Norwich Western Link

Environment Statement

Chapter 12: Road Drainage and the Water Environment

Appendix 12.3: Water Framework Directive Assessment

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Glossary of Abbreviations and Defined Terms

The definition of key terms used in this report are provided below. These definitions have been developed by reference to the definitions used in EU and UK legislation and guidance relevant to the water environment as well as professional judgement based on knowledge and experience of similar schemes in the context of the Proposed Scheme.

Term	Definition
Bank	Side of a river channel or island which extends above the normal (e.g., mean) water level and is only completely submerged during periods of high river flow
Bar	In-channel, elevated sediment deposit exposed during periods of low flow, which may be a side bar (including a point or counterpoint bar, located respectively along the convex or concave bank of a meander bend) or a mid-channel bar
Berm	Natural or artificial, flat-topped, shelf along the margin of a river channel that is exposed above water level during low flows, but is submerged during high flows: natural berms are vegetated features composed of sediments deposited by the river to the baseflow level, which evolve into benches as further deposited sediment raises their surface gradually to higher elevations within the river channel
Channel Straightening	Engineered shortening of the length of a stream/ river artificially by removing meander bends. Often undertaken in conjunction with relocating a channel to the edge of the valley floor to improve utility of the land for farming or development.
Culvert	Arched, enclosed, or piped structure constructed to carry water under roads, railways, and buildings

Term	Definition
Deposition	Laying down of part, or all, of the sediment load of a stream on the bed, banks, or floodplain. Mostly occurs at the end of a high flow event. Forms various sediment features such as bars, berms, and floodplain deposits.
Disproportionate Costs	WFD terminology: alternative WFD objectives (extended deadlines and/or less stringent objectives) may be set where achieving the WFD objective of GES/GEP is considered to have disproportionate costs associated with achieving GES/GEP. This may include situations where there is an unfavourable balance of costs and benefits; a significant risk of unfavourable balance of costs and benefits; and/or disproportionate burdens. A disproportionate burden, as defined by UKTAG, is, 'Implementation of the measure by an earlier deadline would impose disproportionate burdens. Applies where the measure would be: (a) unaffordable to implement within a particular timetable without creating disproportionate burdens for particular sectors or parts of society); or (b) the only solution would be significantly at odds with the polluter pays principle.' This provides a justification for extending the deadline for the achievement of the objectives as provided under Article 4(4) – provided all other criteria of that Article are satisfied.
Ecological Potential	Under the WFD a measured deviation from the optimal ecological condition of a Heavily Modified Water Body.
Ecological Status	Under the WFD a measured deviation from the optimal ecological condition of a Water Body.
Erosion	Removal of sediment or bedrock from the bed or banks of a channel by flowing water. Mostly occurs during high flows and flood events. Forms various river features such as scour holes and river cliffs.

Term	Definition
Floodplain	Valley floor adjacent to a river that is (or was historically) inundated periodically by flood waters and is formed of sediments deposited by the river
Floodplain connectivity	Latitudinal connectivity (e.g. movement of water onto floodplain). It is often reduced through channelisation or dredging rivers for flood protection, embankments etc., or through processes of channel deepening/incision.
Flow regime	Typical magnitude, frequency, timing, and duration of river flows that drive physical and some ecological processes and so, within the constraints of valley slope and confinement, influence the sizes and types of river channel that may be present
Fluvial Geomorphology	The study of sediment sources, fluxes, and storages within a river catchment over all timescales and the associated interaction with the channel's floodplain.
Groundwater	Water located beneath the ground surface.
Hydrology	The study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks.
Hydromorphology	Morphological and hydrological characteristics of rivers including the underlying processes from which they result
Kick Sampling	A WFD-compliant method used to collect a macroinvertebrate sample from the substrate of the watercourse. It consists of 3 minutes of kicking the substrate and marginal areas, and 1 minute hand-searching for animals attached to rocks and plants. Data collected from the analysis of the sample is assessed using a current WFD classification tool, which then assigns an ecological status to the watercourse.
Large wood	Piece of wood that is more than 1 m long and 10 cm in diameter

Term	Definition
Lateral connectivity	Freedom for water, sediments, and biota to move between the channel and the floodplain/hillslopes
Longitudinal connectivity	Freedom for water, sediments, and biota to move along the river channel
Mitigation Measures	Measures defined in the River Basin Management Plan to ensure a Heavily Modified Water Body meets good ecological potential.
Morphological Diversity	Variation in the form (morphology) of a watercourse channel. Generally the greater the morphological diversity the greater degree to which the channel can support Biological Quality Elements.
Planform	The geometric form of a river channel viewed from above
Reach	Section of river along which boundary conditions are sufficiently uniform that the river maintains a near consistent internal set of process–form interactions
Reinforcement	Strengthening of river beds and banks for various purposes (e.g. ford construction, erosion control) using materials such as boulders, sheet piling, geotextiles, etc.
Riparian zone	Transitional, semi-terrestrial area of land adjoining a river channel (including the river bank) that is regularly inundated and influenced by fresh water and can influence the condition of the aquatic ecosystem (e.g. by shading and leaf litter input and through biogeochemical exchanges)
River channel cross profile	Two-dimensional representation of river channel morphology perpendicular to the flow
River long profile	Two-dimensional representation of river bed topography, where bed elevation is plotted against longitudinal distance downstream along the channel

Term	Definition
River restoration	The establishment of natural physical processes (e.g. variation of flow and sediment movement), features (e.g. sediment sizes and river shape) and physical habitats of a river system (including submerged, bank and floodplain areas)
River/Riparian Corridor	Strip of land surrounding the stream channel that is directly affected by flow and sediment processes in the stream/ river.
Riverbed incision	Process where a river has cut vertically to lower its bed
River hydromorphological type	Group of river channels displaying similar morphological and hydrological characteristics and their associated processes
Sediment transport	The movement of sediment particles of a range of sizes by flowing water, which may include mobilization and deposition
Technically infeasible	WFD terminology: alternative WFD objectives (extended deadlines and/or less stringent objectives) may be set where achieving the WFD objective of GES/GEP is considered technically infeasible. Technically infeasible includes: no known technical solution; where the cause of the adverse impact on a given water body is unknown; where there are practical constraints of a technical nature; and/or the problem cannot be addressed due to lack of action by other countries (for example with transboundary water bodies and/or transboundary pollutants).
TraC	WFD water body terminology used to classify transitional (estuarine) and coastal water bodies.
Valley segment	Section of river subject to similar valley-scale influences and energy conditions
Weir	Artificial structure across a river for controlling flow and upstream surface level, or for measuring discharge

1 Introduction

1.1 Background

1.1.1 This Water Framework Directive (WFD) assessment has been prepared on behalf of Norfolk County Council (NCC) as the Applicant in support of the Norwich Western Link (NWL) planning application (hereafter referred to as 'the Proposed Scheme'). The Proposed Scheme interacts with four WFD water bodies throughout its length. Potential construction and operation impacts arising due to the Proposed Scheme are assessed against the biological, physico-chemical and hydromorphological quality elements that comprise the WFD. An assessment of potential impacts to groundwater has also been undertaken.

1.1.2 The purpose of the WFD assessment is to ensure no deterioration in either overall WFD status or the status of any of the WFD quality elements. In addition, an assessment is undertaken to ensure that the Proposed Scheme does not prevent the achievement of WFD objectives set for each water body potentially impacted. This WFD assessment has also been used to inform a **Habitat Regulations Assessment (HRA)** (Document Reference: 4.03.00).

1.2 Overview

1.2.1 The Proposed Scheme consists of the construction, operation, and maintenance of an approximately 6 Kilometre (km) long dual-carriageway road connecting the A1067 Fakenham Road and the A47, with a dualled section of the A1067 to the existing A1270 roundabout.

1.2.2 A full description of the Proposed Scheme is provided in **Chapter 3: Description of the Proposed Scheme** (Document Reference: 3.03.00) of the Environmental Statement. Consideration of all Proposed Scheme components as set out in **Chapter 3: Description of the Proposed Scheme** (Document Reference: 3.03.00) of the Environmental Statement have been considered, however, only those components pertinent to the WFD assessment are listed below and assessed for WFD compliance. All other Proposed Scheme components are scoped out of the WFD assessment due to lack of interaction with the WFD water bodies.

1.2.3 Design drawings of the Proposed Scheme are provided in **General Arrangement (GA) Drawings (**Document Reference 2.03.00) and a map of WFD water bodies is provided in **Sub Appendix A: WFD Study Area** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03a). A description of the Study Area is given in **Section 1.4**.

1.3 River Wensum Viaduct

1.3.1 A viaduct crossing the River Wensum Special Area of Conservation and floodplain (approximately 490 metres long with varying height of 6 -13 metres from existing ground level to the underside of the deck). The ten-span bridge with a reinforced concrete deck slab design includes piled piers within the floodplain.

1.4 Maintenance Access Tracks

1.4.1 During operation, maintenance access tracks for the River Wensum Viaduct would be in place. The tracks run adjacent to the viaduct to allow maintenance from either side of the River Wensum once the Proposed Scheme is operational.

1.4.2 A culvert crossing of a minor watercourse in the River Wensum floodplain is required for maintenance access. This watercourse is referred to as Watercourse 5 (hereafter referred to as WC5) and is a drainage ditch managed by the Internal Drainage Board (IDB). There is an additional ditch within the River Wensum floodplain that would be crossed by the maintenance access track. However, this ditch is terrestrial with no hydraulic connectivity, therefore, there is no requirement for a culvert crossing of this terrestrial ditch.

1.5 Culvert Structure for a Tributary of the River Tud

1.5.1 The Foxburrow Stream (a tributary of the River Tud) is proposed to be realigned and culverted. The proposed Tud tributary culvert / Bat underpass (CU2) is approximately 50 metres in length excluding wingwalls, with approximate internal dimensions of 4 metres wide and 4.5 metres high (headroom of 4 metres above the bed level). The Tud tributary culvert / Bat underpass has reinforced concrete wingwalls at both ends in conjunction with scour protection in the riverbed. A mammal ledge is incorporated into the proposed design of the Tud tributary culvert / Bat underpass.

1.6 Outfalls and Attenuation/Infiltration ponds

1.6.1 A drainage strategy has been developed as part of the Proposed Scheme to collect surface water from the carriageway (see **Drainage Strategy Report** (Document reference: 4.04.00)). The road would be built so water flows into channels and pipes which enter a sedimentary forebay. This ensures water is suitably treated before it enters a final drainage basin and infiltrates into the ground.

1.6.2 The drainage strategy includes five outfalls discharging into the Foxburrow Stream. Of these outfalls, two would discharge treated water from an attenuation pond. Surface water runoff associated with the wider drainage strategy would be discharged to the Foxburrow Stream via the remaining three outfalls.

1.6.3 There are two outfalls proposed discharging into the WC5 and a ditch (known as Ditch D) on the right floodplain of the River Wensum. The discharges of these outfalls are a combination of treated water from an attenuation pond and surface water runoff associated with the wider drainage strategy.

1.6.4 In addition, three attenuation and four infiltration ponds conveying pluvial water from the structures to ground are proposed scheme-wide. One of those attenuation/infiltration ponds is to be connected to the proposed drainage associated with the A47 North of Tuddenham to Easton Development Consent Order (DCO) (hereafter referred to as the National Highways A47 DCO road scheme).

1.7 Temporary Works

1.7.1 During the construction phase, a temporary works platform would be required across the floodplain of the River Wensum to provide a haul route for construction vehicles. This temporary works platform would also include a temporary crossing of River Wensum using a Bailey bridge, which is a temporary structure that provides bunded protection against spillages. From this temporary works platform, piling would be undertaken, viaduct piers constructed, and the viaduct deck lifted and poured (concreting the viaduct stitches from the platform) into place.

1.7.2 Piles for the Bailey bridge would be set-back approximately 3m from the bank top. Post-construction, the piles for the Bailey bridge would be excavated, cut off and capped below ground level and ground reinstated.

1.7.3 The construction of the temporary works platform requires temporary sheet pile walls to be installed and the removal of peaty loam and use of granular engineered fill, which would remain in place under a topsoil cover after construction.

1.7.4 Pre-Earthworks Ditches (PED) would be cut for site drainage during the construction phase.

1.7.5 The footprint of the temporary works platform would be reinstated on completion of the works, except for the maintenance track that would allow access to the viaduct in operation for inspection.

1.8 Vegetation Clearance

1.8.1 Vegetation clearance is proposed in some sections along the Proposed Scheme for enabling works and construction zones.

1.9 Enhancement Areas

1.9.1 Areas within the Red Line Boundary have been identified and designated to enhance aquatic habitat conditions.

1.10 Consultation

1.10.1 Consultation meetings with Geomorphology and Biodiversity Technical Specialists from the Environment Agency and Natural England have been undertaken to discuss and agree on the scope and level of detailed WFD impact assessment required. In addition, expectations for mitigation and enhancements were discussed. Consultation meetings have been held on 18 October 2018, 21 January 2020, 6 October 2020, 21 September 2021, and 13 June 2023.

1.11 Study Area

Surface Water

1.11.1 The Study Area comprises three surface water bodies listed below with their water body reference number (see also **Sub Appendix A: WFD Study Area** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03a)):

- Wensum US Norwich (GB105034055881);
- Wensum DS Norwich (GB105034055882); and
- River Tud (GB105034051000).

1.11.2 The Proposed Scheme crosses the Wensum US Norwich surface water body (GB105034055881) and a small tributary of the River Tud (GB105034051000), known as the Foxburrow Stream.

1.11.3 The River Wensum DS Norwich surface water body (GB105034055882) lies at Hellesdon Mills, approximately 7.3 kilometres downstream of the Proposed Scheme. These three surface water bodies are within the Wensum Operational Catchment, the Broadland Rivers Management Catchment, and the Anglian River Basin District.

1.11.4 For the Wensum US Norwich (GB105034055881), a 1 kilometre long field survey reach with the proposed River Wensum Viaduct crossing located at roughly the midpoint was undertaken to inform the WFD assessment. This Study Area extent was selected due to the specific sensitivities of this Special Area of Conservation (SAC), the size of the river and in accordance with best practice for the geomorphological assessment of rivers. For the desk-study component, a catchment-wide Study Area was used to characterise the baseline conditions of the River Wensum system.

1.11.5 For the River Tud (GB105034051000), a 0.5 kilometre long reach of the Foxburrow Stream was assessed near the proposed Tud tributary culvert / Bat underpass.

1.11.6 The River Wensum DS Norwich water body (GB105034055882) lies at Hellesdon Mills, which is approximately 7.3 kilometres downstream of the Proposed Scheme. This water body is designated as heavily modified (HMWB) and is partially protected as a Drinking Water Protected Area. No formal walkover survey has been undertaken of the River Wensum DS Norwich, given its distance beyond the Study Area and potential impacts being most likely during the construction phase and managed through the **Outline Construction Environment Managemental Plan (OCEMP)** (Document Reference: 3.03.01). However, a photographic record of the River Wensum within this water body were obtained to inform the assessment.

Groundwater

1.11.7 The Study Area lies within the Broadland Rivers & Crag groundwater WFD water body (GB40501G400300) (see also **Sub Appendix A: WFD Study Area** (Document Reference: 3.12.03a)), which sits within the Broadland Rivers and Crag operational catchment. This large groundwater body is over 3,000km^2 and covers much of East Anglia from Fakenham in the North to Kenton in the South. The solid geology that forms this groundwater body along the entire Proposed Scheme alignment comprises various members of the White Chalk subgroup, which are all classified as a Principal aquifer. Principal aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage and may support water supply and / or river base flow on a strategic scale.

1.12 WFD Assessment

1.12.1 The Secretary of State and the Environment Agency are under duties to secure compliance with the requirements of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 407), which is transposed from the European Union's Water Framework Directive (2000/60/EC).

1.12.2 The Planning Inspectorate Advice Note 18: The Water Framework Directive (**Ref 1.2**) also provides guidance on how to undertake a WFD assessment for infrastructure projects consented under the Planning Act 2008, to comply with the legal requirement for WFD compliance. While the Proposed Scheme is not a nationally significant infrastructure project to which the Planning Act 2008 regime applies, the Planning Inspectorate's Advice Note is nonetheless helpful guidance.

1.12.3 The WFD assessment should be consistent with relevant CEN/ISO Standards, as stated within Annex V of the WFD legislation. Relevant standards are listed within Section 3 (Methodology).

1.12.4 The primary aim of the WFD is to improve/maintain the Ecological Status / Potential of all water bodies and to prevent deterioration in the status of the water bodies and their associated WFD quality elements. Ecological Status / Potential is determined by a suite of biological, physico-chemical, chemical and hydromorphological quality elements. This WFD assessment aims to establish the baseline conditions, evaluate potential impacts of the Proposed Scheme, and assess compliance against WFD objectives.

1.12.5 The overarching objective of the WFD is for surface water bodies in Europe to attain overall 'Good Ecological Status' (GES) or 'Good Ecological Potential' (GEP). GES refers to situations where the ecological characteristics show only a slight deviation from natural/near natural conditions. In such a situation, the biological, chemical, physico-chemical and hydromorphological conditions are associated with limited or no human pressure. Artificial and heavily modified water bodies have a target to achieve GEP, which recognises their important uses, whilst ensuring the quality elements are protected as far as possible.

1.12.6 The WFD sets several objectives including:

- Prevent deterioration in the status for water bodies;
- Aim to achieve good biological and good surface water chemical status in water bodies. For those water bodies that did not achieve GES by 2015, alternative objectives have been set by the Environment Agency where water bodies have been allocated a target date for compliance of either 2021 or 2027. The target date set for each water body takes into consideration measures that are practicably achievable for achieving GES or GEP;
- For water bodies that are designated as artificial or heavily modified, the objective is to achieve GEP. Those artificial/heavily modified water bodies that did not achieve GEP by 2015 need to achieve compliance by 2021 or 2027;

- Where it is considered either technically infeasible or disproportionately expensive to achieve GES or GEP by 2021 or 2027, alternative objectives have been set for the water body, such as a target to achieve Moderate status;
- Comply with objectives and standards for protected areas, where relevant; and
- Reduce pollution from priority substances and cease discharges, emissions, and losses of priority hazardous substances.

1.12.7 Where a new modification, change in activity or change to a structure on a water body is proposed, a WFD assessment needs to consider whether the proposed alteration would cause deterioration in the Ecological Status or Potential of any water body. For heavily modified/artificial water bodies, proposed new modifications, or changes to activities or structures, may also result in WFD mitigation measures or actions, set to help a water body achieve GES/GEP, to be ineffective. This could result in the water body failing to meet GES/GEP. Where a WFD assessment concludes that deterioration or failure to achieve GES/GEP may occur, an Article 4(7) assessment under the WFD would be required, which makes provision for deterioration of status provided that certain stringent conditions are met.

2 Methodology

2.1 Data collection

2.1.1 A combination of desk-based study and field survey observations was carried out to inform this WFD assessment. This included reviewing the existing information of the Proposed Scheme to develop a baseline for the catchment, watercourses, and surrounding areas. The following data sources were used for the desk study:

- Contemporary Ordnance Survey (OS) maps (**Ref 2.1**);
- Historical maps of the catchment (**Ref 2.2**);
- Geological and soils maps (**Ref 2.3 and Ref 2.4**);
- Hydrological data (**Ref 2.5**);
- Ecological and solar exposure data (**Ref 2.6**);
- Land use data (**Ref 2.7**);
- Designated areas data, Magic Map (**Ref 2.8**);
- Catchment Data Explorer for WFD status and objectives for cycle 2 data 2019 (cycle 2 data is the most recent data published on Catchment Data Explorer at the time of producing this assessment report. The use of this published cycle 2 data was agreed during consultation with the Environment Agency). (**Ref 2.9**);
- Anglian River Basin Management Plan (RBMP) 2015 (**Ref 2.10**);
- River Wensum Strategy (**Ref 2.11, Ref 2.12**);
- Geomorphological appraisal of the River Wensum Special Area of Conservation (**Ref 2.13 and Ref 2.14**);
- Environment Agency Ecology and Fish Data Explorer (**Ref 2.15**);

- Environment Agency Water Quality Data (**Ref 2.16**); and
- Various academic texts referenced throughout this report.

2.2 Field Survey

Geomorphology Walkover Survey

2.2.1 Stream reconnaissance surveys of the River Wensum were undertaken on 5 December 2019, 10-12 November 2020, and 15 July 2020.

2.2.2 Sediment samples were taken during the site visit on 15 July 2020 and during an aquatic ecology survey on 31 August 2022.

2.2.3 Weather conditions up to and during the first survey (December 2019) were dry and cold with water levels returning to normal levels following heavy rain and flooding in the previous weeks. Conditions leading up to and during the second survey (November 2020) were typically unsettled, with the river displaying elevated winter flows. Conditions leading up to and during the third survey (July 2020) were rainy but with water levels within the normal range. Conditions leading up to the August 2022 survey were wet prior to the survey date following a prolonged period of drought and hot weather. River levels were however normal for summer flows.

2.2.4 Stream reconnaissance surveys of the Foxburrow Stream were undertaken on 25 June 2021 and 25 May 2022.

2.2.5 The conditions during the surveys were overcast, with rainfall leading up to the survey, and river levels within the normal range for the season.

2.2.6 The survey comprised a geomorphological walkover survey, collecting data on the channel and bank morphology, channel substrate, flow types, riparian features, and land use. The survey methodology was adapted from Thorne (**Ref 2.17)** and included data on:

- Land use;
- Floodplain and riparian zone;

- Channel geometry;
- Bank material and structure;
- Bed material and forms;
- Erosion features (sediment sources);
- Depositional forms (sediment sinks); and
- Artificial features and modifications.

2.2.7 This methodology complies with the relevant British standard (**Ref 2.18)** and data were analysed in accordance with the relevant British standard (**Ref 2.19)**.

2.2.8 Sediment sampling was undertaken on the River Wensum in July 2020 and August 2022. Samples were collected with a grab sampler with particle size distribution recorded using the Wentworth scale (**Ref 2.20**).

2.3 River Condition Assessment

2.3.1 River Condition Assessment (RCA) was undertaken on the River Wensum, watercourses along the River Wensum right floodplain and the tributary of the River Tud using the MoRPh5 field survey methodology. These surveys were conducted in June/July 2021 and May 2022. The weather conditions on the day of the survey were dry in the former and wet in the latter. The RCA surveys were undertaken and analysed by four accredited RCA surveyors.

2.3.2 Additional RCA surveys were undertaken in a potential area for Biodiversity Net Gain (BNG) enhancement works. The additional surveys were conducted in October/November 2022 along the River Wensum and a series of ditches on its right floodplain. Conditions leading up to and during the additional RCA surveys were typically unsettled, with the river displaying elevated winter flows. The RCA surveys were undertaken and analysed by four accredited RCA surveyors.

2.3.3 This methodology also complies with relevant British standards (**Ref 2.18** and **Ref 2.19**).

2.4 Aquatic Ecology Surveys

Fish

2.4.1 A 40-minute timed catch per unit effort (CPUE) electric fishing survey was conducted over a 150 metre stretch of the River Wensum between TG 14012 15454 and TG 13841 15598 on 31 August 2022. The survey was carried out from a boat by a two-person fishing team using a single anode with a generator-powered control box system operated from the boat.

2.4.2 Electric fishing methods and techniques followed guidelines developed by the Environment Agency (**Ref 2.21**; **Ref 2.22**; **Ref 2.23**), and which conform to British Standard BS EN 14011:2003 Water Quality. Sampling of Fish with Electricity (**Ref 2.24**).

Aquatic macroinvertebrates

2.4.3 Aquatic macroinvertebrate surveys were conducted at two sampling locations within the River Wensum at TG 14015 15463 and TG 14118 15368. Surveys were conducted on 25 May 2022 and were repeated on 09 September 2022.

2.4.4 Due to the depth of the River Wensum, the three-minute kick sample method was not suitable, therefore both samples were collected via bankside sweep. These surveys were carried out using a standard sampling net (1mm mesh), following the Environment Agency (2017) (**Ref 2.25**) procedure, which conforms to BS EN ISO 10870:2012 Water Quality – Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters (**Ref 2.26**).

Macrophytes

2.4.5 A macrophyte survey was conducted along a 100m stretch of the River Wensum, between TG 14042 15415 and TG 14128 15371, on 15 August 2022. The survey area included the 35m length of river that would be crossed by the River Wensum Viaduct and approximately 32.5 metres up and downstream.

2.4.6 The macrophyte survey was carried out using the Water Framework Directive UK Technical Advisory Group methodology for assessing macrophytes in rivers (**Ref 2.27**). This method conforms with the relevant British standard (**Ref 2.28)**.

Groundwater Walkover Survey

2.4.7 No specific groundwater WFD walkover survey was undertaken to inform the WFD screening and scoping assessment. This is due to the groundwater being subterranean and therefore detail from ground investigation being considered more relevant.

2.5 Data Analysis

Geomorphological Dynamics Assessment

River Wensum

2.5.1 A range of geodynamics assessments were undertaken to assess the potential construction and operation impacts of the proposed River Wensum Viaduct across the River Wensum. These analyses include the assessment of velocity, stream power, shear stress, sediment transport and Froude number. The methods employed to assess potential impacts to fluvial dynamics are provided in **Sub Appendix B: Geomorphological Dynamics Assessment** of the **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03b).

2.5.2 The results of the geodynamics assessment are provided in **Appendix 12.4: River Wensum Geomorphology Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.04).

2.5.3 A fully-2D hydrodynamic model of the River Wensum and surrounding floodplain has been constructed and used as to inform the geomorphological dynamics assessment. A fully-2D model has been selected as the appropriate tool to quantify changes to shear stress, stream power, velocity and flow, as high-resolution output parameters are available within channel. Further details on the approach to the 2D hydrodynamic modelling are provided in **Sub Appendix B: Geomorphological Dynamics Assessment** (Document Reference: 3.12.03b).

Foxburrow Stream

2.5.4 Outputs from a 1D flood model were used to assess potential impacts to velocity, stream power and shear stress for a range of flow events for both baseline and operation. Information on the 1D hydraulic model is explained within **Appendix 12.2: Flood Risk Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.02).

2.5.5 The results of the geomorphology assessment for the Foxburrow Stream are presented in **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03c).

2.6 Aquatic Ecology Assessment

Fish

2.6.1 Fish survey data was analysed to inform the WFD assessment. The results of the fish data analysis are provided in **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement (Document Reference: 3.10.12).

Aquatic macroinvertebrates

2.6.2 The following biological metrics were used in the analysis of aquatic macroinvertebrate data. This enabled the assignation of ecological values to the aquatic macroinvertebrate communities observed and an assessment of pressures on those communities to be made.

- River Invertebrate Classification Tool (RICT);
- Whalley, Hawkes, Paisley, and Trigg (WHPT);
- Lotic-invertebrate Index for Flow Evaluation (LIFE);
- Proportion of Sediment-sensitive Invertebrates (PSI); and
- Community Conservation Index (CCI).

2.6.3 These metrics are detailed further in **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement (Document Reference: 3.10.12).

Macrophytes

2.6.4 The macrophyte communities observed were analysed using the River Predications and Classification Systems for Macrophytes (LEAFPACS2) in order to establish the condition and quality of the macrophyte communities present. The condition of the sampled macrophyte community was assessed by calculating the following indices:

- River Macrophyte Nutrient Index (RMNI);
- Number of Macrophyte Taxa (NTAXA);
- Number of Functional Groups (NFG);
- Cover of Green Filamentous Algae (ALG); and
- Ellenberg Light Indicator Values.

2.6.5 These metrics are detailed further in **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement (Document Reference: 3.10.12).

