity and quality, WRMPs and RBMPs contain similar objectives. Marine plans have complementary objectives to RBMPs, with an overall objective to achieve 'Good Environmental Status' in marine waters, including the same objectives for good ecological and chemical status. All local development plans use RBMPs and

where relevant marine plans to inform the planning policies, forming a complimentary approach to delivering the objectives of the RBMPs and marine plans.

Any interactions with other plans are only likely to affect water dependent Habitats Sites with respect to RBMPs and coastal/estuarine habitats sites with respect to marine plans. WRMPs are identified within the RBMPs as plans to work alongside the RBMP to address pressures on water body status and meet specific plan level objectives. WRMPs and the options arising from them should therefore act as mechanisms to deliver RBMP objectives for water dependent Habitats Sites. Similarly for coastal/estuarine Habitats Sites, WRMPs and the options arising from them should act as mechanisms to deliver the sustainable development objectives of the marine plans they interact with.

Although there is current uncertainty regarding the timing construction and implementation of other development activities, it is assumed that generic mitigations will be put in place in accordance with the respective policy framework set out in emerging plans and within planning conditions and requirements. Therefore, taking in the specific findings of this HRA set out above, no adverse effect on the integrity of any Habitats Sites is anticipated from in-combination effects.

22 Conclusions and recommendations

The HRA, undertaken at plan level, is for ESW Water Resource Management Plan 2024 (WRMP 24) options. It assesses the potential effects of options with llikely significant effect (LSE) on Habitats Sites and taken to Stage 2 AA for further assessment. Assuming all proposed mitigation is implemented it is considered there will not be a significant change in:

- The extent and distribution of qualifying species.
- The structure and function of the habitats of qualifying species.
- The supporting processes on which habitats of qualifying species rely.

All options have been considered with regard to potential for in-combination effects. Where a pathway has been identified, options are taken to Stage 2 AA meaning that no low effects remain. For options that, at this concept stage of design, required a Stage 2 AA, a range of potential control and mitigation techniques that could be applied have been identified. There is confidence that the measures detailed in this plan level assessment can avoid and/or mitigate for all potential effects and therefore, adverse in-combination effects are not anticipated.

It should be noted that the conclusions contained in this document are based on preliminary, indicative design assumptions available at this time and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

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F.1 Indicative options maps with 10km buffer

Option specific maps are not provided due to security considerations. Habitat maps are provided in Appendix D of the environmental report.

F.2 HRA Screening Review Results

Available upon request

F.3 Designated Sites Information

Available upon request