2.7 Water Quality Assessment

2.7.1 In addition to a high-level assessment based on expert judgment using the water quality dataset listed in Section 2.1, a water quality assessment using the Highways England Water Risk Assessment Tool (HEWRAT) was undertaken to ensure water quality objectives are met and appropriate treatment is embedded in the Proposed Scheme. The results of the HEWRAT are detailed in the Drainage Network Quality Assessment (DNWQA) provided in **Appendix 12.1: Drainage Network Water Quality Assessment (DNWQA) of Chapter 12: Road Drainage and the Water Environment of the Environmental Statement** (Document Reference: 3.12.01).

2.8 Groundwater Assessment

2.8.1 Due to the sensitivity of the Rivers Wensum and Tud as ultimate groundwater receptors, both qualitative and quantitative assessment were undertaken.

2.9 Flood Modelling and Flood Risk Assessment

2.9.1 A separate flood risk assessment was produced for the Proposed Scheme and the results have been used to determine any potential impacts to WFD quality elements. For further information on the flood risk assessment, see **Appendix 12.2: Flood Risk Assessment Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.02).

2.10 Biodiversity Net Gain Assessment

2.10.1 A BNG assessment was conducted for the watercourses within the Red Line Boundary, comprising the River Wensum and its interconnected ditches, and the Foxburrow Stream (a tributary of the River Tud). A set of potential enhancement works have been simulated for the river component of the BNG metric to achieve, at least, a 10% gain from the baseline condition. The baseline and enhancement simulation river condition indicators and associated concept designs are provided in **Sub Appendix D: River Condition Indicators and Enhancement Concepts** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03d). For a full analysis of the river component of the BNG metric see **Sub Appendix D: River Condition Assessment** of **Appendix 10.3: Biodiversity Net Gain Technical Report** (Document Reference: 3.10.33d).

2.11 WFD Assessment Process

2.11.1 The assessment methodology used here is based on guidance provided by the Planning Inspectorate Advice Note 18: The Water Framework Directive (**Ref. 1.2**). This guidance outlines a three-stage process to WFD assessment:

Stage 1: Screening

2.11.2 Screening is required to identify activities which have the potential to result in deterioration of a water body or fail to comply with the objectives of that water body. Screening also serves to identify those proposed activities (e.g. proposed construction methods) that are required to be taken through to the scoping stage (see stage 2 below), and those activities that are unlikely to result in the deterioration of the water body.

Stage 2: Scoping

2.11.3 Scoping is required to identify risks to receptors arising from the activities of the Proposed Scheme, based upon the relevant water bodies and their water quality elements (including information on status, objectives, and the parameters for each water body). Potential risks to hydromorphology, biology (habitats and fish), water quality and quantity, WFD protected areas and invasive non-native species (INNS) should be assessed. The scoping stage identifies which elements need to be carried forward to Stage 3.

Stage 3: Impact Assessment

2.11.4 This stage involves a detailed WFD impact assessment of the potential impacts of both the construction and operational phase of the Proposed Scheme against all WFD quality elements, Proposed Scheme and construction activities scoped into the detailed assessment. This full impact assessment is submitted as an appendix to **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement in support of the planning application for the Proposed Scheme (Document Reference: 3.12.00).

2.11.5 Construction potential impacts are also considered within this assessment as they have the potential for detrimental effects on the WFD quality elements and construction periods may sometimes be of long duration (i.e., several years).

2.12 Limitations and Assumptions

2.12.1 Observations recorded during the site visits represent a snapshot of that moment in time; thus, the watercourses have been characterised and assessed based on the prevailing conditions at the time of the site visits. The watercourses may exhibit additional characteristics during, for example, extreme flow events or prolonged drought; however, these were not captured during the survey.

2.12.2 Data recorded during the field survey reflects the weeks and months leading up to the survey: the watercourses may exhibit other morphological phenomena during particularly high-flow events or following an extreme flow event. Thus, in the absence of time series data for the watercourses, inferences have been made based upon field data and a desk study exercise.

3 Baseline condition

3.1 Catchment characteristics

River Wensum

3.1.1 The River Wensum is a low gradient groundwater (chalk aquifer) dominated river which flows easterly for approximately 78 kilometres through the county of Norfolk, from its source (at an altitude of 75mAOD) on Colkirk Heath near South Raynham and Whissonsett to its confluence with the River Yare in Norwich. The catchment area of the River Wensum, as measured at the gauging station Costessey Mill (NRFA Station Number 34004), is 571km^2. The mean flow measured at this gauging station is 4.09m^3/s and the bankfull stage is estimated at 1.5 metres.

3.1.2 The River Wensum is one of 31 rivers in the United Kingdom designated in 1993 as a ‘whole river’ Site of Special Scientific Interest (SSSI) in recognition of its calcareous lowland river characteristics. The Wensum is also one of 16 rivers in England to be selected as a Special Area of Conservation (SAC) under the European Union’s ‘Habitats and Species’ Directive’. The river is also under the Demonstration Test Catchment (DTC) program which was launched in England to provide research to help inform both policy and practical approaches for reducing diffuse pollution and improving the ecological status of freshwater (**Ref 3.1**).

3.1.3 The landscape is predominantly rural with intensive arable farmland dominating the landscape and grazing marsh, fen, scrub, and scattered woodlands characterising the floodplains (**Ref 3.2**). Unusually for a lowland river, much of the floodplain of the River Wensum is still traditionally managed, although there are a series of flooded gravel pits in the vicinity of Costessey, Lenwade, Lyng, Fakenham and Great Ryburgh (**Ref 2.12**). There are numerous small villages located along the course of the River Wensum downstream of the Study Area, with the only small town being Fakenham before reaching Norwich. The results of the UKCEH land cover types within the River Wensum at two gauging stations is summarised in **Table 3.1**.

Table 3.1 Land cover types of the River Wensum recorded at gauging stations along the Wensum (source: Ref 2.7)

Parameter	Wensum at Swanton Morley Total (%) upstream	Wensum at Costessey Mill Total (%) downstream
WoodWoodland	7.61	8.98
Arable / horticultural	76.06	74.02
Grassland	13.22	13.59
Mountain / heath / bog	0.04	0.03
Urban extent	2.82	3.06

3.1.4 No operating gauge stations exist for the middle and lower River Wensum catchment, but land cover data (**Ref 2.7**) indicates that urban extent is the main type of physical coverage within the Wensum DS Norwich (GB105034055882) surface water body.

River Tud

3.1.5 The River Tud catchment is approximately 73.2km^2, extending from Daffy Green to the confluence with the River Wensum. Elevation varies from 81.9mAOD to 10.0mAOD. The Foxburrow Stream catchment is a relatively small portion (2.8km^2) of the River Tud drainage area (73.2km^2). The Foxburrow Stream upper catchment is approximately 45mAOD (near the B1535 road), and the lower catchment is approximately 2.5 kilometres downstream (near Honingham), where it joins the River Tud (OS NGR TG 11492 11650) at approximately 20mAOD.

3.1.6 Currently, the Foxburrow Stream catchment is not situated within any designated area. The Foxburrow Stream does, however, discharge into the River Tud, which is a tributary of the River Wensum SAC.

3.1.7 UKCEH land cover types within the River Tud catchment at a gauging station near its outlet (34005 - Tud at Costessey Park) is summarised in **Table 3.2**.

Table 3.2 Land cover of the River Tud recorded at 34005 – Tud at Costessey Park gauging station (source: Ref 2.7)

Parameter	Percentage (%)
Woodland	8.65
Arable / horticultural	68.21
Grassland	16.65
Urban extent	5.95

3.2 Catchment Geology and Soils

River Wensum

3.2.1 The River Wensum catchment is predominantly underlain by undifferentiated deposits of the White Chalk Subgroup formed during the Cretaceous period (**Ref 2.3**). This includes the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation, and the Portsdown Formation.

3.2.2 High permeability bedrock covers approximately 93% of the Wensum catchment and 7% of moderate permeability bedrock, which indicates that the catchment has highly productive fissured aquifers with intergranular flow.

3.2.3 Superficial geology within the Wensum Catchment is broadly dominated by clay and till material deposited during successive glaciations throughout the Quaternary period. However, the River Wensum corridor is underlain with Alluvium including peaty loam and successions of terrace deposits concurrent with the more recent fluvial history of the system.

3.2.4 The catchment is characterised by 21% high permeability superficial deposits and 74 mixed permeability deposits.

3.2.5 The superficial geology of the Study Area is underlain by Head deposits, Alluvium, River Terrace Deposit (RTD), Sheringham Cliffs Formation (SCF) and the Lowestoft Formation. The RTD and alluvium deposits are in the northern area of the site near the River Wensum. These deposits follow the approximate flow pathway and tributaries of the River Wensum.

3.2.6 Soils within the Wensum catchment are variously comprised of rich loams, sandy peats, and silts. The Wensum valley floor is characterised by low permeability soils over clay; while the valley sides accommodate permeable, highly fertile sandy loams which have considerable cultivation potential, but require extensive irrigation (**Ref. 2.3**).

River Tud

3.2.7 The solid geology of the Foxburrow Stream catchment is predominantly underlain by chalk belonging to the White Chalk Subgroup formed during the Cretaceous period (**Ref 2.3**), which is highly permeable.

3.2.8 The River Tud catchment comprises mixed permeability superficial deposits (89%) with generally high permeability superficial deposits. The superficial geology is dominated by clay and till material deposited during successive glaciations throughout the Quaternary period. However, the Foxburrow Stream corridor is underlain with alluvium concurrent with a more recent fluvial history.

3.2.9 Soils within the Foxburrow Stream catchment are variously comprised of slightly acid loamy and clayey soils with impeded drainage in conjunction with freely draining slightly acid sandy soils. These soils are particularly vulnerable to leaching of nitrate and pesticides to groundwater; highly erodible under arable and vegetable crops, where sloping, resulting in eutrophication and clogging of stream bed with sand.

3.3 Catchment Hydrology

River Wensum

3.3.1 The River Wensum has a groundwater dominated flow regime, arising from the chalk aquifer, characterised by a moderate high Base Flow Index (BFI) and a low index of flashiness (**Ref 2.5**). Discharge of groundwater occurs in the valley bottoms where the river has cut through the overlying Quaternary deposits or where River Terrace Deposits leading to a greater hydraulic connection between the chalk and surface water. The field drains within the valley bottom also exhibit similar groundwater-surface water interactions as the main river channel.

3.3.2 There are three gauging stations on the River Wensum in proximity to the Study Area; the Fakenham gauging station (ID 34011), the Swanton Morley gauging station (ID 34014), and the Costessey Mill gauging station (ID 34004). The Fakenham and Swanton Morley gauging stations are located upstream and the Costessey Mill gauging station downstream of the Proposed Scheme. Data recorded at these gauging stations is summarised in **Table 3.3**.

Table 3.3 Hydrology data for the River Wensum catchment recorded at gauging stations (source: Ref 2.5)

Flow Metric	Costessey Mill	Swanton Morley	Fakenham
Baseflow Index	0.75	0.75	0.82
Mean Flow (m^3/s)	4.1	2.72	0.85
95% Exceedance (Q_{95}) (m^3/s)	1.35	0.94	0.24
70% Exceedance (Q_{70}) (m^3/s)	2.34	1.51	0.48
50% Exceedance (Q_{50}) (m^3/s)	3.22	2.12	0.68
10% Exceedance (Q_{10}) (m^3/s)	7.44	5.02	1.63
5% Exceedance (Q_5) (m^3/s)	9.65	6.52	1.98

River Tud

3.3.3 Runoff along the River Tud is influenced by groundwater abstraction, recharge, and industrial/agricultural abstraction. According to the records from a gauge station near the confluence with the River Wensum, the median annual flow (QMED, equivalent to a 2-year flood flow [Q_2]) is 3.1m^3/s, and average annual rainfall is 649mm. Extensive drainage management has significant effect on floodplain hydrology, as attested by several hydraulic controls such as drains and weirs connecting the Foxburrow Stream into River Tud mainstem.

3.3.4 Further hydrologic details at this gauge station are provided in **Table 3.4**.

Table 3.4 Hydrology data for the River Tud recorded at 34005 – Tud at Costessey Park gauging station (source: Ref 2.5)

Flow Metric	Costessey Mill
Baseflow Index	0.64
Mean Flow (m^3/s)	0.38
95% Exceedance (Q_{95}) (m^3/s)	0.10
70% Exceedance (Q_{70}) (m^3/s)	0.18
50% Exceedance (Q_{50}) (m^3/s)	0.26
10% Exceedance (Q_{10}) (m^3/s)	0.75
5% Exceedance (Q_5) (m^3/s)	1.03

3.4 Historical Channel Change

River Wensum

3.4.1 The recent evolution of the River Wensum system may be considered over the last 10,000 years following the Last Glacial Maximum (LGM) heralding a period of warming and glacial retreat throughout the Upper Pleistocene (17,000 to 6,000 B.P) and Holocene (6,000 B.P. to the present) – a period referred to as The Flandrian. The climatic conditions at the beginning of this period, coupled with periglacial processes, such as rapid deglaciation and meltwater discharge, generated high-energy floods capable of mobilising and transporting large quantities of sediment. Accordingly, this brought about sequences of valley floor alluviation and incision, thus developing the depositional forms that are observable today, for example, river terrace sequences. During this period, the River Wensum exhibited a braided channel morphology, concurrent with high sediment yield and high energy flow regime. As the climate evolved, so the River Wensum transitioned from a high-energy braided system to low-energy, multi-channel anastomosed, in response to development of cohesive floodplain deposits and afforestation.

3.4.2 The complex natural evolution of the Wensum system was further compounded by the introduction of anthropogenic pressures midway through the 10,000-year period considered here. Extensive deforestation and land clearing from around 5,000 B.P. resulted in mobilisation of fine sediment which ultimately deposited across valley floors, blocked multiple channels, and led to the creation of the stable, single-thread, passively meandering system that persists today. However, evidence of former channels remains evident across the valley floor, many of which have been exploited for land drainage purposes. Contemporary alteration of the hydrological functioning of the system throughout the last few centuries, by means of water milling and extensive land drainage, has further reinforced the inactive, modified character of the River Wensum and its tributaries.

3.4.3 Review of historical mapping suggests the channel has been relatively stable since the middle of the 19th century, with little natural channel migration. However, the current river channel is considered to be the product of a long history of modification, from slow anastomosing to moderately sinuous single-thread (**Ref 2.2**). The main planform changes occurred between the 1200s and 1797 were at mill sites (Sculthorpe, Fakenham, Great Ryburgh, Elsing, Lyng and Lenwade) where the course of the Wensum was shortened by abandoning large meander loops. Between 1797 and 1898, a major diversion was constructed near Tatterford (related to Southmill), and the channel was re-aligned from Tatterford to Sculthorpe, with another major diversion upstream of Fakenham in Sculthorpe Fen for the three mills downstream (**Ref 2.2**). Additional channel re-alignment at Little Ryburgh, Great Ryburgh, Sennowe Hall, North Elmham and near Billingford Common are also cited to have been constructed for flood alleviation reasons.

3.4.4 Minor planform changes have occurred during the 20th century (small meanders removed at Sculthorpe Fen, Great Ryburgh Common, Great Ryburgh Carr, downstream of Bintree Mill, upstream of North Elmham and near Attlebridge, Ringland and Drayton) in response to a policy of intensive land drainage and dredging following the end of the Second World War (during the period 1953-57) (**Ref 2.2**).

3.4.5 There are numerous ponds located downstream of the Study Area which are manmade, most probably associated with the Wensum Valley Hotel Golf and Country Club. As previously mentioned, some flooded gravel pits have developed in the vicinity of Costessey, Lenwade, Lyng, Fakenham and Great Ryburgh associated with gravel extraction. The river along the upstream reach of the Study Area appears to have been artificially widened and deepened, as evidenced by a mean width of 8m and a mean depth of over 1m (**Ref 2.2**).

River Tud

3.4.6 The oldest available maps from the Foxburrow Stream catchment (OS map, 1906) show that the mainstem planform has remained largely unchanged, indicating that the construction of drains and weirs preceded the beginning of the 20th century. Land use and land cover have also remained largely the same for the time span, with just minor changes.

3.4.7 The most noticeable change along the River Tud corridor is that currently existing lakes known as Shallowbrook Lakes (centred at NGR TG 18299 11184) were absent in all maps pre-dating the mid-20th century (1971).

3.5 Baseline Characteristics Against WFD Surface Water Quality Elements

3.5.1 The baseline conditions of the surface water WFD quality elements for the potentially impacted WFD water bodies are described below based upon desk study and field survey observations.

River Wensum US Norwich

3.5.2 The River Wensum US Norwich water body (GB105034055881) lies within the Anglian River Basin District (RBD), the Broadland Rivers Management Catchment, and the Wensum Operational Catchment.

3.5.3 The water body is designated heavily modified and is currently achieving Moderate status, comprising Moderate Ecological Status and Fail Chemical Status. The hydromorphological status Supports Good and hydrological regime currently Does Not Support Good. The reasons for not achieving

Good status are poor nutrient management, poor livestock management, sewage discharge, and groundwater abstraction. The water body status objective is to achieve Good by 2027.

3.5.4 A summary of the WFD classification is provided **in Sub Appendix E: WFD Classification Data** of Appendix 12.3: Water Framework Directive Assessment (Document Reference: 3.12.03e).

Biological Quality Elements

Fish

3.5.5 The Wensum US Norwich WFD water body (GB105034055881) water body was classified as High for fish according to the 2019 WFD classification (**Ref 2.9**), exceeding the 2019 status objective for this item in this water body.

3.5.6 A search of the Environment Agency Ecology and Fish Data Explorer returned data from an Environment Agency catch depletion electric fishing survey carried out in 2019, at a site (TG 16676 12847) approximately 8.2 kilometres downstream of the proposed crossing (**Ref 2.15**). Results from the most recent survey at this location, undertaken in 2019, are displayed in **Table 3.5**.

Table 3.5 Environment Agency fish survey data from the River Wensum (TG 16676 12847) collected on 6 August 2019

Common Name	Latin Name	No. of individuals
Minnow	*Phoxinus phoxinus*	274
Dace	*Leuciscus*	79
Roach	*Rutilus*	36
Chub	*Squalius cephalus*	33
Pike	*Esox lucius*	10
Gudgeon	*Gobio*	8
Stone loach	*Barbatula barbatula*	5
Bullhead (SAC Protected habitat designation)	*Cottus gobio*	3
Perch	*Perca fluviatilis*	3

Common Name	Latin Name	No. of individuals
Three-spined stickleback	*Gasterosteus aculeatus*	2
Common bream	*Abramis brama*	1
Brook lamprey ammocoete (SAC Protected habitat designation)	*Lampetra planeri*	1
European eel elver	*Anguilla anguilla*	1
Total	N/A	456

3.5.7 A total of three species of conservation interest were recorded in the Environment Agency survey. European eel *Anguilla* are listed as a Species of Principal Importance (SPI) under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006. European eel are afforded further protection under The Eels (England and Wales) Regulations 2009 and is also listed on the IUCN Red List of Threatened Species as being critically endangered (**Ref 3.3**).

3.5.8 Brook lamprey *Lampetra planeri* and bullhead *Cottus gobio* are listed under Annex II of the European Commission Habitats Directive as species whose conservation requires the designation of Special Areas of Conservation (**Ref 3.4**). Brook lamprey are also protected under The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), transposed into UK national law through the Wildlife and Countryside Act 1981 (as amended) (**Ref 3.5**).

3.5.9 A total of nine fish species were caught during a 40-minute timed electric fishing survey during surveys carried out on the River Wensum, on 31 August 2022. Minnow *Phoxinus* were the most abundant species captured. No species of conservation interest were caught. For full results of the electric fishing survey conducted on the River Wensum (see **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement – Document Reference: 3.10.12).

Aquatic Macroinvertebrates

3.5.10 The Wensum US Norwich WFD water body (GB105034055881) water body was classified as High for aquatic macroinvertebrates according to the 2019 WFD classification (**Ref 2.9**), exceeding the 2019 status objective for this item in this water body.

3.5.11 Aquatic macroinvertebrate data is available for the River Wensum from the Environment Agency Ecology and Fish Data Explorer (**Ref 2.15**). The nearest Environment Agency aquatic macroinvertebrate monitoring location on the River Wensum is located approximately 1.63 kilometres upstream of the proposed crossing. The most recent data from this monitoring location are from a survey carried out in March 2021 at TG 12918 16356.

3.5.12 No protected species were identified in the aquatic macroinvertebrate sample obtained on 26 March 2021, however, the invasive non-native New Zealand mud snail *Potamopyrgus antipodarum* was recorded. Furthermore, there were no species observed with an individual Conservation Score (**Ref 2.15**) of 6 or higher. Conservation Scores for freshwater invertebrates in Great Britain range from 1 – Very Common to 10 – Endangered (with a score of 6 being regionally notable) (**Ref 3.6**).

3.5.13 Aquatic macroinvertebrate sampling was conducted in the River Wensum in spring and autumn 2022. The invasive non-native New Zealand mud snail was recorded in the River Wensum in both the spring and autumn samples. No protected species were recorded, however, grannom caddisfly *Brachycentrus subnubilus* was recorded in the autumn sampling period. The species has a conservation score of 6 and as such is Regionally Notable (uncommon in some parts of the country). For full aquatic macroinvertebrate sampling results refer to **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement (Document Reference: 3.10.12).

Macrophytes

3.5.14 The macrophytes and phytobenthos combined element 2019 status for the Wensum US Norwich WFD water body was considered to be Moderate (**Ref 2.9**).

3.5.15 One of the primary reasons for the selection of this site as a SAC is Annex I habitat consisting of 'watercourses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' (**Ref 3.7)**.

3.5.16 This habitat type is characterised by the abundance of water-crowfoots *Ranunculus* spp., subgenus *Batrachium*. Floating mats of these white-flowered species are characteristic of river channels in early to mid-summer. They may modify water flow, promote fine sediment deposition, and provide shelter and food for fish and invertebrate animals (**Ref 3.8**).

3.5.17 In this habitat type, Ranunculus species are associated with a different assemblage of other aquatic plants, such as water-cress *Rorippa nasturtium-aquaticum*, water-starworts *Callitriche* spp., greater water-parsnip *Sium latifolium* and lesser water-parsnip *Berula erecta*, water-milfoils *Myriophyllum* spp. and water forget-me-not *Myosotis scorpioides*. In some rivers, the cover of these species may exceed that of Ranunculus species (**Ref 3.8**).

3.5.18 Although the River Wensum is extensively regulated by weirs, Ranunculus vegetation occurs sporadically throughout much of the river's length. Stream water-crowfoot *Ranunculus penicillatus* subsp. *pseudofluitans* is the dominant Ranunculus species, but thread-leaved water-crowfoot *Ranunculus trichophyllus* and fan-leaved water-crowfoot *Ranunculus circinatus* also occur (**Ref 3.8**).

3.5.19 The River Wensum has been selected as a SSSI as an example of an enriched, calcareous lowland river. Whilst the river is of rich ecological and cultural value in its present state, the condition of the River Wensum SSSI aquatic units is currently regarded as being "Unfavourable – Recovering."

3.5.20 The nearest Environment Agency macrophyte monitoring location was identified in the desk study as a site located at TG 12918 16356, approximately 1.7 kilometres upstream of the proposed River Wensum Viaduct crossing. The most recent survey at this location was undertaken on 11 August 2021. The results of this survey are displayed below in **Table 3.6**.

Table 3.6 Environment Agency macrophyte survey data from the River Wensum (TG 12918 16356)

Taxon	Common Name	Taxon Cover Value
Apium nodiflorum	Fool's water-cress	2
Berula erecta	Lesser water parsnip	1
Butomus umbellatus	Flowering rush	3
Callitriche sp.	Water starwort	1
Ceratophyllum demersum	Rigid hornwort	1
Cladophora glomerata / Rhizoclonium hieroglyphicum	Filamentous algae (reticulated)	5
Elodea nuttallii	Nuttall's waterweed	3
Fontinalis antipyretica	Greater water-moss	2
Glyceria maxima	Reed sweet grass	6
Lemna gibba	Gibbous duckweed	1
Lycopus sp.	Gypsywort	1
Mentha aquatica	Water mint	1
Myosotis scorpioides	Water forget-me-not	2
Persicaria hydropiper	Water pepper	2
Phalaris arundinacea	Reed canary grass	5
Potamogeton pectinatus	Fennel pondweed	5

Taxon	Common Name	Taxon Cover Value
Potamogeton perfoliatus	Clasping-leaved pondweed	6
Ranunculus sceleratus	Celery-leaved buttercup	2
Rorippa nasturtium-aquaticum agg.	Watercress	2
Sagittaria sagittifolia	Arrowhead	4
Solanum dulcamara	Bittersweet	1
Sparganium emersum	European bur-reed	5
Sparganium erectum	Branched bur-reed	5
Stachys palustris	Marsh woundwort	1
Schoenoplectus lacustris	Common clubrush	6
Veronica anagallis-aquatica	Water speedwell	3
Veronica beccabunga	Brooklime	2
Total number of taxa	No applicable	27

3.5.21 No water crow-foot species that are a characteristic of the River Wensum SAC were recorded in the Environment Agency survey at this monitoring location. However, four species listed on the designation of ‘water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation,’ water starworts, greater water-moss *Fontinalis anntipyretica*, fennel pondweed *Potamogeton pectinatus*, and clasping-leaved pondweed *Potamogeton perfoliatus* were recorded.

3.5.22 The invasive non-native Nuttall’s waterweed *Elodea nuttallii* was recorded in the survey.

3.5.23 A total of 24 macrophyte taxa were recorded in the macrophyte survey of the River Wensum, carried out on 15 August 2022. One water-crowfoot species, stream water-crowfoot *Ranunculus penicillatus* subsp. *pseudofluitans* was recorded in the survey. No INNS were recorded in the survey. For full survey details see **Appendix 10.12: Aquatic Ecology Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement – Document reference: 3.10.12).

Physico-chemical Quality Elements

3.5.24 The water body had an objective of Good status for physico-chemical quality by 2015 (**Ref 2.9)**. Good status was achieved for this item in 2013, 2014, 2016 and 2019. Physico-chemical quality was classified as Moderate in 2015.

Thermal Conditions

3.5.25 Water temperature in the water body was classified as High between 2013-2014 and Good between 2015-2019 with the objective for this item standing at Good by 2015 (**Ref 2.9**).

3.5.26 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between April and December 2022, water temperature within the River Wensum at the Taverham Bridge monitoring location (TG 16000 13650), ranged from 6.7°C to 21.1°C.

Oxygenation Conditions

3.5.27 The water body was allocated a High-status objective for dissolved oxygen concentrations by 2015 (**Ref 2.9**). This was achieved in 2013, 2014, 2016 and 2019, with concentrations being classified as Moderate in 2015.

3.5.28 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between April and December 2022, dissolved oxygen percentage saturation within the River Wensum at the Taverham Bridge monitoring location (TG 16000 13650), ranged from 80.0% to 102.3%.

Salinity

3.5.29 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that between 2015 and 2019 the monthly mean salinity within the River Wensum at the Taverham Bridge monitoring location (TG 16000 13650) ranged from 0.37ppt to 0.40ppt.

Acidification Status

3.5.30 The pH objectives for the water body required Good status by 2015 (**Ref 2.9**). The water body surpassed this objective, achieving High status throughout 2013-2019.

3.5.31 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between April and December 2022, pH within the River Wensum at the Taverham Bridge monitoring location (TG 16000 13650), ranged from 7.94 to 8.25.

Nutrient Conditions

3.5.32 The water body achieved its 2015 objective for ammonia (High status) since 2013 (**Ref 2.9**). The objective for phosphate predicts is High status by 2021 (**Ref 2.9**). The available data suggests a progression towards this target with phosphate achieving Good status between 2013-2015, and raising to High status since 2016.

3.5.33 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between April and December 2022, the ammonia concentration within the River Wensum at the Taverham Bridge monitoring location (TG 16000 13650), ranged from <0.030mg/L to 0.035mg/L.

3.5.34 The phosphorous concentration within the River Wensum was not monitored at the Taverham Bridge monitoring location (TG 16000 13650) in 2022. However, data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between April and December 2019, the phosphorous concentration within the River Wensum at this location, ranged from 0.0401mg/L to 0.3500mg/L.

Hydromorphology Quality Elements

Quantity and Dynamics of Flow

3.5.35 The River Wensum is noted to have a flow derived from the underlying groundwater table, direct surface runoff, and direct recharge to the river and drain network. The hydrological regime is that of a groundwater-fed river, with base flow indices of 0.85 in the upper reaches to Fakenham and 0.7 at Costessey Mill. Water level management of the river and drain network significantly affects the levels and flows within the floodplain.

3.5.36 The high baseflow index of the River Wensum results in a hydrological regime that is slow to react to rainfall events, such that no noteworthy response in river level may occur during a typical storm. Rather, flow is strongly governed by seasonal changes to groundwater levels, with elevated flow occurring throughout winter, followed by a gradual reduction in flow (concurrent with groundwater drawdown) to the summer minimum. Conversely, river flow gradually increases to a winter maximum as aquifers are recharged.

3.5.37 The modified nature of the Wensum, however, has resulted in a loss (or significant reduction) of natural river-floodplain interactions. Prior to anthropogenic modification, the Wensum would have represented a slow anastomosing system, with the entire valley floor occupied by its hydrological network. This would have sustained a complex assemblage of bogs, wet woodlands, and fens, in addition to a multi-thread channel network that supported a range of niche hydraulic habitats.

3.5.38 Further information of the quantity and dynamics of flow is provided in **Appendix 12.4: River Wensum Geomorphology Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document reference: 3.12.04).

River Continuity

3.5.39 Longitudinal connectivity throughout the survey reach is generally unimpeded with no significant in-channel structures noted (other than the small piers of the existing footbridge at TG 13872 15575). Lateral connectivity, however, is limited by the channel and floodplain modifications that have resulted in a single-thread channel and disconnected floodplain. Consequently, the channel is also slightly over-deep, which results in further disconnect from its floodplain and riparian zone.

River Width and Depth Variation

3.5.40 Width and depth variation within the study reach is fairly limited with a relatively uniform width, depth and flow structure noted throughout, though submerged and emergent aquatic macrophytes provide some localised variation within the channel. However, more width and depth variation occurs during lower flow conditions (e.g., during summer), when perennial vegetation is fully grown and variances in bed topography generate a more complex arrangement of flow patterns. In addition, occasional inset sediment berms that support a varied mix of vegetation and create additional niche habitat, were noted throughout the reach. These serve to break-up the general heterogeneity of the reach and provide localised variance in both width and depth.

Structure and Substrate of the river bed

3.5.41 The structure and substrate of the river bed within the Study Area was observed to be of a mixture of predominantly sand and gravels in the upstream reaches and finer materials downstream comprising silt and sand with occasional gravels.

3.5.42 Further information of the sediment is provided in **Appendix 12.4: River Wensum Geomorphology Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.04).

Structure of Riparian Zone

3.5.43 The structure of the riparian zone is varied throughout the study reach but is generally fragmented with long sections of poor-quality riparian habitat. There are, however, sections of good quality riparian habitat, which are enhanced by natural, low-lying sediment berms and a mix of riparian and emergent vegetation. Similarly, occasional deciduous trees, such as willow and alder, provide channel shading and a source of woody material that locally enhances in-channel and riparian habitat. Figure 3.1 shows the structure of riparian zone in the upstream and downstream reaches of the River Wensum.

Figure 3.1 Structure of riparian zone in the upstream (a) and downstream (b) reaches of the River Wensum

(a)

(b)

River Wensum DS Norwich

3.5.44 The River Wensum DS Norwich (GB105034055882) lies within the Anglian River Basin District (RBD); the Broadland Rivers Management Catchment, and the Wensum Operational Catchment. This water body is included within the assessment due to the sensitivity of the river to potential pollution incidents arising due to both construction and operation of the Proposed Scheme.

3.5.45 The water body is designated as Heavily Modified and is currently achieving Moderate status, comprising Moderate Ecological Status and Fail Chemical Status. The hydromorphological status Supports Good and hydrological regime currently Does Not Support Good. The reasons for not achieving Good status are urbanisation - urban development, poor nutrient management, poor livestock management, sewage discharge, and groundwater abstraction. The water body status objective is to achieve Good by 2027.

3.5.46 A summary of the WFD classification is provided in **Sub Appendix E: WFD Classification Data** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03e) of the Environmental Statement **Chapter 12: Road Drainage and the Water Environment**.

Biological Quality Elements

Fish

3.5.47 The Wensum DS Norwich WFD water body (GB105034055882) was classified as High for fish according to the 2019 WFD classification (**Ref 2.9**).

3.5.48 Fish population data is available from the Environment Agency Ecology and Fish Data Explorer, at an Environment Agency monitoring location on the River Wensum, located at TG19914 09798 (**Ref 2.15**). The most recent data is from an Environment Agency catch depletion electric fishing survey conducted on 03 July 2019 and is summarised in **Table 3.7**.

Table 3.7 Environment Agency fish survey data from the River Wensum (TG 19914 09798) collected on 3 September 2019

Species Name	Latin Name	No. of individuals
Roach	*Rutilus rutilus*	75
Chub	*Squalius cephalus*	25
Dace	*Leuciscus leuciscus*	20
Minnow	*Phoxinus phoxinus*	15
Pike	*Esox lucius*	5
Perch	*Perca fluviatilis*	3
Gudgeon	*Gobio gobio*	2
Bullhead	*Cottus gobio*	2
European eel	*Anguilla anguilla*	2
Brown / sea trout	*Salmo trutta*	1
Stone loach	*Barbatula barbatula*	1
Total	N/A	151

3.5.49 Two species of conservation interest were recorded in the Environment Agency survey. Brown/sea trout *Salmo trutta* and European eel are listed as SPIs under Section 41 of the NERC Act 2006. European eel are afforded further protection under The Eels (England and Wales) Regulations 2009 and is also listed on the IUCN Red List of Threatened Species as being critically endangered.

Aquatic Macroinvertebrates

3.5.50 The Wensum DS Norwich WFD water body (GB105034055882) was classified as High for aquatic macroinvertebrates according to the 2019 WFD classification (**Ref 2.9**).

3.5.51 Aquatic macroinvertebrate data is available from the Environment Agency Ecology and Fish Data Explorer, at an Environment Agency monitoring location on the River Wensum, located at TG 22610 09090 (**Ref 2.15**). The most recent data is from this monitoring location is from aquatic macroinvertebrate surveys conducted on 28 April 2014 and 28 October 2014.

3.5.52 No protected species were recorded in either sample. However, the INNS, the New Zealand mudsnail and the freshwater amphipod *Chelicorophium curvispinum* were recorded in both the spring and autumn samples.

Macrophytes

3.5.53 The Wensum DS Norwich WFD water body (GB105034055882) was classified as Good for the macrophytes and phytobenthos combined element according to the 2019 WFD classification (**Ref 2.9**).

3.5.54 Macrophyte data is available from the Environment Agency Ecology and Fish Data Explorer, at an Environment Agency monitoring site on the River Wensum, located at TG 22669 08960 (**Ref 2.15**). The most recent data is from this monitoring location is from a macrophyte survey conducted on 18 July 2016 and is presented in **Table 3.8**.

Table 3.8 Environment Agency macrophyte survey data from the River Wensum (TG 22669 08960) collected on 18 July 2016

Taxon	**Common Name**	**Taxon Cover Value**
Berula erecta	Lesser water parsnip	2
Callitriche sp.	Water starwort	2
Cladophora	Filamentous algae (reticulated)	2
Fontinalis antipyretica	Greater water-moss	2
Lemna sp.	Duckweed	2
Myriophyllum spicatum	Spiked water milfoil	2
Nuphar lutea	Yellow water lily	7
Oenanthe fluviatilis	River water-dropwort	2
Potamogeton perfoliatus	Clasping-leaved pondweed	2
Sagittaria sagittifolia	Arrowhead	7
Sparganium sp.	Bur-reed	5
Total number of taxa	**N/A**	**11**

3.5.55 No protected macrophyte species, nor any INNS were recorded in the Environment Agency survey.

Physico-chemical Quality Elements

Thermal Conditions

3.5.56 Water temperature in this water body was classified as High between 2013-2014 and Good between 2015-2019 with the objective for this item standing at Good by 2015 (**Ref 2.9**).

3.5.57 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, water temperature within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500), ranged from 4.4°C to 20.9°C.

Oxygenation Conditions

3.5.58 The water body was allocated a High-status objective for dissolved oxygen concentrations by 2015 (**Ref 2.9**). This was achieved in 2013, 2014, 2016 and 2019, with concentrations being classified as Moderate in 2015.

3.5.59 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, dissolved oxygen percentage saturation within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500), ranged from 74.0% to 103.2%.

Salinity

3.5.60 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that between 2015 and 2019 the monthly mean salinity recorded within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500) ranged from 0.36ppt to 0.40ppt.

Acidification Status

3.5.61 The pH objectives for the water body required Good status by 2015 (**Ref 2.9**). The water body surpassed this objective, achieving High status since 2013.

3.5.62 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, pH within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500), ranged from 7.79 to 8.29.

Nutrient Conditions

3.5.63 The water body achieved its 2015 objective for ammonia levels by recording High status since 2013 (**Ref 2.9**). The objective for phosphate stands at High status by 2021 (**Ref 2.9**). The available data suggests a positive progression towards this target with phosphate levels given Good status 2013-2015, raising to High status in 2016 and 2019.

3.5.64 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, the ammonia concentration within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500), ranged from <0.030mg/L to 0.051mg/L.

3.5.65 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, the phosphate concentration within the River Wensum at the Sweet Briar Road Bridge monitoring location (TG 20600 09500), ranged from 0.042mg/L to 0.130mg/L.

Hydromorphology Quality Elements

Quantity and Dynamics of Flow

3.5.66 The water body is noted to have a flow derived from the underlying groundwater table, direct surface runoff, and direct recharge to the river and drain network. The hydrological regime is that of a groundwater-fed river, with base flow indices of 0.7 at Costessey Mill (approximately 4.5 kilometres upstream of the confluence with the River Tud). Water level management of the river and drain network significantly affects the levels and flows within the floodplain.

3.5.67 As previously discussed in the River Wensum US Norwich section, the hydrological regime of the river downstream of Norwich is also slow to react to rainfall events due to its high baseflow index. Flow within the River Wensum is strongly governed by seasonal changes to groundwater levels.

3.5.68 Likewise, to the upstream water body, the River Wensum downstream of Norwich would naturally be a slow anastomosing system supporting a complex mosaic of habitats within a hydrologically connected floodplain. However, anthropogenic modification has resulted in significantly reduced or loss of natural river-floodplain interactions.

River Continuity

3.5.69 Longitudinal connectivity is fragmented throughout the water body by in-channel structures such as footbridges, which can affect the channel hydraulics during flood flows, and sluices and pumping stations, which impact hydraulics even during normal and low flow condition. The most significant in-channel structures along the water body are sluice gates (Hellesdon Weir, Mill Lane, TG 19885 10449), approximately 100 metres upstream of the confluence with the River Tud, and a pumping station (New Mills Yard road, TG 22613 09046) which causes the largest changes in river geometry.

3.5.70 Lateral connectivity, however, is limited by the channel and floodplain modifications that have resulted in a single-thread channel and disconnected floodplain, especially within the urban extents of Norwich (between TG 22517 09431 and TG 24562 07649). Consequently, the channel is also slightly over-deep, which results in further disconnect from its floodplain and riparian zone.

River Width and Depth Variation

3.5.71 Width and depth are relatively uniform further up- and downstream of the pumping station (New Mills Yard road, TG 22613 09046) and from the Hellesdon Weir (Mill Lane, TG 19885 10449), though submerged and emergent aquatic macrophytes provide some localised variation within the channel.

3.5.72 The main change in river width and depth along the water body occurs between the sections immediately down and upstream of both the pumping station and the Hellesdon Weir due to typical impounding effect.

3.5.73 Occasional inset sediment berms that support a varied mix of vegetation and create additional niche habitat, were noted throughout the reach. These serve to break-up the general homogeneity of the reach and provide localised variance in both width and depth.

Structure and Substrate of the River Bed

3.5.74 The structure and substrate of the river bed was observed to be of a mixture of predominantly sand and gravels in the upstream reaches and finer materials downstream comprising silt and sand with occasional gravels.

Structure of Riparian Zone

3.5.75 The structure of the riparian zone is varied throughout the study reach but is generally fragmented with long sections of poor-quality riparian habitat. These sections include the Hellesdon Weir, and many others along denser urban areas near Norwich, and around structures such as bridges (**Figure 3.2a**). There are, however, sections of good quality riparian habitat, which are enhanced by natural, low-lying sediment berms and a mix of riparian and emergent vegetation (**Figure 3.2b**). Similarly, occasional deciduous trees, such as willow and alder, provide channel shading and a source of woody material that locally enhances in-channel and riparian habitat.

Figure 3.2 Structure of riparian zone in (a) the upstream section (Mill Lane – Hellesdon Weir), and (b) downstream section with the confluence of the River Tud into the River Wensum DS Norwich

(a)

(b)

River Tud

3.5.76 The River Tud water body (GB105034051000) is designated as heavily modified and lies within the Anglian River Basin District, the Broadland Rivers management catchment, and the Wensum operational catchment. It is partially protected under the Habitats and Species Directive (Norfolk Valley Fens and River Wensum) and the Nitrates Directive (397, 398, and 400). The Proposed Scheme lies within the River Tud Nitrate Vulnerable Zone (NVZ) for surface water.

3.5.77 The River Tud water body is currently performing at Moderate Overall Water Body status; comprising Moderate Ecological Status and Fail Chemical Status. The reasons for not achieving Good status are poor nutrient management, transport drainage, poor livestock management, and sewage discharge. The water body status objective is to achieve Good by 2027.

3.5.78 The River Tud is a tributary of the River Wensum with the confluence approximately 7.3 kilometres downstream of the Study Area (TG 19710 10828). A summary of the WFD classification data is provided in **Sub Appendix E: WFD Classification Data** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03e).

Biological Quality Elements

Fish

3.5.79 In 2019, fish were classified as being of Good status in the River Tud (GB105034051000), consistent with the water body's 2019 objective for this quality element.

3.5.80 The desk study revealed that no fish population data is available for the proposed Foxburrow Stream crossing point. For the purposes of this assessment the nearest Environment Agency monitoring location situated on the River Tud at TG 09259 11951 has been reviewed. The most recent Environment Agency survey data reveals results from a catch depletion electric fishing survey carried out on 06 June 2019. The results of this survey are displayed in **Table 3.9**.

Table 3.9 Environment Agency fish survey data from the River Tud (TG 09259 11951) collected on 6 June 2019

Species Name	Latin Name	Count
Bullhead	*Cottus gobio*	39
Three-spined stickleback	*Gasterosteus aculeatus*	32
Brown / sea trout	*Salmo trutta*	22
Dace	*Leuciscus leuciscus*	5
Stone loach	*Barbatula barbatula*	5
Brook lamprey	*Lampetra planeri*	5
Total	**N/A**	**108**

3.5.81 Two species of conservation interest were recorded in the survey. Brown / sea trout *Salmo trutta* are listed as an SPI under Section 41 of the NERC Act 2006 (**Ref 3.9**).

3.5.82 Brook lamprey and bullhead are listed in Annex II of the European Commission Habitats Directive as species whose conservation requires the designation of Special Areas of Conservation (**Ref 3.4**). Brook lamprey are also protected under The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), transposed into UK national law through the Wildlife and Countryside Act 1981 (as amended) (**Ref 3.5**).

3.5.83 No fish were caught during the semi-quantitative one-run electric fishing survey of a 100 metre section of Foxburrow Stream during surveys carried out on 01 September 2022.

Aquatic Macroinvertebrates

3.5.84 Aquatic macroinvertebrates were classified as being of High status in the River Tud during the 2019 WFD classification (**Ref 2.9**), again, exceeding the water body's 2019 Good objective for this item.

3.5.85 The desk study revealed that no aquatic macroinvertebrate data is available for the proposed Foxburrow Stream crossing point. For the purposes of this assessment the nearest Environment Agency monitoring location situated on the River Tud at TG 16987 112671 has been reviewed. The most recent data from this monitoring location are from Environment Agency surveys carried out in May and November 2019.

3.5.86 No protected species were identified in either the May or November sample, however, the New Zealand mud snail was present in both samples. Furthermore, there were no species observed with a Conservation Score of 6 or higher in either sample. Conservation Scores for freshwater invertebrates in Great Britain range from 1 – Very Common to 10 – Endangered (with a score of 6 being regionally notable) (**Ref 3.6**).

3.5.87 During the aquatic macroinvertebrate surveys carried out in spring and autumn 2022, Foxburrow Stream displayed the lowest diversity of taxa. The spring sample was dominated by the freshwater amphipods *Gammarus pulex / fossarum* agg., and *Gammarus pulex*. The autumn sample from

Foxburrow Stream was also dominated by the freshwater amphipod *Gammarus pulex / fossarum* agg. No INNS nor any protected species were recorded in either sample. For full aquatic macroinvertebrate sampling results refer to **Appendix 10.12: Aquatic Survey Report 2022** of **Chapter 10: Biodiversity** of the Environmental Statement (Document reference: 3.10.12).

Macrophytes

3.5.88 The River Tud water body is not assessed for the macrophytes and phytobenthos combined element, however, the macrophytes sub element was classified as being of Moderate status during the 2019 WFD classification (**Ref 2.9**).

3.5.89 The desk study revealed that no aquatic macroinvertebrate data is available for the proposed Foxburrow Stream crossing point. For the purposes of this assessment the nearest Environment Agency monitoring location situated on the River Tud at TG 09750 11825 has been reviewed. The most recent data from this monitoring location are from an Environment Agency macrophyte survey carried out on 16 July 2015. The results of this survey are displayed in **Table 3.10**.

Table 3.10 Environment Agency macrophyte survey data from the River Tud (TG 09750 11825) collected on 16 July 2015

Taxon	Common Name	Taxon Cover Value
Agrostis stolonifera	Creeping bent	1
Apium nodiflorum	Fool’s water-cress	2
Callitriche sp.	Water starwort	3
Caltha palustris	Marsh marigold	2
Cladophora sp.	Filamentous algae (reticulated)	7
Epilobium hirsutum	Hairy willowherb	2
Equisetum telmateia	Great horsetail	1
Lemna sp.	Duckweed	2
Mentha aquatica	Water mint	2

Taxon	Common Name	Taxon Cover Value
Myosotois scorpidies	Water forget-me-not	2
Nuphar lutea	Yellow water-lily	4
Pellia sp.	Liverwort	1
Phalaris arundinacea	Reed canary grass	2
Phragmites australis	Common reed	2
Ranunculus (Batrachian) spp.	Water crow-foot	6
Ranunculus repens	Creeping buttercup	2
Rorippa microphylla	Narrow-fruited watercress	7
Scrophularia auriculata	Water figwort	2
Solanum dulcamara	Bittersweet	2
Sparganium sp.	Bur-reed	5
Valeriana officinalis	Valerian	1
Veronica beccabunga	Brooklime	2
Total number of taxa	N/A	22

3.5.90 One protected macrophyte species was recorded by the Environment Agency at this monitoring location within the River Tud. Valerian *Valeriana officinalis* is listed at Least Concern on the Vascular Plant Red List for Great Britain (**Ref 3.10**). No invasive non-native macrophyte species were recorded in the survey.

3.5.91 A total of eight macrophyte taxa were recorded in the macrophyte survey of Foxburrow Stream carried out on 15 August 2022. No protected macrophyte species, nor any INNS were recorded in the survey.

Physico-chemical Quality Elements

3.5.92 Due to an unfavourable balance of the costs and benefits, the River Tud had an objective of Moderate status for physico-chemical quality by 2015 (**Ref 2.9**). Moderate status was achieved throughout 2013 to 2016.

Thermal Conditions

3.5.93 The 2015 objective set for the River Tud was for Good status (**Ref 2.9**). High status was achieved between 2013-2015 and Good status achieved in 2016.

3.5.94 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, water temperature within the River Tud at the Costessey Park Bridge monitoring location (TG 17000 11200), ranged from 3.7°C to 21.2°C.

Oxygenation Conditions

3.5.95 The 2015 objective set for the River Tud was for Good status (**Ref 2.9**). High status was achieved between 2013-2015 and Good status achieved in 2016.

3.5.96 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between August and November 2022, the dissolved oxygen percentage saturation within the River Tud at the Costessey Park Bridge monitoring location (TG 17000 11200), ranged from 54.9% to 97.7%.

Salinity

3.5.97 No baseline data is available for salinity.

Acidification Status

3.5.98 The pH objectives for the River Tud required Good status by 2015 (**Ref 2.9)**. The River Tud achieved High status in 2015 and 2016 with pH not assessed in 2013 and 2014.

3.5.99 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between August and November 2022, pH within the River Tud at the Costessey Park Bridge monitoring location (TG 17000 11200), ranged from 7.60 to 8.23.

Nutrient Conditions

3.5.100 The River Tud was given a target of Good status for ammonia by 2015, achieving High status from 2013 to 2016 (**Ref 2.9**).

3.5.101 The River Tud had an objective of Moderate status for phosphate levels by 2015 (**Ref 2.9**); a level achieved throughout 2013 to 2016.

3.5.102 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, the ammonia concentration within the River Tud at the Costessey Park Bridge monitoring location (TG 17000 11200), ranged from <0.03mg/L to 0.14mg/L.

3.5.103 Data obtained from the Environment Agency Water Quality Archive (**Ref 2.16**) show that, between January and November 2022, the phosphate concentration within the River Tud at the Costessey Park Bridge monitoring location (TG 17000 11200), ranged from 0.11mg/L to 0.33mg/L.

Hydromorphology Quality Elements

Quantity and Dynamics of Flow

3.5.104 Flow increases from the headwater of the River Tud to its confluence with the River Wensum. Data from **Ref 2.5** indicate that it has a typical bankfull flow for medium catchment-sizes in the UK (3.1m^3/s). Low flows (Q95) vary from 0.05m^3/s in December to March to 0.2m^3/s in June to September, while moderate flows (Q50) range from 0.2m^3/s to 0.5m^3/s, respectively.

3.5.105 Within the Foxburrow Stream, smooth flow was observed with zones of no perceptible flow due to vegetation choking the channel (submerged linear and broad-leaved vegetation) (see **Figure 3.3**).

Figure 3.3 Average reach of the Foxburrow Stream showing (a) a cross-sectional view and (b) view looking upstream, both images captured at OS NGR TG 10524 13322

(a)

(b)

River Continuity

3.5.106 In the Foxburrow Stream, longitudinal connectivity is impeded by two in-channel structures. One of them is an existing culvert (at TG 10536 13315) and the other is a failed footbridge (TG 10820 13219)

3.5.107 In the River Tud, there is a weir located approximately 5.5 kilometres upstream of the confluence with the River Wensum (at TG 14470 11539). Lateral connectivity along its valley is limited by the channel and floodplain modifications that have resulted in a disconnected floodplain. Consequently, the channel is also slightly over-deep, which results in further disconnect from its riparian zone.

River Width and Depth Variation

3.5.108 Despite a natural increase in width and depth as catchment size increases, variation within the water body is fairly limited with a relatively uniform width, depth and flow structure noted throughout.

3.5.109 The Foxburrow Stream is an unconfined, straight to sinuous channel with an alluvial river bed and a moderate valley gradient of approximately 0.01m/m. The average bankfull channel width is approximately 1.3 metres and bankfull channel depth is approximately 0.9 metres. The bank faces have been obviously modified (resectioned) and were observed as being stable. Poaching of the banks by animals was also noted within the Study Area.

3.5.110 The River Tud is heavily modified with several straightened sections and resectioned banks from its upper to lower catchment. The bankfull channel width at the gauge station (34005 - Tud at Costessey Park) is 3.0m, and the bankfull channel depth is 1.6 metres.

Structure and Substrate of the River Bed

3.5.111 The structure and substrate of the Foxburrow Stream is a mixture of predominantly silt and sand, with occasional fine gravel. Channel substrate particle sizes observed within the Foxburrow Stream indicate the average bed size particle is sand (approximately 0.06mm to 2mm) whilst the coarsest particles range from fine to coarse gravel (2mm to 32mm).

3.5.112 The structure and substrate of the River Tud is also a mixture of silt, sand, and fine gravel, but with a much larger percentage of the latter.

Structure of Riparian Zone

3.5.113 Along the Foxburrow Stream, the structure of the riparian zone is varied but is generally fragmented with long sections of poor-quality riparian habitat. There are, however, sections of good quality riparian habitat, which are enhanced by natural, low-lying sediment berms and a mix of riparian and emergent vegetation.

3.5.114 In the River Tud, the structure of the riparian zone comprises arable and horticulture, grassland, small pockets of woodland, and urban areas. The proportion of woodland and grassland is higher in the lower catchment (near the Proposed Scheme) than in the upper and middle catchment areas.

3.6 Baseline Characteristics Against WFD Groundwater Quality Elements

Broadland Rivers Chalk & Crag Water Body

3.6.1 The baseline conditions of the WFD quality elements for the Broadland Rivers Chalk and Crag (GB40501G400300) groundwater body are described below based upon desk study and field survey observations. This water body lies within the Broadland Rivers Chalk and Crag Operational Catchment and the Anglian River Basin District.

3.6.2 The Broadland Rivers Chalk & Crag groundwater body is currently achieving Poor overall status, comprising Poor Quantitative and Chemical Status elements. The reasons for not achieving Good status are groundwater abstraction, trend assessment and chemical drinking water protected area. The Environment Agency has an objective to improve the Overall WFD status of the groundwater body to Good, which has been considered in the road drainage design. The water body status objective is to achieve Good status by 2027.

3.6.3 Overlaying the WFD groundwater body, are several smaller superficial designated aquifers. The majority of the proposed alignment is covered by superficial deposits classed as Secondary A and Secondary B Aquifers. The designated aquifers are classed as having Medium-High to High groundwater vulnerability across the entire Proposed Scheme alignment.

3.6.4 A summary of the WFD classification is provided in **Sub Appendix E: WFD Classification Data** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03e).

3.6.5 The Proposed Scheme alignment site is situated within a designated agricultural greenfield land area with agricultural activities currently dominating land use. These activities are in part responsible for the designation of the site as being in a Nitrate Vulnerable Zone. One well abstraction licence is located within the Proposed Scheme Red Line Boundary, where the licenced abstraction is approximately $27m^3$ per day and is used for agricultural purposes.

3.6.6 Existing sources of agricultural contaminants such as nitrates enter the groundwater body via rainfall infiltration into the ground. The nitrates percolate down to the groundwater table within the superficial aquifers and ultimately acting as recharge for the regional Chalk aquifer.

3.6.7 The heterogeneous superficial geology contains several permeable and low permeability units throughout and comprises Head Deposits, Alluvium, RTD, SCF and the Lowestoft Formation. These deposits designated by the

Environment Agency as 'Secondary A Aquifers' which are described as being capable of receiving, storing, and transmitting water. Groundwater flow within these superficial aquifers will be predominantly via the more permeable units (porous flow). These superficial aquifers could behave as leaky aquifers with groundwater laterally and vertically hydraulically connected where permeable layers are present. Vertical groundwater flow is recharging deeper aquifers unless local low permeability layers are present restricting flows.

3.6.8 The underlying bedrock geology consists of undifferentiated Chalk of the White Chalk Subgroup and is classified as a Principal Aquifer by the Environment Agency. Predominant flow mechanism through the Chalk is via interconnected fissures and fractures. Flow velocities through the Chalk can be significantly faster than through the superficial deposits.

3.6.9 The BGS Hydrogeological Map Sheet 4 (Northern East Anglia Sheet 1) identifies a groundwater flow catchment divide in the Chalk aquifer, with the apex located approximately at the centre of the Proposed Scheme, with an approximate water table elevation of 33.00mAOD at the centre and Chalk groundwater levels reduce to approximately 10.00mAOD at the River Wensum and 30.00mAOD at the River Tud.

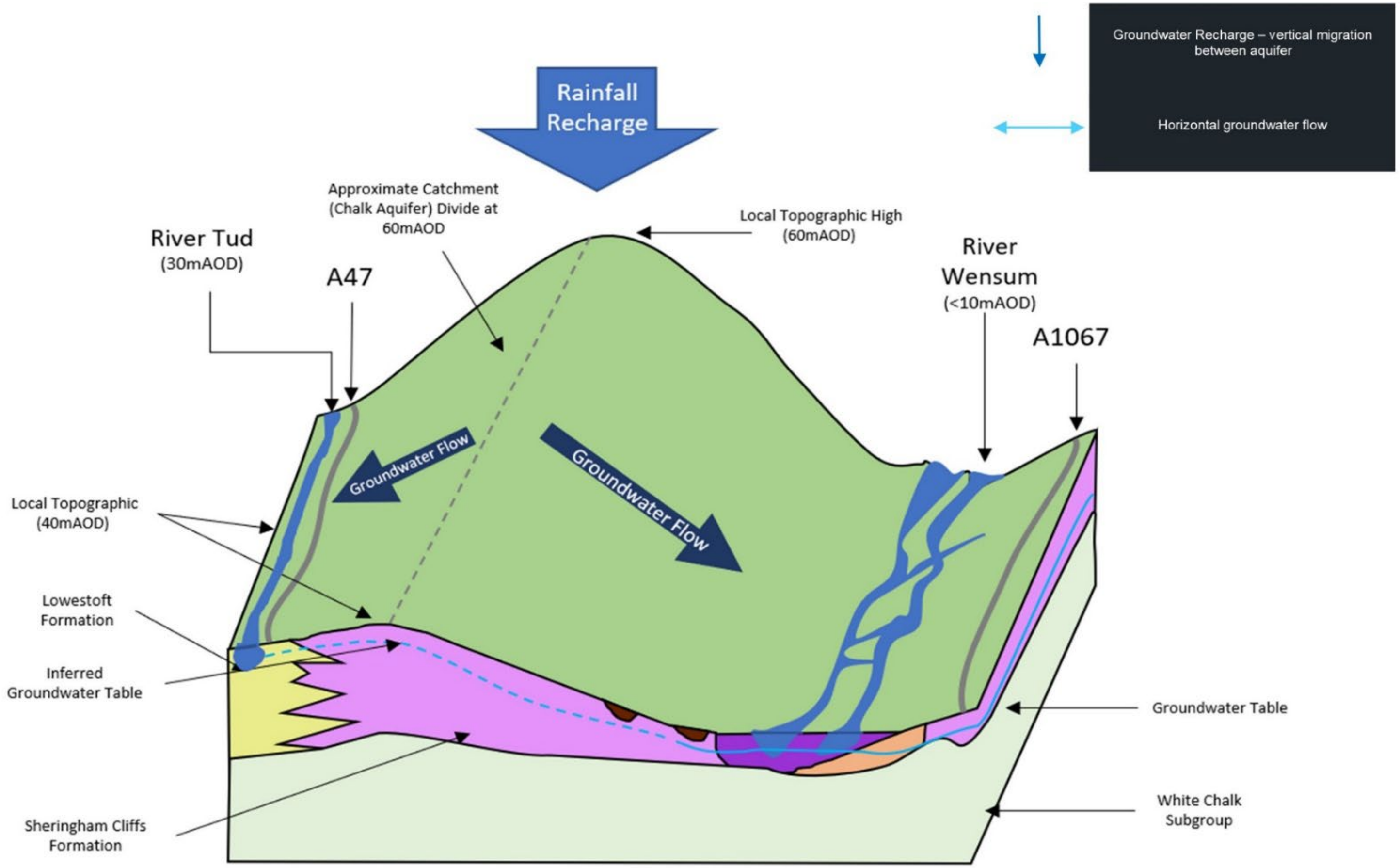
3.6.10 Groundwater flow through the Chalk aquifer is likely to contribute to base flows into the River Wensum and River Tud. These environments together with groundwater abstraction act as key groundwater receptors.

3.6.11 Large scale groundwater abstractions, (which have designated Source Protection Zones (SPZ) may alter groundwater elevations and groundwater flow directions within the Chalk aquifer, presumably contributing to the Poor Quantitative Status. Small-scale private abstractions are also using the aquifer as a water source.

3.6.12 The interaction between rainfall recharge, horizontal groundwater flows and surface water bodies is illustrated in the schematic conceptual model in **Figure 3.4**.

3.6.13 The interaction between rainfall recharge, horizontal groundwater flows and surface water bodies is illustrated in the schematic concetual model in **Figure 3.4**.

Figure 3.4 Hydrogeological conceptual model



4 WFD Screening and Scoping

4.1 Stage 1: WFD Screening

4.1.1 The purpose of the WFD screening stage is to identify the extent to which the Proposed Scheme may affect WFD water bodies that lie within the zone of influence.

Screening of Water bodies

4.1.2 As discussed in Section 3, the WFD surface water bodies screened in for assessment are River Wensum US (GB105034055881), Wensum DS Norwich (GB105034055882) and the River Tud (GB105034051000).

4.1.3 The groundwater body carried forward into the screening assessment is the Broadland Rivers Chalk & Crag (GB40501G400300) groundwater body.

4.1.4 All ordinary watercourses with hydraulic connection to the main rivers are also screened in for assessment.

Screening of Activities

4.1.5 Each activity associated with the construction and operation of the Proposed Scheme is considered in terms of the potential impacts to the water environment that may arise. Potential impacts arising due to the activities are then screened in or out for further assessment. The screening of activities outcome is presented in **Table 4.1** to **Table 4.6**.

4.1.6 The screening outcome for the Wensum US Norwich and Wensum DS Norwich are identical and therefore presented in combination to avoid duplication.

Wensum US Norwich and Wensum DS Norwich

Construction

Table 4.1 Screening of construction activities on the Wensum US Norwich and Wensum DS Norwich WFD water bodies

Activity	Description	Screening Outcome	Key Potential Impacts
Road construction	Construction of a new road, which includes the proposed River Wensum Viaduct , associated embankment and piers within the floodplain, temporary works platform and a haul route across the floodplain of the River Wensum.	In	Fine sediment and pollution risk Alteration to flows and / or habitats Noise and vibration Spread of INNS
Temporary works crossing	A temporary crossing of the River Wensum for access purposes is required during the construction phase. A Bailey bridge would be used for the temporary crossing.	In	Fine sediment and pollution risk Shading Alteration to flows and / or habitats
Culvert	Construction of a culvert and associated channel realignment would be required on a minor watercourse (WC5) within the floodplain of the River Wensum for the haul road. Plus temporary relief culverts for relieving flood flows.	In	Fine sediment and pollution risk Shading Alteration to flows and / or habitats
Piling	Piling and associated cuttings, noise, and vibration.	In	Fine sediment and pollution risk Alteration to flows and / or habitats Noise and vibration
Site compounds	Site compounds for lay down and storage areas, including site offices, parking, and associated facilities.	In	Fine sediment and pollution risk
Outfalls and attenuation / infiltration ponds	Construction of seven attenuation / infiltration ponds in conjunction with outfalls (discharging into two watercourses - WC5 and Ditch D) along the corridor within the River Wensum water body catchment.	In	Fine sediment and pollution risk Alteration to flows and / or habitats

Operation

Table 4.2 Screening of operational activities on the Wensum US Norwich and Wensum DS Norwich WFD water bodies

Activity	Description	Screening Outcome	Key Potential Impacts
New road	New road and associated impermeable area.	In	Road runoff and pollution risk Change in groundwater recharge
River Wensum Viaduct	New River Wensum Viaduct including piled foundation and engineered fill for temporary works platform and below ground Bailey bridge piles left in place.	In	Road runoff and pollution risk Shading Alteration to flows and / or habitats
Permanent access maintenance track	Maintenance access tracks for the River Wensum Viaduct will require one culvert crossings on WC5 within the floodplain of the River Wensum.	In	Shading Alteration to flows and / or habitats
Outfalls and attenuation / infiltration ponds	Operation of seven attenuation / infiltration ponds to store road runoff in conjunction with outfalls discharging into two watercourses (WC5 and Ditch D) adjacent to the River Wensum.	In	Road runoff and pollution risk Alteration to flows and / or habitats

River Tud (Foxburrow Stream)

Construction

Table 4.3 Screening of construction activities on the River Tud WFD water body

Activity	Description	Screening Outcome	Key Potential Impacts
Road construction	Construction of a new road and related pollution impacts (sedimentation, turbidity, plant oil / fuel / hydraulic fluid leaks).	In	Fine sediment and pollution risk Alteration to flows and / or habitats Noise and vibration Spread of INNS
Culvert	Construction of a new Tud tributary culvert / Bat underpass on the Foxburrow Stream and associated channel realignment.	In	Fine sediment and pollution risk Alteration to flows and / or habitats
Outfalls and attenuation / infiltration ponds	Construction of new outfalls and an attenuation pond adjacent to the Foxburrow Stream. Construction of an attenuation / infiltration pond to be connected to the exiting drainage of the National Highways A47 DCO road scheme.	In	Fine sediment and pollution risk Alteration to flows and / or habitats
Cuttings	Cuttings and associated land take, piling, noise and vibration and runoff control.	In	Fine sediment and pollution risk Alteration to flows and / or habitats Noise and vibration

Operation

Table 4.4 Screening of operational activities on the River Tud WFD water body

Activity	Description	Screening Outcome	Key Potential Impacts
New road	A new road would cross the Foxburrow Stream.	In	Road runoff and pollution risk
Culvert	A new Tud tributary culvert / Bat underpass on the Foxburrow Stream and associated channel realignment.	In	Shading Alteration to flows and / or habitats
Outfalls and attenuation / infiltration ponds	Operation of new outfalls and an attenuation pond adjacent to the Foxburrow Stream. Operation of an attenuation / infiltration pond to be connected to the exiting drainage of the National Highways A47 DCO road scheme.	In	Road runoff and pollution risk Alteration to flows and / or habitats

Broadland Rivers Chalk & Crag

Construction

Table 4.5 Screening of construction activities on the Broadland rivers Chalk and Crag water body

Activity	Description	Screening Outcome	Key Potential Impacts
Road construction (earthworks)	Construction of a new road (including temporary works platform for the River Wensum Viaduct) and related pollution impacts and disturbance of ground (sedimentation, turbidity, plant oil / fuel / hydraulic fluid leaks).	Out	**Fine sediment and pollution risk** Such potential impacts would only affect shallow groundwater bodies with a substantial filter and natural attenuation effect of the superficial deposits prior to reaching the chalk aquifer. Standard pollution prevention measures would be implemented as part of the OCEMP minimising pollution risks during construction. Therefore, no impacts are anticipated at the water body scale and no detailed impact assessment is required. **Groundwater levels and flows** Only very localised and shallow groundwater level and flow changes are expected as a result of the construction activities. Groundwater flow changes in the Wensum floodplain due to localised replacement of peaty loam with granular engineered fill has only localised impacts due to already natural occurrence of granular materials within this area. Temporary deep sheet pile walls to support the temporary works platform affect local groundwater flow conditions but with implemented temporary drainage no significant groundwater level changes are expected. The wall systems would be removed following construction of the Wensum Viaduct. Therefore, no impacts are anticipated at the water body scale and no detailed impact assessment is required.
Dewatering	Temporary dewatering required as part of the enabling works and construction activities.	Out	**Groundwater levels and flows** Dewatering may be required at certain locations during construction (e.g. for the temporary works platform for the construction of the River Wensum Viaduct), but these would be temporary works complying with standard permitting requirements with a negligible effect on overall water quantity within the groundwater body. Construction dewatering within the Wensum floodplain would have only a very local and temporary effect on shallow groundwater and not the SAC and river flow. Therefore, no impacts are anticipated at the groundwater or surface water WFD water body scale and no detailed impact assessment is required.

Activity	Description	Screening Outcome	Key Potential Impacts
Piling	Piling (proposed River Wensum Viaduct piles), creating pollution risks	Out	**Pollution risk** There is the potential for creating a pathway / conduit for groundwater contaminants to the Principal Aquifer and disturbance of bedrock during piling. These would be short-term potential impacts arising from construction activities, which are unlikely to affect the main water body. Piling is expected to be required in valley locations which should be characterised by an upwards groundwater flow from the underlying bedrock aquifer (hence risks of major groundwater pollution in the Chalk is low). Therefore, no impacts are anticipated at the water body scale and no detailed impact assessment is required for the water quality element.
Piling	Piling (proposed River Wensum Viaduct piles), creating additional groundwater flow pathways	In	Groundwater levels and flow changes

4.1.7 Therefore, groundwater levels and flows for potential piling impacts during construction is screened in for further assessment. All other potential impacts are not assessed further and would be managed through the OCEMP.

Operation

Table 4.6 Screening of operational activities on the Broadland Rivers Chalk and Crag water body

Activity	Description	Screening Outcome	Key Potential Impacts
New road	New road and associated impermeable area.	In	Groundwater levels and flow changes
Road drainage	Infiltration basins are designed to discharge road runoff to ground with the risk of pollution.	In	Risk of pollution of groundwater
Sub-surface structures	River Wensum bridge foundations.	In	Groundwater level and flow changes
Sub-surface structures	Engineered fill for River Wensum Viaduct temporary works platform left in place	Out	Only localised changes to local groundwater flow conditions within an environment of already naturally occurring high water table and high connectivity between shallow groundwater and surface water.
Road cuttings	Road cuttings may intercept the groundwater table leading to groundwater discharges.	Out	No road cuttings which cut into the chalk aquifer are part of the design. Locally shallow groundwater may be intercepted, e.g. under high groundwater table conditions but that would only affect shallow aquifers and not reduce the overall water availability. No further assessments required.

4.1.8 Those activities screened in for further assessment in **Tables 4.1** to **Table 4.6** are carried forward to Stage 2: scoping.

4.2 Stage 2: WFD Scoping

4.2.1 The WFD scoping stage identifies the potential risk to WFD receptors arising due to the key potential impacts from those activities screened in in Section 4.1 above. The scoping outcomes against WFD quality elements for the construction and operation for the screened in water bodies are provided below.

Wensum US Norwich

Construction

4.2.2 The scoping outcomes for the Wensum US Norwich WFD quality elements that may be affected by the potential impacts arising from the construction phase activities screened in above are provided in **Table 4.7**.

Table 4.1 Scoping outcomes for potential construction impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the Wensum US Norwich WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Shading	Alteration to Flow and / or Habitats	Noise and Vibration	Spread of INNS
Fish	Yes	Yes	Yes	Yes	Yes
Invertebrates	Yes	Yes	Yes	Yes	Yes
Macrophytes and Phytobenthos Combined	Yes	Yes	Yes	No	Yes

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Shading	Alteration to Flow and / or Habitats	Noise and Vibration	Spread of INNS
Thermal Conditions	Yes	Yes	Yes	No	No
Oxygenation Conditions	Yes	Yes	Yes	No	No
Salinity	No	No	No	No	No
Acidification Status	Yes	Yes	Yes	No	No
Nutrient Conditions	Yes	Yes	Yes	No	No
Quantity and Dynamics of Water Flow	Yes	Yes	Yes	No	No
Connection to Groundwater Bodies	Yes	No	No	No	No
River Continuity	Yes	Yes	Yes	No	No
River Depth and Width Variation	Yes	Yes	Yes	No	Yes
Structure and Substrate of the River Bed	Yes	Yes	Yes	No	Yes
Structure of the Riparian Zone	Yes	Yes	Yes	No	Yes

4.2.3 The majority of WFD quality elements are not sensitive to noise and vibration and are therefore scoped out of further assessment, except for fish and invertebrates.

4.2.4 During the construction phase, salinity is not sensitive to the potential construction impacts and is therefore scoped out of further assessment.

4.2.5 The risk of spreading INNS is not anticipated to affect physico-chemical quality elements, quantity and dynamics of flow, connection to groundwater or river continuity. Therefore, these quality elements are scoped out of further assessment.

4.2.6 Those quality elements where no risk to the receptor is identified are scoped out of further assessment. Where there is a potential risk to the receptor, those quality elements and potential impacts are carried forward to the impact assessment stage.

Operation

4.2.7 The scoping outcomes for the Wensum US Norwich WFD quality elements that may be affected by the potential impacts arising from the operation phase activities screened in above are provided in **Table 4.8**.

Table 4.1 Scoping outcomes for potential operation impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the Wensum US Norwich WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Road Runoff and Pollution Risk	Shading	Alteration to Flow and / or Habitats
Fish	Yes	Yes	Yes
Invertebrates	Yes	Yes	Yes
Macrophytes and Phytobenthos Combined	Yes	Yes	Yes
Thermal Conditions	Yes	Yes	Yes
Oxygenation Conditions	Yes	No	Yes*
Salinity	Yes	No	Yes

WFD Surface Water Quality Element	Road Runoff and Pollution Risk	Shading	Alteration to Flow and / or Habitats
Acidification Status	Yes	No	Yes
Nutrient Conditions	Yes	No	Yes
Quantity and Dynamics of Water Flow	Yes	Yes	Yes
Connection to Groundwater Bodies	Yes	No	Yes
River Continuity	No	Yes	Yes**
River Depth and Width Variation	Yes	Yes	Yes
Structure and Substrate of the River Bed	Yes	Yes	Yes
Structure of the Riparian Zone	No	Yes	Yes

*risk to alteration to habitats only
**risk to alteration to flows only

4.2.8 During operation, alteration to flows is limited to out-of-bank events and therefore, no impact is anticipated to oxygenation conditions at the water body scale.

4.2.9 During operation, shading effects are not anticipated to impact upon oxygenation conditions, salinity, acidification status, or nutrient conditions given that the impacts would be highly localised and upon flowing water too.

4.2.10 During operation, road runoff and pollution risk would not impact upon river continuity or the structure of the riparian zone. Road runoff and pollution risk impacts would not interfere with connectivity along the river corridor, floodplain interactions or cause an alteration to riparian habitats.

4.2.11 During operation, the piling for the Bailey bridge being left in situ is not considered to have an impact to WFD quality elements at the water body scale due to the piles being set-back by approximately 3m from the bank top and cut off and capped below ground, with ground reinstated.

4.2.12 Those quality elements where no risk to the receptor is identified are scoped out of further assessment. Where there is a potential risk to the receptor, those quality elements and potential impacts are carried forward to the impact assessment stage.

Wensum DS Norwich

Construction

4.2.13 The scoping outcomes for the Wensum DS Norwich WFD quality elements that may be affected by the potential impacts arising from the construction phase activities screened in above are provided in **Table 4.9**.

Table 4.9 Scoping outcomes for potential construction impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the Wensum DS Norwich WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Shading	Alteration to Flow / or Habitats	Noise and Vibration	Spread of INNS
Fish	Yes	No	No	No	Yes
Invertebrates	Yes	No	No	No	Yes
Macrophytes and Phytobenthos Combined	Yes	No	No	No	Yes
Thermal Conditions	No	No	No	No	No
Oxygenation Conditions	Yes	No	No	No	No
Salinity	No	No	No	No	No
Acidification Status	No	No	No	No	No
Nutrient Conditions	No	No	No	No	No
Quantity and Dynamics of Water Flow	Yes	No	No	No	No
Connection to Groundwater Bodies	No	No	No	No	No

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Shading	Alteration to Flow / or Habitats	Noise and Vibration	Spread of INNS
River Continuity	Yes	No	No	No	No
River Depth and Width Variation	Yes	No	No	No	Yes
Structure and Substrate of the River Bed	Yes	No	No	No	Yes
Structure of the Riparian Zone	No	No	No	No	Yes

4.2.14 During the construction phase, the key potential impact to the Wensum DS Norwich water body is the risk of fine sediment and pollution arising due to the construction activities. Fine sediment and pollution entering the watercourses during construction could be transported rapidly to the downstream water body and therefore, this potential impact is scoped in for impact assessment.

4.2.15 Physico-chemical quality elements, except for oxygenation, are scoped out due to dilution and the distance to the downstream water body.

4.2.16 The risk of spreading INNS is not anticipated to affect physico-chemical quality elements, quantity and dynamics of flow, connection to groundwater or river continuity. Therefore, these quality elements are not assessed further.

4.2.17 Connection to groundwater is scoped out due to insignificant pathways. All other potential impacts are likely to be highly localised to the construction zone and contained within the directly impacted water body. Therefore, all other potential impacts are scoped out of further assessment for the Wensum DS Norwich water body.

Operation

4.2.18 The scoping outcomes for the Wensum DS Norwich WFD quality elements that may be affected by the potential impacts arising from the operation phase activities screened in above are provided in **Table 4.10**.

Table 4.10 Scoping outcomes for potential operation impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the Wensum DS Norwich WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Road Runoff and Pollution Risk	Shading	Alteration to Flow and / or Habitats
Fish	Yes	No	No
Invertebrates	Yes	No	No
Macrophytes and Phytobenthos Combined	Yes	No	No
Thermal Conditions	No	No	No
Oxygenation Conditions	No	No	No
Salinity	No	No	No
Acidification Status	No	No	No
Nutrient Conditions	No	No	No
Quantity and Dynamics of Water Flow	No	No	No
Connection to Groundwater Bodies	No	No	No
River Continuity	No	No	No
River Depth and Width Variation	No	No	No
Structure and Substrate of the River Bed	No	No	No
Structure of the Riparian Zone	No	No	No

4.2.19 During operation, potential impacts arising from the Proposed Scheme are anticipated to be localised and not extend to the downstream WFD water body, which is approximately 7.3 kilometres downstream.

4.2.20 During operation, there would be a residual risk of road runoff and pollution incidents, which, if they enter the watercourse, could be transported to the downstream water body. These risks would be managed through a road drainage strategy and treatment trains to trap sediments and pollutants. Potential impacts of road runoff and pollution upon the biological quality elements have been scoped in for impact assessment.

4.2.21 All other quality elements for the Wensum DS Norwich water body have been scoped out of further assessment.

River Tud

Construction

4.2.22 The scoping outcomes for the River Tud water body WFD quality elements that may be affected by the potential impacts arising from the construction phase activities screened in above are provided in **Table 4.11**.

Table 4.11 Scoping outcomes for potential construction impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the River Tud WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Alteration to Flow and / or Habitats	Noise and Vibration	Spread of INNS
Fish	Yes	Yes	Yes	Yes
Invertebrates	Yes	Yes	Yes	Yes
Macrophytes and Phytobenthos Combined	Yes	Yes	No	Yes
Thermal Conditions	Yes	Yes	No	No

WFD Surface Water Quality Element	Fine Sediment and Pollution Risk	Alteration to Flow and / or Habitats	Noise and Vibration	Spread of INNS
Oxygenation Conditions	Yes	Yes	No	No
Salinity	No	No	No	No
Acidification Status	Yes	Yes	No	No
Nutrient Conditions	Yes	Yes	No	No
Quantity and Dynamics of Water Flow	Yes	Yes	No	No
Connection to Groundwater Bodies	No	No	No	No
River Continuity	Yes	Yes	No	No
River Depth and Width Variation	Yes	Yes	No	Yes
Structure and Substrate of the River Bed	Yes	Yes	No	Yes
Structure of the Riparian Zone	No	No	No	Yes

4.2.23 During the construction phase, potential impacts arising due to noise and vibration are only anticipated for fish and macroinvertebrates. Whilst no fish were found to be present within the Foxburrow Stream Study Area, potential impacts of noise and vibration to fish are included as a precaution. Noise and vibration impacts are scoped out of further assessment for all other quality elements.

4.2.24 The risk of spreading INNS is not anticipated to affect physico-chemical quality elements, quantity and dynamics of flow, connection to groundwater or river continuity. Therefore, these quality elements are not assessed further.

4.2.25 Connection to groundwater is scoped out due to insignificant pathways and the connectivity with the regional chalk aquifer is limited.

4.2.26 Fine sediment and pollution risk, and alteration to flows and / or habitats are the key potential impacts anticipated during the construction phase; therefore, they are scoped in for impact assessment for most of the WFD quality elements.

Operation

4.2.27 The scoping outcomes for the River Tud WFD quality elements that may be affected by the potential impacts arising from the operation phase activities screened in above are provided in **Table 4.12**.

Table 4.12 Scoping outcomes for potential operation impacts upon WFD biological, physico-chemical and hydromorphological quality elements for the River Tud WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Surface Water Quality Element	Road Runoff and Pollution Risk	Shading	Alteration to Flow and / or Habitats
Fish	Yes	Yes	Yes
Invertebrates	Yes	Yes	Yes
Macrophytes and Phytobenthos Combined	Yes	Yes	Yes
Thermal Conditions	Yes	Yes	Yes
Oxygenation Conditions	Yes	Yes	Yes

WFD Surface Water Quality Element	Road Runoff and Pollution Risk	Shading	Alteration to Flow and / or Habitats
Salinity	Yes	No	Yes
Acidification Status	Yes	No	Yes
Nutrient Conditions	Yes	No	Yes
Quantity and Dynamics of Water Flow	Yes	Yes	Yes
Connection to Groundwater Bodies	No	No	No
River Continuity	Yes	Yes	Yes
River Depth and Width Variation	Yes	Yes	Yes
Structure and Substrate of the River Bed	Yes	Yes	Yes
Structure of the Riparian Zone	No	Yes	Yes

4.2.28 During operation, potential impacts arising from the Proposed Scheme are anticipated for most quality elements and are therefore carried forward to the impact assessment stage.

4.2.29 The exception is for shading due to the proposed Tud tributary culvert / Bat underpass, which is unlikely to have an impact to most of the physico-chemical quality elements, apart from thermal and oxygenation conditions. In addition, connection to groundwater is unlikely to be impacted during operation at the water body scale. Therefore, these quality elements are scoped out of further assessment.

Broadland Rivers Chalk & Crag

Construction

4.2.30 Apart from River Wensum Viaduct related piling and its potential impacts on groundwater levels and flows (see **Table 4.13**), construction phase activities and associated potential impacts were screened out of further assessment. The **OCEMP** (Document Reference 3.03.01) would apply to manage all construction-phase potential impacts.

Table 4.13 Scoping outcomes for potential construction impacts upon WFD quality elements for the Broadland Rivers Chalk and Crag WFD water body showing whether a risk to receptor is anticipated (yes / no)

WFD Groundwater Quality Element	Groundwater level and flow changes
Quantitative status (current status: Poor; Objective Good by 2027)	N/A
Saline Intrusion	No
Water Balance	No
Groundwater Dependent Terrestrial Ecosystems (GWDTE) Test	No
Dependent Surface Water Body Status	No
Chemical status (current status: Poor; Objective: Good)	N/A
Drinking Water Protected Area	No
General Chemical Test	No
GWDTEs Test	No
Dependent Surface Water Body Status	No
Saline Intrusion	No
Trend Assessment – Upward trend	No
Protected Areas – Nitrates Directive – Drinking Water Protected Area	No

4.2.31 The piling required for the construction of the River Wensum Viaduct is carried out in an environment which is already characterised by a high hydraulic connectivity between surface water, shallow groundwater, and groundwater in the chalk aquifer. The piles therefore are unlikely to create additional pathways for vertical groundwater flow and groundwater barrier effects are also not expected due to the dimensions of the piles being relatively small allowing groundwater to easily flow around them. Detailed evaluations of the long-term impacts were assessed in **Appendix 12.5 - River Wensum Crossing – Groundwater Modelling Report** of **Chapter 12 – Road Drainage and the Water Environment** of the Environmental Statement (Document reference: 3.12.05).

4.2.32 Therefore, all quality elements for groundwater are scoped out of further assessment for construction phase impacts. Potential construction impacts would be managed through the **OCEMP** (Document Reference 3.03.01).

Operation

4.2.33 The scoping outcomes for the Broadland Rivers Chalk & Crag water body quality elements that may be affected by the potential impacts arising from the operation phase activities screened in above are provided in **Table 4.14**.

Table 4.14 Scoping outcomes for potential operation impacts upon WFD quality elements for the Broadland Rivers Chalk and Crag WFD water body showing whether a risk receptor is anticipated (yes / no)

WFD Groundwater Quality Element	Road Runoff and Pollution Risk	Groundwater Level and Flow Changes
Quantitative status (current status: Poor; Objective Good by 2027)	N/A	N/A
Saline Intrusion	No	No
Water Balance	No	Yes
Groundwater Dependent Terrestrial Ecosystems (GWDTE) Test	No	No

WFD Groundwater Quality Element	Road Runoff and Pollution Risk	Groundwater Level and Flow Changes
Dependent Surface Water Body Status	No	No
Chemical status (current status: Poor; Objective: Good)	N/A	N/A
Drinking Water Protected Area	No	No
General Chemical Test	Yes	No
GWDTEs Test	No	No
Dependent Surface Water Body Status	Yes	No
Saline Intrusion	Yes	No
Trend Assessment - Upward trend	No	No
Protected Areas - Nitrates Directive - Drinking Water Protected Area	No	No

4.2.34 During operation, most groundwater quality elements are not anticipated to be impacted by the Proposed Scheme and are therefore scoped out of further assessment.

4.2.35 The exception is for water balance for the quantitative status and general chemical test, saline intrusion, and dependant surface water body status for chemical status, which are carried forward to the WFD impact assessment stage. Assessments are driven by the new road with its below ground structures and drainage system potentially altering groundwater flows and levels and potentially forming pollution risks. Hydrogeological reviews suggest an important hydraulic linkage between the regional chalk aquifer, shallow groundwater, and the River Wensum in proximity of the river exists and requires consideration with regards to potential pollution from drainage discharges and groundwater levels and flow impacts from permanent below ground structures (River Wensum Viaduct piles). The saline intrusion risks are not related to true saline water intrusion but the potential effects of salt spraying (de-icing during winters) in particular for the River Wensum Viaduct which could increase groundwater and subsequently surface water salinity.

The risk of directly spraying salt beyond the viaduct is considered very low due to the environmental barrier. However, it is considered that there is a risk that salt may migrate indirectly towards the River Wensum via the road drainage system and subsequently the groundwater pathway.

4.2.36 Those activities and receptors screened and scoped in are now carried forward into the stage 3 WFD impact assessment stage.

5 WFD Impact assessment

5.1 Step 1: Potential generic operational impacts of the scheme on WFD quality elements

5.1.1 Potential pressures and impacts of the Proposed Scheme have been identified using UK Technical Advisory Group (UKTAG) Guidance (**Ref 5.1**) along with the standard toolkit of recommended mitigation measures set out in the UKTAG Guidance; these are presented in **Table 5.1**.

5.1.2 The UKTAG mitigation measures provides a suite of good practice recommendations to be considered in the design. Where practicable, these UKTAG standard WFD mitigation measures have been taken into account in the design and ongoing maintenance of the Proposed Scheme. In particular, these WFD mitigation measures provided in **Table 5.1** have been considered in the design of any off-setting and enhancements to ensure WFD compliance and BNG Rivers and Stream net gain.

Table 5.1 Pressures, potential impacts, and associated mitigation for works to the impacted watercourses and downstream water bodies (Source: Annex IV: Flood Risk Management, UKTAG, 2008) (Ref 5.1)

Pressure	Sub-pressures	Potential Impacts	Mitigation Measures
Channel alteration	Culverts	Loss of morphological diversity and habitat	Re-opening existing culverts and alteration of channel bed

Pressure	**Sub-pressures**	**Potential Impacts**	**Mitigation Measures**
Channel alteration	Culverts	Continuity	Re-opening existing culverts and alteration of channel bed
Channel alteration	River realignment	Loss of morphological diversity and habitat including increase in channel gradient, flow velocity and stream power	Retain marginal aquatic and riparian habitats and increase in-channel morphological diversity
Operations and maintenance	Vegetation control	Physical disturbance of bed and or bank - increased sediment input; sediment mobilisation and loss of marginal / riparian vegetation	Appropriate vegetation control regime e.g., a) minimise disturbance to channel bed and margins; b) selective vegetation management for example only cutting from one side of the channel; c) providing / reducing shade; and / or, d) seasonal maintenance
Operations and maintenance	Vegetation control	Transfer and establishment of invasive non-native species	Appropriate techniques to prevent transfer of invasive non-native species e.g., appropriate training of operational staff

Pressure	Sub-pressures	Potential Impacts	Mitigation Measures
Operations and maintenance	Pipes, inlets, outlets, and offtakes	Hydromorphological alterations of water and sediment inputs through artificial means	Appropriate techniques to align and attenuate flow to limit detrimental effects of these features

5.2 Step 2: Site Specific Assessment of the Proposed Scheme against WFD Quality Elements

5.2.1 The site-specific impacts of the Proposed Scheme on the WFD quality elements for both surface water and groundwater are presented below. An assessment of both potential construction and operational impacts are presented in turn for each WFD water body screened in for assessment. Only those activities and quality elements screened and scoped in are presented within the assessment tables.

5.2.2 Results from the following reports were used to inform the WFD assessment, these are:

- **Appendix 12.1: Drainage Network Water Quality Assessment (DNWQA)** of Environmental Statement **Chapter 12: Road Drainage and the Water Environment** (Document reference: 3.12.01) – referred to as the DNWQA assessment in the tables below;
- **Appendix 12.4 River Wensum Geomorphology Assessment** of Environmental Statement **Chapter 12: Road Drainage and the Water Environment** (Document reference: 3.12.04) – referred to as the Wensum geomorphology assessment below;
- **Appendix 10.37: Solar Exposure Analysis** of Environmental Statement **Chapter 10: Biodiversity** (Document Reference: 3.10.37) – referred to as the shading assessment below;

- **Appendix 12.5 River Wensum Crossing – Groundwater Modelling Report** of Environmental Statement **Chapter 12: Road Drainage and the Water Environment** (Document reference: 3.12.05) – referred to as River Wensum Groundwater Modelling Report below; and
- **Appendix 10.12 – Aquatic Survey Report 2022** of **Chapter 10 – Biodiversity** of the Environmental Statement (Document reference: 3.10.12).

5.2.3 In addition, the geomorphological dynamics assessment results for the Foxburrow Stream are provided in **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03c).

Construction

5.2.4 Potential construction impacts may have a detrimental impact upon WFD quality elements, and some construction activities may be long in duration. Mitigation measures would be in place during the construction phase and will form part of the proposed **OCEMP** for the Proposed Scheme (Document Reference: 3.03.01). The relevant OCEMP measures for mitigating potential construction impacts to WFD quality elements and WFD status are provided in **Sub Appendix F: WFD Mitigation** of **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03f). This appendix should be read in conjunction with the impact assessment tables below. The OCEMP measures detailed in **Sub Appendix F: WFD Mitigation** (Document Reference: 3.12.03f) have been allocated a construction mitigation reference, which is used in the tables below to avoid lengthy duplication of text.

Wensum US Norwich

5.2.5 An assessment of the potential construction impacts on those activities and quality elements screened and scoped in for the Wensum US Norwich water body are presented in **Table 5.2**.

Table 5.2 Potential construction impacts on the scoped in WFD biological, physico-chemical and hydromorphological quality elements on the Wensum US Norwich (G105034055881) water body

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Fine sediment and pollution risk** The potential release of fine sediment because of construction activities (through surface water run-off; and through chemicals, fuels, and construction materials via outfall construction) could impact upon fish and their habitat. This could lead to degradation of spawning habitat, food sources, and water quality. Fine sediment pollution could lead to direct fish mortality, with sediment affecting the gills of adult and juvenile fish, and the smothering of fish eggs. The construction activities could also alter surface water flow paths resulting in silt laden runoff and pollution risk. There is also a risk of pollution incidents due to the storage of chemicals, oils, and cements in the compounds and working areas. Fine sediment and pollutant ingress to the ditches or minor watercourses within the Wensum floodplain may also result in a pollution incident within the receiving watercourse with the potential for far-reaching downstream impacts to the River Wensum water body. During the construction of the cuttings, it is possible that some contaminated land may be disturbed and some of this material may be delivered to the River Wensum. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing fish fauna, including fish species listed as qualifying features of the River Wensum SAC.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Shading** The installation of the Bailey bridge on the River Wensum and culvert on WC5 would result in a reduction in sunlight hours, solar radiation, and illuminance. This would likely result in localised shading and temporary loss of macrophyte cover within the immediate vicinity of the Bailey bridge and under construction culvert. The temporary loss of macrophytes would result in a temporary loss of shelter, food items, and breeding habitat for fish within the immediate vicinity of the Bailey bridge and culvert. Where a permanent culvert is being constructed on WC5 of the Wensum floodplain for the maintenance access track, macrophyte losses are expected to be permanent within the culvert, which is approximately 18m in length. Degradation of habitat within the culvert would be mitigated through culvert design and enhancement measures, the details of which are covered within the operational impacts assessment in **Table 5.5.** The direct effects of shading created by the Bailey bridge and under-construction culvert on fish would likely be negligible due to their tolerance of shade and the ability of fish to change their individual spatial distribution (i.e., move in and out of shade freely). Shading impacts during the construction phase would be temporary in nature. However, with the embedded mitigation measures in place, the impacts from shading during construction are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on the composition, abundance, and age structure of fish fauna, including fish species listed as qualifying features of the River Wensum SAC.	**Shading** Shading - CM-RDWE-12.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Alteration to flow and / or habitats** The Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with temporary works platform and associated Bailey bridge, flood relief culverts, access roads, outfall construction and a box culvert) could influence local hydraulics during the construction phase within a zone of approximately 175m of the River Wensum. Impacts from these alterations would be limited to high magnitude events, with a low likelihood of occurrence during the construction period. In addition, due to the River Wensum being primarily groundwater fed, any dewatering activities could result in a change in the hydrological regime. The temporary culverting of approximately 100m of WC5 would result in the temporary loss of macrophytes and open water habitat, which could have indirect impacts upon fish communities (e.g., loss of shelter, degradation of habitats and habitat severance). However, alterations to aquatic habitat during construction within the River Wensum and its floodplain would be short-term and highly localised with mitigation measures in place. These measures include the removal of the Bailey bridge over the River Wensum, fish translocation on WC5 prior to temporary culverting works and return of WC5 to its previous condition post-construction. Following these measures, the impacts from alteration to flow and / or habitats are expected to be negligible with no long-term impact on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Alteration to flow and / or habitats** Floodplain storage – CM-RDWE-06; Landscape plan – CM-RDWE-08; Channel modifications – CM-RDWE-09; and Fish translocation - CM-RDWE-10.
Composition, Abundance and Age Structure of Fish Fauna	**Noise and vibration** There is the potential for construction activities such as movement of large machinery and pile driving to create noise and vibration which might lead to delay or disruption of normal fish behaviour and migration. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from noise and vibration are expected to be negligible with no long-term impact on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Noise and vibration** Noise management - CM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction of Himalayan balsam (*Impatiens glandulifera*) could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports fish at their various life stages. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible with no long-term impact on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Spread of INNS** INNS management - CM-RDWE-04.
Composition and Abundance of Benthic Invertebrate Fauna	**Fine sediment and pollution risk** The potential release of fine sediment and pollutants because of construction activities (through surface water run-off via outfall construction; and through chemicals, fuels, and construction materials) could impact upon benthic invertebrate fauna and their habitat. This could cause degradation of spawning habitat, food sources, and water quality. Fine sediment pollution could lead to direct benthic invertebrate fauna mortality. The construction activities could also alter surface water flow paths resulting in silt laden runoff and pollution risk. There is also a risk of pollution incidents due to the storage of chemicals, oils, and cements from the compounds and working areas. Fine sediment ingress to the ditches or minor watercourses within the Wensum floodplain may also result in a pollution incident within the receiving watercourse with the potential for far-reaching downstream impacts to the River Wensum water body. During the construction of the cuttings, it is possible that some contaminated land may be disturbed and some of this material may be delivered to the River Wensum. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible with no long-term impact on invertebrates at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Shading** The installation of the Bailey bridge on the River Wensum and culvert on WC5 of the Wensum floodplain would result in a reduction in sunlight hours, solar radiation, and illuminance. This would likely result in localised shading and temporary loss of the macrophyte community within the immediate vicinity of the Bailey bridge and under construction culvert. The temporary loss of macrophytes would result in a temporary loss of shelter, food items, and breeding habitat for benthic invertebrate fauna within the immediate vicinity of the Bailey bridge and culverts. Where a permanent culvert is being constructed on WC5 of the Wensum floodplain for the maintenance access track, macrophyte losses are expected to be permanent within the culvert, which is approximately 18m in length. Degradation of habitat within the culvert would be mitigated through culvert design and enhancement measures, the details of which are covered within the operational impacts assessment in **Table 5.5**. The direct effects of shading created by the Bailey bridge and under-construction culvert on benthic invertebrate fauna would likely be negligible due to their tolerance of shade and the ability to change their individual spatial distribution (i.e., move in and out of shade freely). The design of the Bailey bridge and the culverts would reduce the shading extents on river channels. With the embedded mitigation in place, the impacts from shading during construction on benthic invertebrate fauna are expected to be negligible with no long-term impact at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Alteration to flow and / or habitats** The Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with a temporary works platform and associated Bailey bridge, flood relief culverts, access roads, outfall construction and a box culvert) could influence local hydraulics during the construction phase within a zone of approximately 175m of the River Wensum. Impacts from these alterations would be limited to high magnitude events, with a low likelihood of occurrence during the construction period. In addition, due to the River Wensum being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime. The temporary culverting of approximately 100m of WC5 would result in a temporary loss of macrophytes and open water habitat, which would have indirect impacts upon benthic invertebrate communities (e.g., temporary loss of shelter and micro habitats). However, alterations to habitat during construction on the River Wensum and its floodplain would be short-term and highly localised with mitigation measures in place. These measures include the removal of the Bailey bridge (excluding below ground piling) over the River Wensum and the reinstatement of WC5. Following these measures, the impacts from alteration to flow and / or habitats are expected to be negligible with no long-term impact on benthic invertebrates at the WFD water body scale.	**Alteration to flow and / or habitats** Floodplain storage – CM-RDWE-06; Landscape plan – CM-RDWE-08; and Channel modifications – CM-RDWE-09.
Composition and Abundance of Benthic Invertebrate Fauna	**Noise and vibration** There is the potential for construction activities such as movement of large machinery and pile driving to create noise and vibration which might affect the benthic invertebrate community. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from noise and vibration are expected to be negligible at the WFD water body scale.	**Noise and vibration** Noise management - CM-RDWE-11.
Composition and Abundance of Benthic Invertebrate Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction or spread of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports benthic invertebrates at their various life stages. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible with no long-term impact at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Fine sediment and pollution risk** The potential release of fine sediment because of construction activities (through surface water run-off; and through chemicals, fuels, and construction materials via outfall construction) could impact upon the macrophyte community within the River Wensum and floodplain network. This could cause degradation of water quality and, by extension, degradation of the aquatic flora. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible with no long-term impact at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Composition and Abundance of Aquatic Flora	**Shading** The installation of the Bailey bridge on the River Wensum and culvert on WC5 of the Wensum floodplain would result in a reduction in sunlight hours, solar radiation, and illuminance. This would result in localised shading and therefore a temporary loss of the macrophyte community within the immediate vicinity of the Bailey bridge and under construction culvert. However, the design of the Bailey bridge and the culverts would reduce the shading extents on river channels, reducing the impact on the macrophyte community. Where a permanent culvert is being constructed on WC5 of the Wensum floodplain for the maintenance access track, macrophyte losses are expected to be permanent within the culvert, which is approximately 18m in length. Degradation of habitat and loss of aquatic flora within the culvert would be mitigated through culvert design and enhancement measures, the details of which are covered within the operational impacts assessment in **Table 5.5**. Following completion of the construction phase, the removal of temporary structures causing shading (such as the Bailey bridge) would lead to the recovery of the macrophyte community that was potentially lost. Furthermore, with the embedded mitigation measures in place, the impacts from shading during construction are expected to be negligible, with no long-term impact on the composition and abundance of aquatic flora at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Shading** Shading - CM-RDWE-12.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Alteration to flow and / or habitats** The Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with a temporary works platform and associated Bailey bridge, flood relief culverts, access roads, outfall construction and a box culvert) could influence local hydraulics during the construction phase within a zone of approximately 175m of the River Wensum. In addition, due to the River Wensum being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime. The temporary culverting of approximately 100m of WC5 would result in the temporary loss of macrophyte cover within the original channel. However, alterations to habitat within the floodplain ditch network and the River Wensum would be short-term and highly localised with mitigation measures in place. These measures include the removal of the Bailey bridge over the River Wensum and the reinstatement of WC5. It is expected that the macrophyte community within WC5 would recover naturally over time. Following these measures, the impacts from alteration to flow and / or habitats are expected to be negligible, with no long-term impact on the composition and abundance of aquatic flora at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Alteration to flow and / or habitats** Floodplain storage - CM-RDWE-06; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Composition and Abundance of Aquatic Flora	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. The spread and / or introduction of INNS may lead to a reduction in the aquatic flora community, with native species being outcompeted for resources by INNS. However, with the proposed combination of embedded mitigation and the OCEMP measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on the composition and abundance of aquatic flora at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Spread of INNS** INNS management - CM-RDWE-04.
Thermal Conditions	**Fine sediment and pollution risk** The potential release of fine sediment because of construction activities (through surface water run-off; and through chemicals, fuels, and construction materials via outfall construction) could impact existing thermal conditions (e.g., through a reduction of light exposure at the river bed and shallowing due to aggradation). However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible with no long-term impact to thermal conditions at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Shading** The shading study revealed that the temporary haul route structure (Bailey bridge) and culverts would reduce light exposure along their lengths, which may subsequently affect thermal conditions. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting in a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Shading** Shading - CM-RDWE-12.
Thermal Conditions	**Alteration to flow and / or habitats** Changes in the low to flood flows caused by dewatering, the outfall construction and new drainage schemes, and the operation of the temporary works platform and associated Bailey bridge during the construction phase could change thermal conditions of the flow. For instance, a reduction in discharge could increase water temperature in some parts of the channel, impacting on the baseline thermal condition. However, the footprint of the flow / habitat alteration is far smaller than the water body length, hence resulting in a negligible overall impact to the water body. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Oxygenation Conditions	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities could impact upon existing oxygenation conditions (e.g., through a reduction of light exposure at the river bed and in-channel photosynthesis). These impacts might arise primarily from silt input and vegetation reduction. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing oxygenation conditions.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Oxygenation Conditions	**Shading** The shading study revealed that the temporary haul route structure (Bailey bridge) and culverts would reduce light exposure along their lengths, indirectly affecting oxygen conditions. The temporary loss in macrophytes in shaded areas may reduce the amount of oxygen being generated by photosynthetic and respiration activity within the watercourse. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body oxygenation condition.	**Shading** Shading - CM-RDWE-12.
Oxygenation Conditions	**Alteration to flow and / or habitats** Changes in the low to flood flows caused by dewatering, outfall and new drainage schemes construction, and the operation of the temporary works platform and associated Bailey bridge during the construction phase could change oxygenation conditions. For instance, a reduction in discharge could reduce the availability of oxygen to macrophytes and fauna in some parts of the channel, further impacting the oxygenation condition. However, besides the small footprint of those activities compared to the WFD water body, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of flow / habitat alteration are expected to be negligible with no long-term impact on oxygenation conditions at the WFD water body scale.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Acidification Status	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities could impact upon existing pH levels (e.g., through an input of hydrogen ions). These impacts might arise primarily from silt and oil input, and vegetation reduction. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediment and pollution are expected to be negligible with no long-term impact on acidification status at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Acidification Status	**Shading** The shading study revealed that the temporary haul route structure (Bailey bridge) and culverts would reduce light exposure along their lengths, therefore, impacting on existing photosynthesis production and pH levels. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body acidification status	**Shading** Shading - CM-RDWE-12.
Acidification Status	**Alteration to flow and / or habitats** Changes in the low to flood flows caused by dewatering, outfall and new drainage schemes construction, and the operation of the temporary works platform and associated Bailey bridge during the construction phase could change pH levels. For instance, a reduction in discharge could reduce the natural mixing of waters, hence, impacting acid–base reaction. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body acidification status.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Nutrient Conditions	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities could impact upon existing nutrient conditions (e.g., through the discharge of different physico-chemical compounds). These impacts might arise primarily from silt and oil input, and vegetation reduction. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediment and pollution are expected to be negligible with no long-term impact on nutrient conditions at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Nutrient Conditions	**Shading** The shading study revealed that the temporary haul route structure (Bailey bridge) and culverts would reduce light exposure along their lengths, therefore impacting on existing photosynthesis production and nutrient conditions. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body nutrient condition.	**Shading** Shading - CM-RDWE-12.
Nutrient Conditions	**Alteration to flow and / or habitats** Changes in the low to flood flows caused by dewatering, outfall, and new drainage schemes construction, and the operational of the temporary works platform and associated Bailey bridge during the construction phase could change nutrient supply to in-channel habitats. Potential loss of macrophytes from temporary works and vegetation clearance could reduce photosynthesis along the river corridor, hence, impacting on existing nutrient conditions. However, the water is flowing and therefore no residency time is anticipated beneath the Bailey bridge structure. In addition, the temporary haul route structure dimensions are far smaller than the water body length (65.7 kilometres), hence resulting a negligible overall impact to the water body. The design of the Bailey bridge and the culverts further reduces the shading extents on river channels. Therefore, this activity is not expected to have a significant impact on the WFD water body nutrient condition.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Quantity and Dynamics of Water Flow	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities could impact on the river morphology (e.g., in river bed levels, river morphology), hence, ultimately altering the quantity and dynamics of flow (e.g., velocity, discharge, flow type). In addition, increased runoff rates from the construction site could result in overland flow reaching the river faster than compared to baseline. Similarly, vegetation clearance could increase rates of silt laden surface water runoff to the river, which can change river morphology and flow dynamics. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing the quantity and dynamics of flow.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04. In addition, flood relief channels are embedded in the design of the temporary works to reduce the potential impacts to flow dynamics.

Quality Element	Potential Impact	Mitigation
Quantity and Dynamics of Water Flow	**Shading** The shading study revealed that the temporary haul route structure (Bailey bridge) and culverts would reduce light exposure along their lengths, which may subsequently affect macrophyte community. For instance, macrophyte reduction can increase flow velocity and, therefore, the quantity and dynamics of flow. However, the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that macrophyte loss due to shading is expected to have a negligible impact upon flow velocity, stream power, and shear stress. Therefore, with the embedded mitigation measures in place, the impacts from shading are expected to be negligible, with no long-term impact on the quantity and dynamics of flow at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.
Quantity and Dynamics of Water Flow	**Alteration to flow and / or habitats** The River Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with temporary works platform and associated Bailey bridge, flood relief culverts, access roads, and a box culvert) could influence local hydraulics during the construction phase. However, these impacts would be highly localised and extend for an approximate 175m within the zone of the temporary works platform. The assessment revealed that flow velocities are predicted to increase during the construction phase for all modelled flood return periods within the zone of the temporary works platform due to the constriction of flows with the Bailey bridge in place. The associated vegetation removal along the banks for the installation of the Bailey bridge could also expose banks to higher velocities and potential erosive forces. The assessment also indicates a change in habitat biotopes (as measured by Froude) for all modelled flood return periods. During the 1 in 2-year flood return period, glide habitats would be replaced by riffles for approximately 150m within the zone of the temporary works platform due to the flow constriction. The modelled results also indicate alteration to habitat biotopes upstream due to the temporary works, with an extension of pool and glide habitat. Despite the increase in energetic flow types within the zone of the temporary works platform, given that the threshold for the onset of erosion-dominated processes is not predicted to be exceeded, alteration to habitats due to changes in flow dynamics is not anticipated or would be highly localised. The results of the Wensum geomorphology assessment (Document reference: 3.12.04) indicate that any localised impacts would be off-set by natural processes and return to baseline conditions once the works have completed. Due to the River Wensum being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime. Nevertheless, these are only anticipated to be short-term during construction and to be highly localised. Therefore, these activities are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics.

Quality Element	Potential Impact	Mitigation
Connection to Groundwater Bodies	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities could impact upon existing baseline ground water quality (e.g., through the discharge of different physico-chemical compounds). However, by applying the embedded mitigation measures, this activity is not expected to have a significant impact on the WFD groundwater body scale. Therefore, these activities are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment and pollution risk - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
River Continuity	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities could impact on the river morphology (e.g., in river bed levels, river morphology), hence, ultimately altering the river continuity (e.g., longitudinal connectivity of flow and habitats). In addition, potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river continuity though impounding effects of sediment accumulation However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, these activities are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics.
River Continuity	**Shading** The construction of the temporary works platform and associated Bailey bridge would reduce solar exposure upon the river corridor, causing a temporary loss of the macrophyte community. The loss of in-channel macrophytes may result in a change in river bed roughness, with further impacts upon flow velocity and longitudinal river continuity. However, the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that macrophyte loss due to shading is expected to have a negligible impact upon flow velocity, stream power, and shear stress. Therefore, with the embedded mitigation measures in place, the impacts from shading are expected to be negligible, with no long-term impact on the river continuity at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.

Quality Element	Potential Impact	Mitigation
River Continuity	**Alteration to flow and / or habitats** The River Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with temporary works platform and associated Bailey bridge, flood relief culverts, access roads, and a box culvert) could influence local hydraulics during the construction phase. The assessment reveals an increase in predicted water depth upstream of the zone of the temporary works platform due to the constriction of flows caused by the Bailey bridge and temporary works platform, and, hence, a reduction of river continuity. The zone of impact extends from between 400m upstream under a 1 in 2-year flood return period to approximately 850m upstream under the higher magnitude flood return periods modelled. However, these impacts would be temporary in nature and predicted to return to baseline conditions post-construction. It is expected that any temporary impacts would be off-set by natural processes once the works have completed. Due to the River Wensum being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, these impacts are expected to be temporary, localised in nature, and with negligible long-term impact on river continuity at the WFD water body scale.	**Alteration to flow and / or habitats** Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plant - CM-RDWE-08; and Channel modifications - CM-RDWE-09. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics.
River Depth and Width Variation	**Fine sediment and pollution risk** Construction activities and potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river geometry though sediment accumulation. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from fine sediment and pollution are expected to be negligible on the WFD water body. Therefore, these activities are expected to be temporary, localised in nature, and with negligible long-term impact on river geometry at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04. Flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics. The potential construction impacts are expected to be short-lived and off-set by natural processes during the operational phase.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Shading** The operation of the temporary works platform, culverts and associated Bailey bridge could reduce solar exposure upon the river corridor, hence, causing a loss of in-channel macrophyte density. The loss of in-channel vegetation could result in a change in river bed roughness, with further impacts upon river geometry. However, the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the impacts would be highly localised and return to baseline levels within a short distance downstream of the zone of the temporary works platform. These results also indicated negligible sensitivity to macrophyte die back upon hydraulics (e.g., flow velocity, stream power, shear stress). Therefore, no significant effect is anticipated to river width and depth variation at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.
River Depth and Width Variation	**Alteration to flow and / or habitats** Potential release of fine sediment because of construction activities could impact on the river morphology (e.g., in river bed levels, river morphology), hence, altering the river geometry (e.g., in-channel habitats). In addition, potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river geometry through impounding effects of sediment accumulation. The Wensum geomorphology assessment (Document reference: 3.12.04) reveals an increase in predicted water depth upstream of the zone of the temporary works platform due to the constriction of flows caused by the Bailey bridge and temporary works platform. The zone of impact extends from between 400m upstream under a 1 in 2-year flood return period to approximately 850m upstream under the higher magnitude flood return periods modelled. During construction, the impacts of flow constriction on upstream water depths could result in increased sedimentation of both the channel and floodplain. These impacts would be temporary in nature and predicted to return to baseline conditions post-construction. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, these impacts are expected to be temporary, localised in nature, and with negligible long-term impact on river geometry at the WFD water body scale.	**Alteration to flow and / or habitats** Fine sediment management - CM-RDWE-01; Vegetation clearance - CM-RDWE-03; Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Spread of INNS** INNS (e.g., Himalayan balsam) can increase soil instability and exposure to overland flow via dieback. It is particularly concerning along riverbanks, which can result in bank failure and increased sediment load to the channel. An increase in sediment load, especially fines, can disrupt existing spawning gravel habitats by pore filling, hence, changing the river bed geometry. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on river geometry at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.
Structure and Substrate of the River Bed	**Fine sediment and pollution risk** Construction activities and potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river bed grain size though sediment accumulation. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing river bed characteristics.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04.
Structure and Substrate of the River Bed	**Shading** The operation of the temporary works platform and associated Bailey bridge would reduce solar exposure upon the river corridor, causing a loss of in-channel macrophyte density. The loss of in-channel vegetation could result in a change in river bed roughness, with further impacts upon river bed structure. However, the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the impacts would be highly localised and return to baseline levels within a short distance downstream of the zone of the temporary works platform. These results also indicated negligible sensitivity to macrophyte die back upon flow velocity, stream power, and shear stress. Therefore, no significant effect is anticipated to river bed structure and substrate at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Alteration to flow and / or habitats** The Wensum geomorphology assessment (Document reference: 3.12.04) revealed that the haul route (in conjunction with temporary works platform and associated Bailey bridge, flood relief culverts, access roads, and a box culvert) could influence local hydraulics during the construction phase, hence, changing the river bed characteristics. However, these impacts would be highly localised and extend for an approximate maximum of 175m within the zone of the temporary works platform. Under the 2-year flood return period, the Wensum geomorphology assessment (Document reference: 3.12.04) predicts no alteration to sediment transport within the River Wensum. This is the most likely flood return period during the construction phase. Localised impacts to bed shear stress are predicted under the 1 in 20-year flood return period and greater, which have a low-likelihood of occurrence during the construction period. Under a 1 in 20-year flood event, coarse gravels could be entrained within an approximate 120m reach within the zone of the temporary works platform with bed shear stress values returning to baseline approximately 50m downstream of the zone of the temporary works platform. The zone of potential impact extends to up to approximately 135m under higher magnitude events with an increase in bed shear stress levels that could mobilise very coarse gravels. However, the Wensum geomorphology assessment (Document reference: 3.12.04) results also indicate that the threshold for erosion-dominated processes, as measured by specific stream power, would not be overcome. Therefore, no perceptible impact to the structure and substrate of the river bed or alteration to habitats is anticipated. It is expected that any temporary impacts would be off-set by natural processes once the works have completed. Due to the River Wensum being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime. Nevertheless, these are only anticipated to be short-term during construction and to be highly localised. Therefore, these impacts are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Alteration to flow and / or habitats** Fine sediment management - CM-RDWE-01; Vegetation clearance - CM-RDWE-03; Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics.
Structure and Substrate of the River Bed	**Spread of INNS** INNS (e.g., Himalayan balsam) can increase soil instability and exposure to overland flow via dieback. It is particularly concerning along riverbanks, which can result in bank failure and increased sediment load to the channel. An increase in sediment load, specially fines, can disrupt existing spawning gravel habitats by pore filling, hence, changing the river bed characteristics. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on river bed characteristics at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Structure of the Riparian Zone	**Fine sediment and pollution risk** Construction and associated enabling works activities would require the removal of a strip of riparian vegetation, which could result in fine sediment release. Fine sediment could be transported downstream and deposited within the riparian zone during out-of-bank flow events. These potential impacts would be temporary in nature and mitigated through the OCEMP. Therefore, no significant impacts are anticipated to the structure riparian zone at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and INNS management - CM-RDWE-04.
Structure of the Riparian Zone	**Shading** The temporary works platform and associated Bailey bridge and flood relief culverts would locally remove riparian vegetation along the River Wensum and along ditches within the Wensum floodplain. In addition, shading impacts would limit or prevent vegetation growth of the riparian zone. These impacts would be highly localised and temporary in nature with vegetation recovering post-construction and shading impacts removed where permanent structures are not required during operation. Therefore, no significant effect is anticipated to the riparian zone at the WFD water body scale.	**Shading** Shading - CM-RDWE-12.
Structure of the Riparian Zone	**Alteration to flow and / or habitats** Vegetation clearance required as part of the enabling works could directly impact riparian vegetation structure and alter the available habitats for species, but the riparian zone could still be protected by appropriate mitigation measures. In addition, changes in the low to flood flows caused by dewatering, new drainage schemes, and the operational of the temporary works platform and associated Bailey bridge during the construction phase are anticipated to be restricted to the channel and not influence the riparian zone. Hence, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, these impacts are expected to be temporary, localised in nature, and with negligible long-term impact on the riparian zone at the WFD water body scale.	**Alteration to flow and / or habitats** Vegetation clearance - CM-RDWE-03; Drainage management - CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents - CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Structure of the Riparian Zone	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter the structure of the riparian zone, altering the riparian vegetation composition. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on riparian zone at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Wensum DS Norwich

5.2.6 An assessment of the potential construction impacts on those activities and quality elements screened and scoped in for the Wensum DS Norwich water body are presented in **Table 5.3**.

Table 5.3 Potential construction impacts on the scoped in WFD biological, physico-chemical and hydromorphological quality elements on the Wensum DS Norwich (GB105034055882) water body

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Fine sediment and pollution risk** The potential release of fine sediment and pollutants because of construction activities through surface water run-off; and through chemicals, fuels, and construction materials, could potentially impact upon fish and their habitat. This could cause degradation of habitat, loss of food sources and degradation of water quality. Additionally, there is the potential for input of fine sediment due to vegetation clearance resulting in silt laden run off and alteration to overland flow paths. However, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. With the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on the composition, abundance, and age structure of fish fauna.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Composition, Abundance and Age Structure of Fish Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports fish at their various life stages. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on fish fauna at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Fine sediment and pollution risk** The potential release of fine sediment because of construction activities through surface water run-off; and through chemicals, fuels, and construction materials, could potentially impact upon benthic invertebrates and their habitat. Fine sediment and pollution could cause degradation of habitat, loss of food sources and degradation of water quality, which may lead to indirect impacts upon the benthic invertebrate communities. There is the potential for input of fine sediment due to vegetation clearance resulting in silt laden run off and alteration to overland flow paths. However, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. With the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on the composition and abundance of benthic invertebrate fauna.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Composition and Abundance of Benthic Invertebrate Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports benthic invertebrate communities. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.
Composition and Abundance of Aquatic Flora	**Fine sediment and pollution risk** The potential release of fine sediment because of construction activities through surface water run-off; and also, through chemicals, fuels, and construction materials, could potentially impact upon macrophytes. Fine sediment and pollution could cause degradation of habitat and degradation of water quality, leading to indirect impacts upon the macrophyte community. There is the potential for input of fine sediment due to vegetation clearance resulting in silt laden run off and alteration to overland flow paths. However, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. With the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on the composition and abundance of aquatic flora.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. The spread and / or introduction of INNS may lead to a reduction in the aquatic flora community, with native species being outcompeted for resources by INNS. However, with the proposed combination of embedded mitigation and the OCEMP measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on aquatic flora at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.
Oxygenation Conditions	**Fine sediment and pollution risk** Cuttings with associated land take, piling, noise, vibration, and runoff control can produce short-term impact on the baseline oxygenation condition of the water body. These impacts might arise primarily from silt input and vegetation reduction. However, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. With the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on oxygenation condition of the water body.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Quantity and Dynamics of Water Flow	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities could impact on the river morphology (e.g., in river bed levels, river units), hence, altering the quantity and dynamics of flow (e.g., velocity, discharge, flow type). In addition, increased runoff rates from the construction site could result in overland flow reaching the river faster than baseline. However, due to the distance from the Proposed Scheme (7.3 kilometres), adverse impacts are not expected to be significant due to pollution / sediment dispersal and upstream sediment settling. With the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on quantity and dynamics of flow of this water body.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics. Hence, the potential construction impacts are expected to be short-lived and off-set by natural processes during the operational phase.

Quality Element	Potential Impact	Mitigation
River Continuity	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities could impact on the river morphology (e.g., in river bed levels, river units), hence, altering the river continuity (e.g., longitudinal connectivity of flow and habitats). Potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river continuity though impounding effects of sediment accumulation. However, the distance from the Proposed Scheme (7.3 kilometres) significantly reduces the risk of negative impacts due to dilution effect and particle settling velocities prior to arriving in this water body. By applying appropriate mitigation, the risk to river continuity is expected to be negligible. Therefore, no significant impacts are foreseen on river continuity.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics. Hence, the potential construction impacts are expected to be short-lived and off-set by natural processes during the operational phase.
River Depth and Width Variation	**Fine sediment and pollution risk** Construction activities could result in silt laden runoff, which could enter the channel and alter bedforms, therefore changing the river depth and width variation. Sediment input into the channel could be transported downstream and could potentially impact the downstream water body. However, the distance from the Proposed Scheme (7.3 kilometres) significantly reduces the risk of negative impacts due to dilution effect and particle settling velocities prior to arriving in this water body. By applying appropriate mitigation, the risk to river continuity is expected to be negligible. Therefore, no significant impacts are foreseen on river geometry.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03. In addition, flood relief channels are embedded in the design of the temporary works platform to reduce the potential impacts to flow dynamics. Hence, the potential construction impacts are expected to be short-lived and off-set by natural processes during the operational phase.
River Depth and Width Variation	**Spread of INNS** INNS (e.g., Himalayan balsam) can increase soil instability and exposure to overland flow via dieback. It is particularly concerning along riverbanks, which can result in bank failure and increased sediment load to the channel. An increase in sediment load, specially fines, can change the river bed characteristics (e.g., river geometry). However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on river geometry characteristics at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Fine sediment and pollution risk** Construction activities could result in silt laden runoff, which could enter the channel and alter bedforms, therefore changing the river bed structure. Sediment input into the channel could be transported downstream and impact the downstream water body. However, the distance from the Proposed Scheme (7.3 kilometres) significantly reduces the risk of negative impacts due to dilution effect and particle settling velocities prior to arriving in this water body. By applying appropriate mitigation, the risk to river bed characteristics is expected to be negligible. Therefore, no significant impacts are foreseen on river bed forms.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Structure and Substrate of the River Bed	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially alter the structure and substrate of the river bed. For example, the introduction of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a change in the composition of the substrate of the river bed. However, by applying appropriate mitigation, the risk to river bed characteristics is expected to be negligible. Therefore, no significant impacts are foreseen on river bed forms.	**Spread of INNS** INNS management - CM-RDWE-04.
Structure of the Riparian Zone	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter the structure of the riparian zone, altering the riparian vegetation composition. However, by applying appropriate mitigation, the risk to river bed characteristics is expected to be negligible. Therefore, no significant impacts are foreseen on the structure of the riparian zone.	**Spread of INNS** INNS management - CM-RDWE-04.

River Tud

5.2.7 An assessment of the potential construction impacts on those activities and quality elements screened and scoped in for the River Tud water body are presented in **Table 5.4**.

Table 5.4 Potential construction impacts on the scoped in WFD biological, physico-chemical and hydromorphological quality elements on the River Tud (GB105034051000)

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Fine sediment and pollution risk** The release of fine sediment and chemicals from the construction activities (Tud tributary culvert / Bat underpass and associated channel realignment, attenuation / infiltration ponds, outfall construction, cuttings, associated earthworks, and vegetation clearance) could potentially impact upon fish and their habitat. Whilst surveys revealed that no fish were present within Foxburrow Stream itself, fine sediment could be transported downstream to the River Tud where fish populations are present. The release of fine sediment could lead to degradation of habitat and water quality, and loss of food sources for fish. The construction activities could also alter surface water flow paths resulting in silt laden runoff and pollution risk. There is also a risk of pollution incidents due to the storage of chemicals, oils, and cements from the compounds and working areas. Fine sediment ingress to the channel may also result in a pollution incident within the receiving watercourses with the potential for far-reaching downstream impacts to the River Tud water body. During the construction of the cuttings, it is possible that some contaminated land may be disturbed and some of this material may be delivered to the River Tud. Fine sediment could cause degradation of spawning habitat, food sources, and water quality. Fine sediment pollution could also lead to direct fish mortality, with sediment particles affecting the gills of fish. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing fish fauna, or species that are qualifying features of the River Wensum SAC, a Protected Area of the River Tud waterbody catchment.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, and new outfall drainage schemes during the construction phase could lead to a loss of functional habitat for fish. Construction of the Tud tributary culvert / Bat underpass and associated channel realignment would temporarily disrupt available habitat for fish due to related activities, which may involve overpumping, variability in flow, temporary impediment of passage and a reduction of available shelter. However, no fish were observed to be present within the Foxburrow Stream and these potential impacts are not anticipated to extend to the River Tud downstream. Dewatering and drainage of cuttings can lower groundwater levels which may influence the groundwater regime. Due to the River Tud being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime, which could impact upon fish populations. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of flow / habitat alteration are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on fish fauna in the water body.	**Alteration to flows and / or habitats** Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; Channel modifications - CM-RDWE-09; and Fish translocation - CM-RDWE-10.
Composition, Abundance and Age Structure of Fish Fauna	**Noise and vibration** There is the potential for construction activities such as movement of large machinery and pile driving to create noise and vibration that may lead to disruption of normal fish behaviour and migration within Foxburrow Stream. However, no fish were observed to be present within the Foxburrow Stream and these potential impacts are not anticipated to extend to the River Tud downstream. In addition, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of noise and vibration are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on fish fauna in the water body.	**Noise and vibration** Noise management - CM-RDWE-11.
Composition, Abundance and Age Structure of Fish Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports fish at their various life stages. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on fish fauna at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Fine sediment and pollution risk** The release of fine sediment and chemicals from the construction activities (road, Tud tributary culvert / Bat underpass and associated channel realignment, attenuation / infiltration ponds, outfalls, cuttings, associated earthworks, and vegetation clearance) could potentially impact upon benthic invertebrates and their habitat. Fine sediment and pollution could cause degradation of habitat, food sources and water quality, leading to indirect impacts upon the benthic invertebrate communities within Foxburrow Stream. There is the potential for input of fine sediment due to vegetation clearance resulting in silt laden run off and alteration to overland flow paths. The input of fine sediment has the potential to affect benthic invertebrate habitat. Fine sediment pollution could lead to changes in the macrophyte community, leading to indirect impacts upon benthic invertebrates through loss of functional habitat. Fine sediment and pollutant ingress to the channel may also result in a pollution incident within the receiving watercourses with the potential for far-reaching downstream impacts to the River Tud water body. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing benthic invertebrate fauna.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Composition and Abundance of Benthic Invertebrate Fauna	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, and new outfalls and drainage schemes during the construction phase could lead to a loss of functional habitat for benthic invertebrates. Construction of the Tud tributary culvert / Bat underpass and associated channel realignment would temporarily disrupt available habitat for benthic invertebrates due to related activities, which may involve variability in flow, temporary impediment of passage and a reduction of available shelter. However, these potential impacts are not anticipated to extend to the River Tud downstream. Dewatering and drainage of cuttings can lower groundwater levels which may influence the groundwater regime. Due to the River Tud being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime, which could impact upon benthic invertebrate communities. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of flow / habitat alteration are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on benthic invertebrate fauna in the water body.	**Alteration to flows and / or habitats** Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Noise and vibration** There is the potential for construction activities such as movement of large machinery and pile driving to create noise and vibration which could cause localised disturbance to benthic invertebrate communities. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of noise and vibration are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on benthic invertebrate fauna in the water body.	**Noise and vibration** Noise management - CM-RDWE-11.
Composition and Abundance of Benthic Invertebrate Fauna	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. For example, the introduction of Himalayan balsam could destabilise the banks and increase sediment ingress to the watercourse, leading to a negative effect on the aquatic habitat that supports benthic invertebrate communities. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.
Composition and Abundance of Aquatic Flora	**Fine sediment and pollution risk** The release of fine sediment and pollutants from the construction activities (road, Tud tributary culvert / Bat underpass and associated channel realignment, attenuation / infiltration ponds, outfalls, cuttings, associated earthworks, and vegetation clearance) could impact upon the macrophyte community within the Foxburrow Stream. This could cause degradation of water quality and, by extension, degradation of the aquatic flora. The construction activities could also alter surface water flow paths resulting in silt laden runoff and pollution risk. There is also a risk of pollution incidents due to the storage of chemicals, oils, and cements from the compounds and working areas. Fine sediment and pollutant ingress to the channel may also result in a pollution incident within the receiving watercourses with the potential for far-reaching downstream impacts to the River Tud water body. During the construction of the cuttings, it is possible that some contaminated land may be disturbed and some of this material may be delivered to the River Tud. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the River Tud WFD water body. Therefore, no significant impacts are foreseen on the composition and abundance of aquatic flora at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, and new drainage schemes during the construction phase could lead to a loss of functional habitat for macrophytes. Construction of the Tud tributary culvert / Bat underpass and associated channel realignment would affect the macrophyte community of Foxburrow Stream due to related activities, which may involve variability in flow and heavy shading resulting in a loss of macrophyte cover within the Tud tributary culvert / Bat underpass. However, these potential impacts are not anticipated to extend to the River Tud downstream. Dewatering and drainage of cuttings can lower groundwater levels which may influence the groundwater regime. Due to the River Tud being primarily groundwater fed, any dewatering activities may result in a change in the hydrological regime, which could impact upon macrophyte communities. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of flow / habitat alteration are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on the composition and abundance of aquatic flora.	**Alteration to flows and / or habitats** Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Composition and Abundance of Aquatic Flora	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter ecosystem dynamics and potentially degrade aquatic habitats. The spread and / or introduction of INNS may lead to a reduction in the aquatic flora community, with native species being outcompeted for resources by INNS. However, with the proposed combination of embedded mitigation and the OCEMP measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on aquatic flora is expected at the WFD water body scale.	**Spread of INNS** INNS management - CM-RDWE-04.
Thermal Conditions	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from culverting, vegetation clearance and attenuation / infiltration pond / road construction activities could impact upon existing thermal conditions (e.g., through an increase in bed levels or changes in turbidity). However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing thermal conditions.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, and new outfalls and drainage schemes during the construction phase could change thermal conditions of the flow. For instance, a reduction in discharge could increase water temperature in some parts of the channel, impacting the baseline thermal condition. However, the footprint of the flow / habitat alteration is far smaller than the water body length, hence resulting in a negligible overall impact to the water body. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Oxygenation Conditions	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from culverting, vegetation clearance and attenuation / infiltration pond / road construction activities could impact upon existing turbidity and oxygenation conditions (e.g., through a reduction of light exposure at the river bed and in-channel photosynthesis), which could in turn affect aquatic species. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing oxygenation conditions.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Oxygenation Conditions	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, new outfalls and drainage schemes during the construction phase could impact on oxygenation conditions of the flow. For instance, a reduction in discharge could restrict the availability of oxygen to macrophytes and fauna in some parts of the channel, further impacting the oxygenation condition. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the footprint of the flow / habitat alteration is far smaller than the water body length, hence resulting in a negligible overall impact to the water body. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Acidification Status	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities and enabling works could impact upon existing pH levels (e.g., through an input of hydrogen ions). However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediment and pollution are expected to be negligible. Therefore, this activity is not expected to have a significant impact on the WFD water body acidification status.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.

Quality Element	Potential Impact	Mitigation
Acidification Status	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, new outfalls and drainage schemes during the construction phase could change pH levels. For instance, a reduction in discharge could reduce the natural mixing of waters, hence, impacting acid–base reaction. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of flow / habitat alteration are expected to be negligible. Therefore, this activity is not expected to have a significant impact on the WFD water body acidification status.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Nutrient Conditions	**Fine sediment and pollution risk** Potential release of fine sediment and chemicals from construction activities and enabling works could impact upon existing nutrient conditions (e.g., through the discharge of different physico-chemical compounds). These impacts might arise primarily from silt and oil input, and vegetation reduction. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediment and pollution are expected to be negligible. Therefore, this activity is not expected to have a significant impact on the WFD water body nutrient condition.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Nutrient Conditions	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, new outfalls and drainage schemes during the construction phase could change nutrient supply to in-channel habitats. Potential loss of macrophytes from temporary works and vegetation clearance could reduce photosynthesis along the river corridor, hence, impacting on existing nutrient conditions. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, this activity is not expected to have a significant impact on the WFD water body nutrient conditions.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Quantity and Dynamics of Water Flow	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities and enabling works could impact on the river morphology (e.g., in river bed levels, river units), hence, altering the quantity and dynamics of flow (e.g., velocity, discharge, flow type). Increased rates runoff from the construction site could result in overland flow reaching the river faster than compared to baseline, also changing flow. Vegetation clearance could increase rates of silt laden surface water runoff to the river. However, with mitigation in place, any potential impacts would be managed through the OCEMP and temporary in nature. Therefore, no impacts are anticipated at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; Vegetation clearance - CM-RDWE-03; and Drainage management – CM-RDWE-05.

Quality Element	Potential Impact	Mitigation
Quantity and Dynamics of Water Flow	**Alteration to flows and / or habitats** During construction, flow may be diverted or over pumped for the installation of the Tud tributary culvert / Bat underpass. However, it would cause only a localised and temporary impact to the quantity and dynamics of flow. Changes in the low to flood flows caused by dewatering, and new outfalls (with associated scour protection) and drainage schemes during the construction phase could change the quantity and dynamics of flow (e.g., velocity, discharge, flow type). In addition, the loss of in-channel vegetation due to construction activities can change river bed roughness, with further impacts upon the quantity and dynamics of flow (e.g., velocity, discharge, flow type). Nevertheless, these are only anticipated to be short-term during construction and to be highly localised, especially with the proposed combination of embedded mitigation and the OCEMP measures in place. Therefore, these activities are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
River Continuity	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities and enabling works could impact on the river morphology (e.g., in river bed levels, river units), hence, altering the river continuity (e.g., longitudinal connectivity of flow and habitats). In addition, potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river continuity though impounding effects of sediment accumulation. However, with construction mitigation in place, these potential impacts would be managed and are not anticipated to have an effect at the WFD water body scale. Therefore, these activities are expected to be temporary, localised in nature, and with no impact at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
River Continuity	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, new outfalls and drainage schemes during the construction phase could disrupt the existing river continuity. In addition, the proposed channel realignment for the Tud tributary culvert / Bat underpass and outfalls (with associated scour protection) and outfalls (with associated scour protection) installation would disrupt river continuity. Nevertheless, these are only anticipated to be short-term during construction and to be highly localised, especially with the proposed combination of embedded mitigation and the OCEMP measures in place. Therefore, these activities are expected to be temporary, localised in nature, and with no impact on river continuity at the WFD water body scale.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities and enabling works could impact on the river morphology and channel geometry due to sediment accumulation (e.g., in river bed levels, river units), hence, altering the river geometry. Potential loss of macrophytes from temporary works and vegetation clearance could increase fine sediment input to the channel, hence, altering the river geometry though sediment accumulation. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from fine sediment and pollution are expected to be negligible on the WFD water body. Therefore, these activities are expected to be temporary, localised in nature, and with negligible long-term impact on river geometry at the WFD water body scale.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
River Depth and Width Variation	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, new outfalls and drainage schemes during the construction phase could disrupt the existing river geometry. During construction, the installation of the Tud tributary culvert / Bat underpass and outfalls (with associated scour protection) would have direct potential impact upon the cross-sectional form of the channel. The construction of the outfalls would directly alter the form of the bank and therefore the cross-sectional profile locally. In addition, vegetation clearance during the construction phase would expose bare ground, which could expose banks to scour, which may locally alter the cross-sectional profile. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, these impacts are expected to be temporary, localised in nature, and with negligible long-term impact on river geometry at the WFD water body scale.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
River Depth and Width Variation	**Spread of INNS** INNS (e.g., Himalayan balsam) can increase soil instability and exposure to overland flow via dieback. It is particularly concerning along riverbanks, which can result in bank failure and increased sediment load to the channel. An increase in sediment load, especially fines, can disrupt existing spawning gravel habitats by pore filling, hence, changing the river bed geometry. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on river geometry at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Fine sediment and pollution risk** Potential release of fine sediment because of construction activities and enabling works could impact on the river morphology due to sediment accumulation (e.g., in river bed levels, river units), hence, altering the river bed characteristics. In addition, the fine sediment input arising from construction activities may alter the structure and substrate of the river bed. Potential loss of macrophytes from temporary works and vegetation clearance could further increase fine sediment input to the channel, hence, altering the river bed grain size though sediment accumulation. However, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts of fine sediments and pollution are expected to be negligible on the WFD water body. Therefore, no significant impacts are foreseen on existing river bed characteristics.	**Fine sediment and pollution risk** Fine sediment management - CM-RDWE-01; Pollution prevention management - CM-RDWE-02; and Vegetation clearance - CM-RDWE-03.
Structure and Substrate of the River Bed	**Alteration to flows and / or habitats** Changes in the low to flood flows caused by dewatering, and new drainage schemes during the construction phase could disrupt the existing river bed characteristics. During construction, the installation of the Tud tributary culvert / Bat underpass and outfalls (with associated scour protection) would have direct potential impact upon the river bed profile locally. In addition, vegetation clearance during the construction phase would expose bare ground, which could expose banks to scour, which may locally alter the river bed grain size. However, besides being short-term and highly localised, with the proposed combination of embedded mitigation and the OCEMP measures in place, the impacts from alteration to flow and / or habitats are expected to be negligible on the WFD water body. Therefore, these impacts are expected to be temporary, localised in nature, and with negligible long-term impact on river geometry at the WFD water body scale.	**Alteration to flows and / or habitats** Drainage management – CM-RDWE-05; Floodplain storage - CM-RDWE-06; Consents – CM-RDWE-07; Landscape plan - CM-RDWE-08; and Channel modifications - CM-RDWE-09.
Structure and Substrate of the River Bed	**Spread of INNS** INNS (e.g., Himalayan balsam) can increase soil instability and exposure to overland flow via dieback. It is particularly concerning along riverbanks, which can result in bank failure and increased sediment load to the channel. An increase in sediment load, specially fines, can disrupt existing spawning gravel habitats by pore filling, hence, changing the river bed characteristics. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on river bed characteristics at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Structure of the Riparian Zone	**Spread of INNS** Construction activities could spread and / or introduce new INNS. This has the potential to alter the structure of the riparian zone, altering the riparian vegetation composition. However, with the proposed mitigation measures to control INNS spread in place, the impacts from INNS are expected to be negligible on the WFD water body. Therefore, no long-term impact on riparian zone at the WFD water body scale are foreseen.	**Spread of INNS** INNS management - CM-RDWE-04.

Operation

5.2.8 Potential operation impacts may have a permanent or long-term detrimental impact upon WFD quality elements. Embedded mitigation included within the design serves to off-set potential impacts as far as practicable. Proposed mitigation for the operation of the Proposed Scheme is provided in **Sub Appendix F: WFD Mitigation** (Document Reference: 3.12.03f). This appendix should be read in conjunction with the impact assessment tables below. The operational mitigation measures detailed in **Sub Appendix F: WFD Mitigation** (Document Reference: 3.12.03f) have been allocated an operation mitigation reference, which is used in the tables below to avoid lengthy duplication of text.

Wensum US Norwich

5.2.9 An assessment of the potential operational impacts on those activities and quality elements screened and scoped in for the Wensum US Norwich water body are presented in **Table 5.5**.

Table 5.5 Potential operational impacts on the scoped in WFD biological, physico-chemical and hydromorphological quality elements on the Wensum US Norwich (GB105034055881) water body

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff via outfalls and any subsequent pollution risk to the River Wensum during the operational phase may impact upon fish and their habitat. This could cause degradation of spawning habitat, food sources and water quality. Any reduction in dissolved oxygen and increased levels of toxic parameters may lead to direct mortality of fish. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). Therefore, no long-term impact is expected on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Shading** During the operational phase of the Proposed Scheme there may be a potential change in the composition of the macrophyte community in areas affected by shading from the River Wensum Viaduct and permanent culvert on WC5 associated with the maintenance access track. The direct effects of shading on fish within the vicinity of the River Wensum Viaduct would be negligible due to their tolerance of shade and ability to change their individual spatial distribution. However, there is the potential that localised indirect effects from shading on fish are possible through the temporary loss of shelter, food items and breeding habitat. Localised loss of macrophyte cover is expected on WC5, directly beneath the approximate 18m long culvert despite embedded designs to oversize the culvert to allow light penetration. The loss of macrophytes and open water habitat would make this section of the ditch less favourable for fish and lamprey species present. The culvert has been designed (through oversizing and invert level below that of the streams natural bed) to allow fish passage, preserve a natural substrate and increase light penetration, which would lessen the negative effects of the culvert on fish fauna. The culvert itself may also provide a benefit in the form of shelter from predation and higher temperatures in an otherwise poorly shaded habitat. The loss of open water habitat on WC5 and the potential degradation of habitat on the River Wensum is to be mitigated by the enhancement of aquatic habitat on both the River Wensum and the floodplain ditch network. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. Due to the localised negligible impact expected and implementation of mitigation measures, no long-term impact is expected on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05. Culvert shading mitigation - OM-RDWE-06 River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct and the attenuation / infiltration ponds can change hydraulics, which may potentially lead to a loss of functional habitat for the fish community. The maintenance access crossing and associated culvert on the minor floodplain watercourse can reduce the solar exposure and may potentially lead to the alteration of fish habitat. Although localised, changes or losses of vegetation along some structures (e.g., the permanent culvert on WC5 and the floodplain beneath the River Wensum Viaduct) of the Proposed Scheme is anticipated. There is a potential for indirect impacts from the clearance of bankside vegetation and loss of in-channel macrophytes in WC5 on the fish community through loss of shelter and food sources. Hydraulic modelling presented in the Wensum geomorphology assessment (Document reference: 3.12.04) shows that the operational phase is not expected to have a significant impact on existing river processes (e.g., river morphological units, shear stress, stream power) within the River Wensum. It is also anticipated that any impacts on certain macrophyte species below the River Wensum Viaduct would be replaced by less light sensitive species, therefore no overall reduction is expected in macrophyte cover. Therefore, no reduction of in-channel habitat for fish is expected within the River Wensum. Additionally, any degradation of aquatic habitat on the River Wensum or ditch network is to be mitigated by the enhancement of aquatic habitat on both the River Wensum and the floodplain ditch network. This would provide an additional 10% uplift to achieve target BNG conditions. Therefore, no long-term impact is expected on fish fauna at the WFD water body scale, or on those fish species that are listed as qualifying features of the River Wensum SAC.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08 Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10. River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff via outfalls and any subsequent pollution risk to the River Wensum during the operational phase may impact upon benthic invertebrates and their habitat. This could cause degradation of habitat, food sources and water quality, leading to indirect impacts upon the benthic invertebrate communities. However, the seven attenuation / infiltration ponds proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Composition and Abundance of Benthic Invertebrate Fauna	**Shading** During the operational phase of the Proposed Scheme there may be a potential change in the composition of the macrophyte community in areas affected by shading from the River Wensum Viaduct and permanent culvert on WC5 associated with the maintenance access track. The direct effects of shading on benthic invertebrates would be negligible due to their tolerance of shade and ability to change their individual spatial distribution. However, there is the potential that indirect effects from shading on benthic invertebrates are possible through the temporary loss of shelter, food items and habitat in a localised area. There would be a loss of macrophytes beneath the permanent culvert on WC5, which would result in a permanent loss of habitat and food availability for benthic invertebrates in this localised area. Any degradation of aquatic habitat on the River Wensum or ditch network that supports benthic invertebrate fauna is to be mitigated by the enhancement of aquatic habitat on both the River Wensum and the floodplain ditch network. This would provide an additional 10% uplift to achieve target BNG conditions. Due to the localised negligible impact expected and additional enhancement measures, no long-term impact on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05. River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct and the attenuation / infiltration ponds can change hydraulics, which may potentially lead to a loss of functional habitat for the benthic invertebrate community. The permanent culvert on WC5 would reduce the solar exposure and lead to a loss of macrophyte cover and therefore a degradation of benthic invertebrate habitat. Although minimal, permanent vegetation clearance along some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme is anticipated, there is the potential for indirect impacts from the clearing or loss of vegetation on the benthic invertebrate community through loss of shelter and food sources. Hydraulic modelling presented in the Wensum geomorphology assessment (Document reference: 3.12.04) shows that the operational phase is not expected to have a significant impact on existing river processes (e.g., river morphological units, shear stress, stream power) within the River Wensum. Additionally, any degradation of aquatic habitat on the River Wensum or ditch network is to be mitigated by the enhancement of aquatic habitat on both the River Wensum and the floodplain ditch network. This would provide an additional 10% uplift to achieve target BNG conditions. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08 Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10. River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13
Composition and Abundance of Aquatic Flora	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk to the River Wensum during the operational phase may impact upon macrophytes and their habitat. This could cause degradation of habitat and water quality, leading to indirect impacts upon macrophyte communities. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). Therefore, no long-term impact on the composition and abundance of aquatic flora is anticipated at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Shading** During the operational phase of the Proposed Scheme, shading from the River Wensum Viaduct structure would lead to a change in the composition of the macrophyte community within the vicinity of the River Wensum Viaduct. However, recovery or replacement by shade tolerant macrophyte species is expected within the localised section of the River Wensum, as discussed in the shading assessment report. Shading from the permanent culvert on WC5 would lead to a localised loss of macrophytes. Adverse impacts on the macrophyte community of WC5 would be mitigated against by the implementation of enhancements on both the River Wensum and the floodplain ditch network. This would provide an additional 10% uplift to achieve target BNG conditions. With the proposed mitigation and enhancement measures, no long-term impact on the composition and abundance of aquatic flora is anticipated at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; and River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13
Composition and Abundance of Aquatic Flora	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct and the attenuation / infiltration ponds can change hydraulics, which may lead to a loss of functional habitat for the macrophyte community. Although minimal, permanent vegetation clearance around some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme is anticipated. The localised clearance of vegetation around these structures would result in a loss of riparian and bankside flora, as well as a loss of in-channel macrophytes beneath the permanent culvert on WC5. The alteration of habitat and its impact on aquatic flora would be mitigated against by the implementation of enhancements on both the River Wensum and the floodplain ditch network. This would provide an additional 10% uplift to achieve target BNG conditions. Hydraulic modelling presented in the Wensum geomorphology assessment (Document reference: 3.12.04) shows that the operational phase is not expected to have a significant impact on existing river processes (e.g., river morphological units, shear stress, stream power) within the River Wensum. As a result of this and the implementation of mitigation and enhancement measure, no long-term impact on the composition and abundance of aquatic flora is anticipated at the WFD water body scale or on the vegetation community that characterises the habitat type listed as a qualifying feature of the River Wensum SAC.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08 Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10. River Wensum Enhancements - OM-RDWE-12 Ditch Network Enhancements - OM-RDWE-13

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Road runoff and pollution risk** During the operational phase, road runoff can introduce water with a different thermal condition into the water body (e.g., due to higher residence time on shallow surfaces). However, as described in the DNWQA report (Document reference: 3.12.01), the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces thermal impact of returning water to the channel). Therefore, no long-term impact on thermal conditions at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Thermal Conditions	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme would reduce solar exposure which could reduce local temperature of the water body. The shading study revealed that the River Wensum Viaduct structure over the River Wensum could reduce light exposure along its length. However, loss of shade sensitive macrophyte species is likely to off-set in the short-term by the growth of more shade tolerant species. In addition, the River Wensum Viaduct dimensions (0.6 kilometres) are far smaller than the water body length (65.7 kilometres), resulting in a negligible overall impact to the water body. Additionally, the flowing water beneath the proposed River Wensum Viaduct is not likely to be impacted by shading from the bridge due to the lack of residency time in shaded conditions. An approximate 18m wide permanent culvert on WC5 is expected to reduce the thermal condition within the ditch, directly beneath the structure. There may be unexpected benefits from shading and cooler temperatures in the ditch, where there is a distinct lack of natural shading. The negative impacts are expected to be localised in nature, and with negligible long-term impact on river thermal conditions. Therefore, this activity is not expected to have a significant impact on the thermal conditions of the river at the WFD water body scale.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; Culvert design mitigation - OM-RDWE-09; and Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct and the attenuation / infiltration ponds can change hydraulics and therefore thermal conditions. The approximate 18m permanent culvert on WC5 would cause shading, impacting thermal conditions within the ditch. The same effect on thermal conditions is not expected within the River Wensum from the River Wensum Viaduct, due to comparably faster flowing water and therefore a lack of residency time beneath the structure to cause effects on thermal conditions. Although minimal, permanent vegetation clearance along some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme is anticipated. The increase in solar exposure due to vegetation loss can change local thermal condition of the water body. Although the presence of attenuation / infiltration ponds can change thermal conditions locally, they are not expected to change the overall thermal condition of the WFD water body. For comparison, the largest attenuation / infiltration pond is ~ $0.05km^2$ whilst the WFD water body is ~ $189.2km^2$. In addition, the hydraulic modelling presented in the Wensum geomorphology assessment (Document reference: 3.12.04) shows that the operational phase is not expected to have a significant impact on existing river processes (e.g., river morphological units, shear stress, stream power). Therefore, no long-term impact on thermal conditions at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08 Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Enhancements - OM-RDWE-11.
Oxygenation Conditions	**Road runoff and pollution risk** During the operational phase, road runoff and pollution risk can introduce waters with a different chemical condition into the water body. These new chemical characteristics can impact the oxygen content either by increasing the proportion of other compounds or by impacting the photosynthesis. However, as described in the DNWQA report (Document reference: 3.12.01), the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces oxygenation impact of returning water to the channel). Therefore, no long-term impact on oxygenation conditions at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Oxygenation Conditions	**Alteration to flows and / or habitats** During the operational phase, alteration to flow is restricted to out of bank events and minor changes from some structures (e.g., attenuation / infiltration ponds). It is not anticipated that these changes to flow are sufficient to alter baseline oxygenation conditions. The loss of macrophytes due to shading from the permanent culvert on WC5 can reduce photosynthesis along the bank face / bottom, therefore altering local oxygenation conditions. As attenuation / infiltration ponds are constructed outside existing channel, they are not expected to change the overall oxygenation condition of the WFD water body. For comparison, the largest attenuation / infiltration pond is ~ 0.05km^2 whilst the WFD water body is ~ 189.2km^2. In addition, the hydraulic modelling presented in the Wensum geomorphology assessment (Document reference: 3.12.04) shows that the operational phase is not expected to have a significant impact on existing river processes (e.g., river morphological units, shear stress, stream power). Therefore, no long-term impact on oxygenation conditions at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08 Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Enhancements - OM-RDWE-11.
Salinity	**Road runoff and pollution risk** Potential release of salt spray and chemical compounds during the operational phase could impact on salinity levels. However, as described in the DNWQA report (Document reference: 3.12.01), the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces the impact of returning water to the channel). In addition, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on salinity levels at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Salinity	**Alteration to flows and / or habitats** Alteration to habitats due to permanent vegetation clearance is not anticipated to increase salt input to the watercourse or result in a change to the chemical composition of the water. Potential release of salt spray and chemical compounds during the operational phase could impact on salinity levels via new flow paths. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces the impact of returning water to the channel). In addition, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on salinity levels at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
Acidification Status	**Road runoff and pollution risk** Potential release of salt spray and chemical compounds during the operational phase could impact acidification levels. However, as described in the Appendix 12.1: Drainage Network Water Quality Assessment (DNWQA) of Chapter 12: Road Drainage and the Water Environment of the Environmental Statement (Document Reference: 3.12.01), the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces thermal impact of returning water to the channel). In addition, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on acidification status at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; and Pollution and spillages incidents - OM-RDWE-03.
Acidification Status	**Alteration to flows and / or habitats** Potential release of salt spray and chemical compounds during the operational phase could impact on acidification levels via new flow paths. Alteration to habitats due to permanent vegetation clearance is not anticipated to increase acidification levels of the watercourse or result in a change to the chemical composition of the water. In addition, potential release of salt spray and chemical compounds during the operational phase could impact acidification levels via new flow paths. As attenuation / infiltration ponds are constructed outside existing channel, there are not expected to change the overall acidification status of the WFD water body. For comparison, the largest attenuation pond is approximately 0.05km^2 whilst the WFD water body is approximately 189.2km^2. In addition, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces the impact of returning water to the channel). Similarly, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on acidification status at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
Nutrient Conditions	**Road runoff and pollution risk** Potential release of salt spray and chemical compounds during the operational phase could impact on nutrient condition. However, as described in the Appendix 12.1: Drainage Network Water Quality Assessment (DNWQA) of Chapter 12: Road Drainage and the Water Environment of the Environmental Statement (Document Reference: 3.12.01), the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels (e.g., four of them are infiltration basins, which reduces thermal impact of returning water to the channel). In addition, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on nutrient conditions at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; and Pollution and spillages incidents - OM-RDWE-03.
Nutrient Conditions	**Alteration to flows and / or habitats** During operational condition, alteration to flows and / or habitats are not anticipated to impact on the existing nutrient condition. Alteration to habitats due to permanent vegetation clearance is not anticipated to alter nutrient conditions or result in a change to the chemical composition of the watercourse. However, potential release of salt spray and chemical compounds during the operational phase could impact on nutrient condition via new flow paths. As attenuation / infiltration ponds are constructed outside the existing channel, they are not expected to change the overall nutrient condition of the WFD water body. In addition, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of flow / habitat alteration (e.g., four of them are infiltration basins, which reduces the impact of returning water to the channel). Similarly, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. Therefore, no long-term impact on nutrient conditions at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Quantity and Dynamics of Water Flow	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body during the operational phase. However, from the seven proposed attenuation / infiltration basins, four are for infiltration only, meaning that road runoff and pollution risk to the river channel are expected to be negligible, as described in the DNWQA report (Document reference: 3.12.01). Therefore, no long-term impact on water flow from road runoff at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Quantity and Dynamics of Water Flow	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme would reduce solar exposure and cause a loss of macrophytes or change in the macrophyte community composition. Any loss of or change in the macrophyte community can impact on hydraulics. However, ecological studies show that light-sensitive vegetation would be replaced by shade tolerant species, off-setting the loss. In addition, the Wensum geomorphology assessment (Document reference: 3.12.04) shows that a reduction in roughness due to aquatic vegetation replacement would not be sufficient to produce significant changes in river hydraulics. In addition, there are embedded mitigation measures within the design of the Proposed Scheme that further minimise the impacts of shading. Therefore, no long-term impact on water flow from shading at the WFD water body scale are foreseen.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; and Enhancements - OM-RDWE-11.
Quantity and Dynamics of Water Flow	**Alteration to flows and / or habitats** Any permanent vegetation clearance could alter floodplain roughness and therefore hydraulics in and out of bank flows along the water body. During the operational phase, the piers of the River Wensum Viaduct, the outfall scour protection, and the attenuation / infiltration ponds can change hydraulics for out of bank flows. The permanent approximate 18m long culvert on WC5 would reduce solar exposure, causing a loss of macrophytes. This loss of macrophytes can impact on hydraulics. The hydraulic modelling results presented in the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for the quantity and dynamics of flow during the operational. Attenuation / infiltration ponds would be located outside of the floodplain and would infiltrate to ground and therefore they are not expected to change the overall quantity and dynamics of water flow. Therefore, no long-term impacts on water flow at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., reconnection to historic meander) proposed are expected to significantly improve the flow characteristics whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** Increase in overland flow - OM-RDWE-04; River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08; Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10: and, Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Connection to Groundwater Bodies	**Road runoff and pollution risk** Impermeabilisation of the soil and changes in flow routes (e.g., road runoff) due to the Proposed Scheme can impact on infiltration rates and, hence, the recharge and connection between surface and groundwater bodies. However, the operation of the attenuation / infiltration ponds would maintain baseline-like infiltration rates to the ground and, therefore, are not expected to change the connection between surface and groundwater at the WFD waterbody scale. In addition, pollution risk to the river channel is expected to be negligible, as described in the DNWQA report (Document reference: 3.12.01), further reducing chemical exchange with groundwater. Similarly, the groundwater modelling study (Document reference: 3.12.05) found that the impact from the infiltration of chloride into the aquifer remains at local scale only, with no significant impact to the River Wensum. In addition, there are embedded mitigation measures within the design of the Proposed Scheme that further minimise the impacts of road runoff and pollution risk. Therefore, no long-term impacts on connection to groundwater bodies at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Increase in overland flow - OM-RDWE-04.
Connection to Groundwater Bodies	**Alteration to flows and / or habitats** Permanent vegetation clearance and operation of attenuation / infiltration ponds can change flows and habitats, and, ultimately, impact the connection to groundwater (e.g., infiltration rates and water table levels). However, the hydraulic modelling results presented in the Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for the flow during the operational phase. Attenuation / infiltration ponds would be located outside of the floodplain and would infiltrate to ground and therefore they are not expected to change the overall quantity and dynamics of water flow. Therefore, no long-term impacts on water flow and the connection to groundwater bodies at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., reconnection to historic meander) proposed are expected to significantly improve the connectivity between surface and groundwater bodies whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** Description of mitigation

Quality Element	Potential Impact	Mitigation
River Continuity	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme would reduce solar exposure and cause a loss of macrophytes or change in macrophyte community composition. Any reduction or change in the macrophyte community can impact on hydraulics and, by extension, upon river continuity. However, ecological studies show that light-sensitive vegetation would be replaced by shade tolerant species, off-setting the loss. The Wensum geomorphology assessment (Document reference: 3.12.04) shows that a reduction in roughness due to aquatic vegetation replacement would not be sufficient to produce significant changes in river hydraulics. In addition, there are embedded mitigation measures in the design of the Proposed Scheme that further minimise the impacts of shading. Therefore, no long-term impact on river continuity at the WFD water body scale are foreseen.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; and Culvert shading mitigation - OM-RDWE-06.
River Continuity	**Alteration to flows and / or habitats** Any permanent vegetation clearance could alter floodplain roughness and, hence, lateral continuity in out of bank flows along the water body. During the operational phase, the piers of the River Wensum Viaduct, the outfall scour protection, and the attenuation / infiltration ponds can change hydraulics for out of bank flows, hence, river continuity. The permanent approximate 18m long culvert on WC5 would reduce solar exposure, causing a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river continuity. The hydraulic modelling and Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for river continuity during the operational phase of the permanent access track. The attenuation / infiltration ponds would be located outside of the floodplain and would infiltrate to ground. Therefore, no long-term impacts on river continuity at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., reconnection to historic meander) proposed are expected to significantly improve the river continuity whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08; Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Enhancements - OM-RDWE-11.
River Depth and Width Variation	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body, which has further implications to the river geometry. However, from the seven proposed attenuation / infiltration basins, four are for infiltration only, meaning that road runoff and pollution risk to the river channel are expected to be negligible, as described in the DNWQA report (Document reference: 3.12.01). In addition, there are embedded mitigation measures in the design of the Proposed Scheme that further minimise the impacts of road runoff. Therefore, no long-term impacts on river geometry at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme can reduce solar exposure and cause a loss of macrophytes or change in the macrophyte community. This reduction of macrophytes can impact on hydraulics and, by extension, upon river geometry. However, ecological studies show that light-sensitive vegetation would be replaced by shade tolerant species, hence, off-setting the loss. In addition, the Wensum geomorphology assessment (Document reference: 3.12.04) shows that a reduction in roughness due to aquatic vegetation replacement would not be sufficient to produce significant changes in river hydraulics. In addition, there are embedded mitigation measures within the design of the Proposed Scheme and enhancement opportunities that further minimise the impacts of shading. Therefore, no long-term impact on river geometry from shading at the WFD water body scale are foreseen.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; and Enhancements - OM-RDWE-11.
River Depth and Width Variation	**Alteration to flows and / or habitats** Any permanent vegetation clearance could alter floodplain roughness and, hence, river geometry in out of bank flows. During the operational phase, the piers of the River Wensum Viaduct, the outfall scour protection, and the attenuation / infiltration ponds can change hydraulics for out of bank flows, and therefore river geometry. The permanent approximate 18m long culvert on WC5 would reduce solar exposure, causing a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river geometry. The hydraulic modelling and Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for the river depth and width variation during the operational phase of the Proposed Scheme. Attenuation / infiltration ponds would be located outside of the floodplain and would infiltrate to ground and therefore they are not expected to change the overall river depth and width variation. Therefore, no long-term impact on river geometry at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., installation of large wood structures) proposed are expected to significantly improve the river geometry whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Increase in overland flow - OM-RDWE-04; River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08; Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body, which has further implications to the river bed structure and substrate. However, from the seven proposed attenuation / infiltration basins, four are for infiltration only, meaning that road runoff and pollution risk to the river channel are expected to be negligible, as described in the DNWQA report (Document reference: 3.12.01). In addition, there are embedded mitigation measures within the design of the Proposed Scheme that further minimise the impacts of road runoff. Therefore, no long-term impact on river bed substrate at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Structure and Substrate of the River Bed	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme can reduce solar exposure and cause a loss of macrophytes or change in the macrophyte community composition. This reduction of or change in macrophytes can impact on hydraulics and, by extension, upon river bed characteristics. However, ecological studies show that light-sensitive vegetation would be replaced by non-sensitive ones, hence, off-setting the loss. In addition, the Wensum geomorphology assessment (Document reference: 3.12.04) shows that a reduction in roughness due to aquatic vegetation replacement would not be sufficient to produce significant changes in river hydraulics. In addition, there are embedded mitigation measures within the design of the Proposed Scheme and enhancement opportunities that further minimise the impacts of shading. Therefore, no long-term impact on river bed characteristics from shading at the WFD water body scale are foreseen.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; and Enhancements - OM-RDWE-11.
Structure and Substrate of the River Bed	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct, the outfall scour protection, and the attenuation / infiltration ponds can change hydraulics for out of bank flows, hence, river bed characteristics. The permanent approximate 18m long culvert on WC5 would reduce the solar exposure, causing a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river bed characteristics. The hydraulic modelling and Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for the structure and substrate of the river bed during the operational phase of the Proposed Scheme. Attenuation / infiltration ponds would be located outside of the floodplain and would infiltrate to ground and therefore they are not expected to change the overall structure and substrate of the river bed. Therefore, no long-term impacts on river bed characteristics at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., installation of large wood structures) proposed are expected to significantly improve the river bed characteristics whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Increase in overland flow - OM-RDWE-04; River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
Structure of the Riparian Zone	**Shading** During the operational phase, some structures (e.g., culvert and River Wensum Viaduct) of the Proposed Scheme can reduce solar exposure and cause a loss of vegetation within the riparian zone. The shading assessment revealed that the River Wensum Viaduct structure could reduce light exposure along its length, hence, inducing changes in the structure of the riparian zone. However, the deck height of the bridge has been designed to allow for riparian vegetation growth beneath the bridge deck. In addition, the width of the River Wensum Viaduct crossing on a 65.7 kilometres long water body would be insignificant at the water body scale. The hydraulic modelling and Wensum geomorphology assessment (Document reference: 3.12.04) revealed that no adverse impacts are predicted for the structure of the riparian zone during the operational phase of the permanent access track. Therefore, this activity is not expected to have a significant impact on the structure of the riparian zone along the WFD water body.	**Shading** River Wensum Viaduct shading mitigation - OM-RDWE-05; Culvert shading mitigation - OM-RDWE-06; and Enhancements - OM-RDWE-11.
Structure of the Riparian Zone	**Alteration to flows and / or habitats** During the operational phase, the piers of the River Wensum Viaduct and the attenuation / infiltration ponds can change hydraulics for out of bank flows, hence, the riparian zone characteristics. Any permanent vegetation clearance could directly impact upon the riparian zone. The permanent approximate 18m long culvert on WC5 would reduce solar exposure, causing a loss of riparian vegetation. However, the hydraulic modelling revealed that changes in out of bank flows are negligible during the operational phase. Therefore, no long-term impact on riparian zone at the WFD water body scale are foreseen. In addition, the biodiversity enhancements (e.g., native riparian planting) proposed are expected to significantly improve the riparian zone whilst uplifting, at least, 10% of the river component metrics of the BNG of the River Wensum within the Red Line Boundary.	**Alteration to flows and / or habitats** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; Increase in overland flow - OM-RDWE-04; River Wensum Viaduct habitat mitigation - OM-RDWE-07; Maintenance access mitigation - OM-RDWE-08; Culvert design mitigation - OM-RDWE-09; Realignment mitigation – OM-RDWE-10; and Enhancements - OM-RDWE-11.

River Tud

5.2.11 An assessment of the potential operational impacts on those activities and quality elements screened and scoped in for the River Tud water body are presented in **Table 5.7**.

Table 5.7 Potential operational impacts on the scoped in WFD biological, physico-chemical and hydromorphological quality elements on the River Tud (GB105034051000)

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk during the operational phase may impact upon fish and their habitat, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. This could cause degradation of spawning habitat, food sources and water quality. Any reduction in dissolved oxygen and increased levels of toxic parameters may lead to direct mortality of fish. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). The proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact is expected on fish fauna at the WFD water body scale or on those fish species that are listed as qualifying features of the downstream River Wensum SAC.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation – OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Shading** During the operational phase of the Proposed Scheme there would be a direct loss of macrophytes within the permanent Tud tributary culvert / Bat underpass on Foxburrow Stream, as a result of shading from culvert structure. There would be direct and indirect effects of shading on fish within the vicinity of this culvert, from loss of shelter and spawning habitat and a possible deterrence effect for migrating fish. The low light levels and overall length of the Tud tributary culvert / Bat underpass would possibly deter movement upstream. The Tud tributary culvert / Bat underpass on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structures and hence reduce the shading effect as far as practicable. It should be noted that no fish were caught in this section of Foxburrow Stream during surveys in 2021 and 2022. Despite the mitigation measures, the loss of macrophytes and open water habitat would make this section of the stream less favourable for fish. The loss of open water habitat on Foxburrow Stream is to be mitigated by the enhancement of aquatic habitat on the Foxburrow stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat, remove existing barriers to movement (such as pipe culverts), install livestock fencing and introduce large wood to the channel to slow flows. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. No downstream impacts from shading are expected on the River Tud or River Wensum SAC. Due to the localised negligible impact expected and implementation of mitigation measures, no long-term impacts on fish fauna at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06; and Foxburrow Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Alteration to flows and / or habitats** During the operational phase of the Proposed Scheme, the permanent Tud tributary culvert / Bat underpass, associated channel realignment and the attenuation pond may change hydraulics which would lead to a loss of functional habitat for fish habitat, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. Additionally, there would be a direct effect on fish through the loss of open water habitat from the permanent Tud tributary culvert / Bat underpass on Foxburrow Stream. Effects on fish within the vicinity of this culvert include loss of shelter and spawning habitat and a possible deterrence effect for migrating fish. The low light levels and overall length of this culvert would possibly deter movement upstream. The negative effects of the Tud tributary culvert / Bat underpass are to be mitigated through physical design (such as oversizing and depressed invert of this culvert), to minimise impacts on fish passage, preserve a natural substrate and increase light penetration. The depressed invert would also reduce the risk of bed and bank scour at the inlet and outlet of this culvert, and prevent the formation of physical barriers to fish migration. It should be noted that no fish were caught in this section of Foxburrow Stream during surveys in 2021 and 2022. Despite the embedded design measures, the loss of macrophytes and open water habitat would make this section of the stream less favourable for fish. The loss of open water habitat on Foxburrow Stream is to be mitigated by the enhancement of aquatic habitat on the Foxburrow Stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat by reconnecting the floodplain, remove existing barriers to movement (such as pipe culverts), install livestock fencing and introduce wood debris to the channel to diversify flows and create additional diversity of aquatic habitat. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. In addition, proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. No downstream impacts from alterations to flows or habitat are expected on the River Tud or River Wensum SAC. Due to the localised negligible impact expected and implementation of mitigation measures, no long-term impacts on fish fauna at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10. Foxburrow Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk during the operational phase may impact upon benthic invertebrates and their habitat especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. This could cause degradation of habitat, food sources and water quality, leading to indirect impacts on benthic invertebrate communities. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). The proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Composition and Abundance of Benthic Invertebrate Fauna	**Shading** During the operational phase of the Proposed Scheme there would be a direct loss of macrophytes within the Tud tributary culvert / Bat underpass on Foxburrow Stream, as a result of shading from this culvert. There would be indirect effects of shading on benthic invertebrate fauna within the vicinity of this culvert, from loss of shelter and food source. The Tud tributary culvert / Bat underpass on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structures and hence reduce the shading effect as far as practicable. Despite the mitigation measures, the loss of macrophytes and open water habitat would make this section of the stream less favourable for benthic invertebrates. The loss of open water habitat on Foxburrow Stream is to be mitigated by the enhancement of aquatic habitat on the Foxburrow stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat, remove existing barriers to improve habitat connectivity (such as pipe culverts), install livestock fencing and introduce large wood to the channel to slow flows. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. No downstream impacts from shading are expected on the River Tud. Due to the localised impact expected and implementation of mitigation measures, no long-term impacts on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06; and Foxburrow Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Benthic Invertebrate Fauna	**Alteration to flows and / or habitats** During the operational phase of the Proposed Scheme, the Tud tributary culvert / Bat underpass, associated channel realignment and the attenuation pond may change hydraulics which would lead to a loss of functional habitat for benthic invertebrate fauna, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. Additionally, there would be a direct effect on invertebrates through the loss of open water habitat from the Tud tributary culvert / Bat underpass on Foxburrow Stream. Effects on invertebrates within the vicinity of this culvert include loss of shelter and food sources. The negative effects of the Tud tributary culvert / Bat underpass are to be mitigated through physical design (such as oversizing and depressed invert of this culvert), to minimise impacts on habitat connectivity, preserve a natural substrate and increase light penetration. The depressed invert would also reduce the risk of bed and bank scour at the inlet and outlet of this culvert. Despite the embedded design measures, the loss of macrophytes and open water habitat would make this section of the stream less favourable for benthic invertebrate fauna. The loss of open water habitat on Foxburrow Stream is to be mitigated by the enhancement of aquatic habitat on the Foxburrow Stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat, remove existing barriers to movement (such as pipe culverts), install livestock fencing and introduce wood debris to the channel to diversify flows and create additional diversity of aquatic habitat. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. In addition, proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. No downstream impacts from alterations to flows or habitat are expected on the River Tud. Due to the localised negligible impact expected and implementation of mitigation measures, no long-term impacts on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Foxburrow Enhancements - OM-RDWE-11

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk during the operational phase may impact upon macrophytes and their habitat, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. This could cause degradation of habitat and water quality, leading to indirect impacts on macrophyte communities. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). The proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on aquatic flora at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Composition and Abundance of Aquatic Flora	**Shading** During the operational phase, the Tud tributary culvert / Bat underpass would reduce solar exposure causing a loss of macrophytes within the immediate vicinity of this culvert. The Tud tributary culvert / Bat underpass would be over-sized to enable maximum light penetration through the structures and hence reduce the shading effect as far as practicable. Despite the mitigation measures, there would still be a localised loss of macrophytes. This loss is to be mitigated by the enhancement of aquatic habitat on the Foxburrow Stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat, remove existing barriers to improve habitat connectivity (such as pipe culverts), install livestock fencing and introduce wood debris to the channel to diversify flows and create additional diversity of aquatic habitat. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. It is expected that a more diverse macrophyte assemblage than is currently present would establish over time. In addition, proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. No downstream impacts from shading are expected on the River Tud or River Wensum SAC macrophyte community. However, with the proposed mitigation measures and enhancement opportunities, no long-term impact on the composition and abundance of aquatic flora is anticipated at the WFD water body scale.	**Shading** Culvert shading mitigation - OM-RDWE-06; and Foxburrow Enhancements - OM-RDWE-11.

Quality Element	Potential Impact	Mitigation
Composition and Abundance of Aquatic Flora	**Alteration to flows and / or habitats** During the operational phase of the Proposed Scheme, the Tud tributary culvert / Bat underpass, associated channel realignment and the attenuation pond may change hydraulics which may lead to a loss of functional habitat for macrophytes, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. Additionally, there would be a direct localised loss of macrophytes beneath the Tud tributary culvert / Bat underpass on Foxburrow Stream. The negative effects of the Tud tributary culvert / Bat underpass are to be mitigated through physical design (such as oversizing and depressed invert of this culvert), to preserve a natural substrate and increase light penetration. The depressed invert would also reduce the risk of bed and bank scour at the inlet and outlet of this culvert. Despite the embedded design measures, there would still be a localised loss of aquatic flora. This loss is to be mitigated by the enhancement of aquatic habitat on the Foxburrow Stream, both upstream and downstream of the Tud tributary culvert / Bat underpass. The enhancements would aim to create wet woodland habitat, remove existing structures (such as pipe culverts and dilapidated bridges), install livestock fencing and introduce wood debris to the channel to diversify flows and create additional diversity of aquatic habitat. This would off-set any degradation of aquatic habitat and provide an additional 10% uplift to achieve target BNG conditions. It is expected that a more diverse macrophyte assemblage than is currently present would establish over time. In addition, proposed treatment trains would ensure the discharged water meets water quality standards in conjunction with controlled discharged rates set out within the drainage strategy. No downstream impacts from alterations to flows or habitat are expected on the River Tud or River Wensum SAC macrophyte community. Due to the localised negligible impact expected and implementation of mitigation measures, no long-term impacts on aquatic flora at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; Realignment mitigation - OM-RDWE-10; and Foxburrow Enhancements - OM-RDWE-11

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Road runoff and pollution risk** During the operational phase, road runoff can introduce water with a different thermal condition and fine sediments into the water body (e.g., due to higher residence time on shallow surfaces), especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on thermal condition at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Thermal Conditions	**Shading** During the operational phase, the Tud tributary culvert / Bat underpass would reduce solar exposure and may therefore reduce local temperature of the water body, however, due to the expected flow rate and short residency time within the structure, changes are expected to be minimal. Therefore, installation of the Tud tributary culvert / Bat underpass on the Foxburrow Stream has the potential to cause negligible changes to the baseline condition along the structure. However, the Tud tributary culvert / Bat underpass length (approximately 0.05 kilometres) is far shorter than the WFD water body length (28.3 kilometres) and covers a very localised area of a small stream tributary of the Tud catchment. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Shading** Culvert shading mitigation - OM-RDWE-06.

Quality Element	Potential Impact	Mitigation
Thermal Conditions	**Alteration to flows and / or habitats** During the operational phase, the Tud tributary culvert / Bat underpass and the attenuation pond can change hydraulics which may affect thermal conditions, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. The operation of the outfalls to return pluvial water into the Foxburrow Stream is unlikely to alter the WFD water body thermal condition within the River Tud WFD water body. Although some differences between the water temperature at the outfalls and in-channel may vary, the outfalls water temperature is expected to be like those from overland flow within the same part of the catchment. In addition, the catchment area of the Foxburrow Stream (0.3km^2) is much smaller than the River Tud WFD water body (70.2km^2), further reducing potential impacts on thermal conditions. In total, the catchment area draining upstream of the outfalls is less than 100 orders of magnitude smaller than the River Tud WFD water body. The operation of attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. As described for the outfalls, its operation is unlikely to alter the WFD water body thermal condition. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, this activity is not expected to have a significant impact on the WFD water body thermal condition.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Oxygenation Conditions	**Road runoff and pollution risk** During the operational phase, road runoff and pollution risk can introduce waters with a different chemical condition into the water body, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. These new chemical characteristics can impact the oxygen content either by increasing the proportion of other compounds or by impacting the photosynthesis. However, as described in the DNWQA report (Document reference: 3.12.01), the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, significantly minimising oxygenation issues. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on oxygenation at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Oxygenation Conditions	**Shading** During the operational phase, the Tud tributary culvert / Bat underpass would reduce solar exposure and reduce photosynthesis of in-channel macrophytes and, hence, may prevent oxygen input via photosynthesis in the affected reach. Installation of the Tud tributary culvert / Bat underpass has the potential to alter the baseline condition along the structure. However, the approximate culvert length (0.05 kilometres) is far shorter than the WFD water body length (28.3 kilometres) and covers a very localised area of a small stream tributary of the Tud catchment, so changes are expected to be negligible. There is a benefit of providing shading which would cool water temperatures, increasing the streams capacity for holding dissolved oxygen. Therefore, this activity is not expected to have a significant impact on the WFD water body oxygenation condition.	**Shading** Culvert shading mitigation - OM-RDWE-06.
Oxygenation Conditions	**Alteration to flows and / or habitats** During the operational phase, alteration to flow and solar exposure due to the culvert can reduce photosynthesis of in-channel macrophytes and, hence, prevent oxygen input via photosynthesis in the affected reach. However, the operation of the outfalls to return pluvial water into the River Tud (Foxburrow Stream) is likely to be negligible. Although some differences between the water oxygen content at the outfalls and in-channel may vary, the outfalls water oxygenation is expected to be like those from overland flow within the same part of the catchment. In addition, the catchment area of the Foxburrow Stream (0.3km^2) is much smaller than the River Tud WFD water body (70.2km^2), further reducing potential impacts on oxygenation condition. In total, the catchment area draining upstream of the outfalls is less than 100 orders of magnitude smaller than the River Tud WFD water body. Therefore, this activity is not expected to have a significant impact on the WFD water body oxygenation condition. The operation of attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation / infiltration ponds further reduce any impact from pollutants and fines in the water composition to be returned via outfalls. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter the WFD water body oxygenation condition.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
Salinity	**Road runoff and pollution risk** Potential release of salt spray and chemical compounds because of road runoff during the operational phase could impact on salinity levels, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, as described in the DNWQA report (Document reference: 3.12.01), the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, significantly minimising any potential salinity issues. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on salinity levels at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation – OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Salinity	**Alteration to flows and / or habitats** Potential release of salt spray and chemical compounds during the operational phase could impact on salinity levels via new flow paths, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, significantly minimising potential salinity issues. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on salinity levels at the WFD water body scale are foreseen.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Acidification Status	**Road runoff and pollution risk** Potential release of salt spray and chemical compounds during the operational phase could impact on acidification levels, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, as described in the DNWQA report (Document reference: 3.12.01), the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, significantly minimising acidification issues. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on acidification status at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation – OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Acidification Status	**Alteration to flows and / or habitats** Potential release of salt spray and chemical compounds during the operational phase due to road runoff could impact on acidification levels via new flow paths. The operation of the outfalls to return pluvial water into the River Tud (Foxburrow Stream) is unlikely to alter the WFD water body thermal condition. Although some differences between the water pH at the outfalls and in-channel may vary, the outfalls acidification is expected to be like those from overland flow within the same part of the catchment (with the attenuation pond in effect). In addition, the catchment area of the Foxburrow Stream (0.3km^2) is much smaller than the River Tud WFD water body (70.2km^2), further reducing potential impacts on baseline condition. In total, the catchment area draining upstream of the outfalls is less than 100 orders of magnitude smaller than the River Tud WFD water body. Therefore, this activity is not expected to have a significant impact on the WFD water body acidification status. The operation of attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation / infiltration ponds further reduce any impact from pollutants and fines in the water composition which can alter pH. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter the WFD water body acidification status.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Nutrient Conditions	**Road runoff and pollution risk** Potential release of spray and road run-off during the operational phase could impact nutrient condition, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, as described in the DNWQA report (Document reference: 3.12.01), the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, significantly minimising nutritional issues. In addition, proposed treatment trains would ensure controlled discharged rates set out within the drainage strategy. Therefore, no long-term impact on nutrition conditions at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
Nutrient Conditions	**Alteration to flows and / or habitats** Potential release of spray and road run-off during the operational phase could impact on nutrient condition via new flow paths. The operation of the outfalls to return pluvial water into the River Tud (Foxburrow Stream) is unlikely to alter the WFD water body nutrient condition. Although some differences between the water pH at the outfall and in-channel may vary, the water at the outfalls is expected to be like those from overland flow within the same part of the catchment (with the attenuation pond in effect). In addition, the catchment area of the Foxburrow Stream (0.3km^2) is much smaller than the River Tud WFD water body (70.2km^2), further reducing potential impacts on baseline condition. In total, the catchment area draining upstream of the outfalls is less than 100 orders of magnitude smaller than the River Tud WFD water body. Therefore, this activity is not expected to have a significant impact on the WFD water body nutrient condition. The operation of attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation / infiltration ponds further reduce any impact from pollutants and fines in the water composition which can alter nutrient availability. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter the WFD water body nutrient condition.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Quantity and Dynamics of Water Flow	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body, especially with the resulting cumulative effect of discharge from the Proposed Scheme and the National Highways A47 DCO road. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff to the existing discharge by limiting the outfalls flow to greenfield runoff rates. Therefore, no long-term impact on quantity and dynamics of water flow at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation – OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Quantity and Dynamics of Water Flow	**Shading** During the operational phase, the culvert of the Proposed Scheme would reduce solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics. However, the proposed culvert on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structures, hence, reducing the shading effect as far as practicable. Therefore, no long-term impact on water flow from shading at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06.

Quality Element	Potential Impact	Mitigation
Quantity and Dynamics of Water Flow	**Alteration to flows and / or habitats** During the operational phase, the culvert and associated channel realignment, the attenuation / infiltration ponds and outfalls can change local hydraulics (e.g., hydrograph characteristics). The hydraulic modelling and geomorphology study (see **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** (Document Reference: 3.12.03c)) revealed that culvert structure could only produce a small influence on local hydraulics during operation. Reach-wise, the length of the watercourse (would reduce by approximately 7m (with consequent river bed gradient increase) as works remove the meander under the Proposed Scheme. However, this is not foreseen to significantly increase stream power during operation. Whilst small-scale morphological changes can occur due to an increase in river bed gradient, the Foxburrow Stream is expected to retain the same hydraulic and geomorphic behaviour, with no adjustment during low to medium-magnitude events (Q2 to Q100) to both baseline and operational Conditions. Therefore, this activity is not expected to have a significant impact on the WFD water body quantity and dynamics of flow. The operation of an attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation ponds further reduce any possible increase in overland flow arriving at the channel. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter the quantity and dynamics of flow of the River Tud WFD water body. In addition, the biodiversity enhancements (e.g., reconnection to historic meander) proposed are expected to significantly improve the flow characteristics whilst uplifting, at least, 10% of the river component metrics of the BNG of the Foxburrow Stream within the Red Line Boundary. Finally, the proposed removal of the poorly placed stepped culvert in the Foxburrow Stream is also expected to positively impact river dynamics.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
River Continuity	**Road runoff and pollution risk** Fine sediments transported via road runoff could impact on river continuity through sediment accumulation. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff to the existing discharge by limiting the outfalls flow to greenfield runoff rates. Hence, the impact of siltation due to road runoff should be negligible with a restriction to in-channel sediment accumulation. Therefore, no long-term impact on quantity and dynamics of water flow at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Quality Element	Potential Impact	Mitigation
River Continuity	**Shading** The culvert would reduce the solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river continuity. However, the proposed culvert on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structure and therefore reduce the shading effect as far as practicable. Therefore, no long-term impact on river continuity from shading at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06.
River Continuity	**Alteration to flows and / or habitats** The culvert would reduce the solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river continuity. The hydraulic modelling and geomorphology study (see **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** (Document Reference: 3.12.03c)) revealed that culvert structure could only produce a small influence on local hydraulics during operation. Reach-wise, the length of the watercourse would reduce by approximately 7m (with consequent river bed gradient increase) as works remove the meander under the Proposed Scheme. However, this is not foreseen to significantly increase stream power during operation. Whilst small-scale morphological changes can occur due to an increase in river bed gradient, the Foxburrow Stream is expected to retain the same hydraulic and geomorphic behaviour, with no adjustment during low to medium-magnitude events (Q2 to Q100) to both baseline and operational conditions. Therefore, this activity is not expected to have a significant impact on the flow continuity along the WFD water body. The operation of the attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation ponds further off-set an increase in overland flow arriving at the channel. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter flow continuity along the River Tud WFD water. In addition, the biodiversity enhancements (e.g., reconnection to historic meander) proposed are expected to significantly improve the river continuity whilst uplifting, at least, 10% of the river component metrics of the BNG of the Foxburrow Stream within the Red Line Boundary. Finally, the proposed removal of the poorly placed stepped culvert in the Foxburrow Stream would also positively impact river continuity.	**Alteration to flows and / or habitats** Outfall mitigation – OM-RDWE-02; Culvert design mitigation – OM-RDWE-09; and Realignment mitigation – OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body, which has further implications to the river geometry. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff to the existing discharge by limiting the outfalls flow to greenfield runoff rates. Hence, the impact of siltation due to road runoff should be negligible with a restriction to in-channel sediment accumulation. Therefore, no long-term impact on river depth and width variation at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management – OM-RDWE-01; Outfall mitigation – OM-RDWE-02; Pollution and spillages incidents – OM-RDWE-03; Increase in overland flow – OM-RDWE-04; and Culvert design mitigation – OM-RDWE-09.
River Depth and Width Variation	**Shading** During the operational phase, the proposed culvert would reduce solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river geometry. However, the proposed culvert on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structures and therefore reduce the shading effect as far as practicable. Therefore, no long-term impact on river geometry from shading at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06.

Quality Element	Potential Impact	Mitigation
River Depth and Width Variation	**Alteration to flows and / or habitats** The culvert can reduce the solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river geometry. In addition, the attenuation / infiltration ponds can change the local hydraulics (e.g., flow velocity). The culvert and associated channel realignment would locally alter flow patterns and habitats, which could affect the river depth and width variation. The hydraulic modelling and geomorphology study (see **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** (Document Reference: 3.12.03c)) revealed that the culvert structure could only produce a small influence on local hydraulics during operation. Reach-wise, the length of the watercourse would reduce by approximately 7m (with consequent river bed gradient increase) as works remove the meander under the Proposed Scheme. However, this is not foreseen to significantly increase stream power during operation. Whilst small-scale morphological changes can occur due to an increase in river bed gradient, the Foxburrow Stream is expected to retain the same hydraulic and geomorphic behaviour, with no adjustment during low to medium-magnitude events (Q2 to Q100) to both baseline and operational conditions. The operation of the attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation ponds further off-set an increase in overland flow arriving at the channel. However, the culvert and associated channel realignment would locally alter the river depth and width variation. Additionally, the culverts would be over-sized with a depressed invert to allow the formation of a natural bed through the structure. The depressed invert would also reduce the risk of bed and bank scour at the culvert inlet and outlet. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter channel depth and width along the River Tud WFD water. In addition, the biodiversity enhancements (e.g., installation of large wood structures) proposed are expected to significantly improve the river geometry whilst uplifting, at least, 10% of the river component metrics of the BNG of the Foxburrow Stream within the Red Line Boundary. Finally, the proposed removal of the poorly placed stepped culvert in the Foxburrow Stream would also positively impact river geometry.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Road runoff and pollution risk** Road runoff could alter the baseline discharge along the water body, which has further implications to the river bed structure and substrate. Fine sediment and pollution could also enter the channel, which could affect the structure and substrate of the river bed. However, the attenuation basin near the Foxburrow Stream proposed as part of the embedded mitigation should reduce the impact of road runoff to the existing discharge by limiting the outfalls flow to greenfield runoff rates. Therefore, no long-term impact on river bed characteristics at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Outfall mitigation - OM-RDWE-02; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Structure and Substrate of the River Bed	**Shading** During the operational phase, the proposed culvert can reduce solar exposure and cause a loss of macrophytes, which in turn could reduce roughness of the channel bed and increase sediment transport capability. The potential reduction in macrophyte cover could also reduce the trapping of sediment being transported by the Foxburrow Stream. However, the proposed culvert on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structure and therefore reduce the shading effect as far as practicable. The results of the geomorphology assessment vindicate negligible difference in stream hydraulics between baseline and operation, therefore no impacts to the structure and substrate of the river bed are anticipated at the water body scale.	**Shading** Culvert shading mitigation - OM-RDWE-06; and Culvert design mitigation - OM-RDWE-09.

Quality Element	Potential Impact	Mitigation
Structure and Substrate of the River Bed	**Alteration to flows and / or habitats** The culvert can reduce the solar exposure and cause a loss of macrophytes. This reduction of macrophytes can impact on hydraulics and, by extension, upon river geometry. In addition, the attenuation ponds can change the local hydraulics (e.g., flow velocity) and the river bed characteristics. The realigned channel and bed through the culvert would locally alter the structure and substrate of the river bed. The hydraulic modelling and geomorphology study (see **Sub Appendix C: Foxburrow Stream Geomorphology Assessment** (Document Reference: 3.12.03c)) revealed that culvert structure could only produce a negligible influence on local hydraulics during operation. Reach-wise, the length of the watercourse would reduce by approximately 7m (with consequent river bed gradient increase) as works remove the meander under the Proposed Scheme. However, this is not foreseen to significantly increase stream power during operation. Whilst small-scale morphological changes can occur due to an increase in river bed gradient, the Foxburrow Stream is expected to retain the same hydraulic and geomorphic behaviour, with no adjustment during low to medium-magnitude events (Q2 to Q100) to both baseline and operational conditions. Therefore, this activity is not expected to have a significant impact on the channel bed structure and substrate along the WFD water body. The operation of the attenuation pond adjacent to the Foxburrow Stream is coupled to the outfalls of pluvial waters. In addition to the outfalls dynamics, the attenuation ponds further to off-set an increase in overland flow arriving at the channel. Hence, the attenuation pond operation is, in conjunction with the outfalls, unlikely to alter channel bed structure and substrate along the River Tud WFD water. In addition, the biodiversity enhancements (e.g., installation of large wood structures) proposed are expected to significantly improve the river bed characteristics whilst uplifting, at least, 10% of the river component metrics of the BNG of the Foxburrow Stream within the Red Line Boundary. Finally, the proposed removal of the poorly placed stepped culvert in the Foxburrow Stream would also positively impact river bed substrate.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.
Structure of the Riparian Zone	**Shading** During the operational phase, the proposed culvert can reduce solar exposure and cause a loss of macrophytes in the riparian zone. However, the proposed culvert on the Foxburrow Stream would be over-sized to enable maximum light penetration through the structure and therefore reduce the shading effect as far as practicable. Therefore, no long-term impact on riparian zone from shading at the WFD water body scale are foreseen.	**Shading** Culvert shading mitigation - OM-RDWE-06.

Quality Element	Potential Impact	Mitigation
Structure of the Riparian Zone	**Alteration to flows and / or habitats** Although the attenuation pond is outside the floodplain, the culvert can disconnect the banks and floodplain from out of bank flows, therefore, reducing connectivity and nutrient supply on the floodplain. The hydraulic modelling and geomorphology study revealed that culvert structure could only produce a small influence on local hydraulics during operation. Reach-wise, the length of the watercourse would reduce in by approximately 7m (with consequent river bed gradient increase) as works remove the meander under the Proposed Scheme. However, this is not foreseen to significantly increase stream power during operation. Whilst small-scale morphological changes can occur due to an increase in river bed gradient, the Foxburrow Stream is expected to retain the same hydraulic and geomorphic behaviour, with no adjustment during low to medium-magnitude events (Q2 to Q100) to both baseline and operational conditions. Therefore, this activity is not expected to have a significant impact on the riparian structure and substrate along the WFD water body. In addition, the biodiversity enhancements (e.g., native riparian planting) proposed are expected to significantly improve the riparian zone whilst uplifting, at least, 10% of the river component metrics of the BNG of the Foxburrow Stream within the Red Line Boundary.	**Alteration to flows and / or habitats** Outfall mitigation - OM-RDWE-02; Culvert design mitigation - OM-RDWE-09; and Realignment mitigation - OM-RDWE-10.

Wensum DS Norwich

5.2.10 An assessment of the potential operational impacts on those activities and quality elements screened and scoped in for the Wensum DS Norwich water body are presented in **Table 5.6**.

Table 5.6 Potential operational impacts on the scoped in WFD biological quality elements on the Wensum DS Norwich (GB105034055882) water body

Quality Element	Potential Impact	Mitigation
Composition, Abundance and Age Structure of Fish Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk to the River Wensum during the operational phase may impact upon fish and their habitat. This could cause degradation of spawning habitat, food sources and water quality. Any reduction in dissolved oxygen and increased levels of toxic parameters may lead to direct mortality of fish. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). Additionally, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. Therefore, no long-term impact on fish fauna at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Composition and Abundance of Benthic Invertebrate Fauna	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk to the River Wensum during the operational phase may impact upon benthic invertebrates and their habitat. This could cause degradation of habitat, food sources and water quality, leading to indirect impacts on benthic invertebrates communities. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). Additionally, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. Therefore, no long-term impact on benthic invertebrate fauna at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.
Composition and Abundance of Aquatic Flora	**Road runoff and pollution risk** There is the potential that surface water road runoff and any subsequent pollution risk to the River Wensum during the operational phase may impact upon macrophytes and their habitat. This could cause degradation of habitat and water quality, leading to indirect impacts on macrophyte communities. However, the seven attenuation / infiltration basins proposed as part of the embedded mitigation should reduce the impact of road runoff and pollution to baseline levels, as described in the DNWQA report (Document reference: 3.12.01). Additionally, due to the distance from the Proposed Scheme (7.3 kilometres) adverse impacts are not expected to be significant due to pollution / sediment dispersal. Therefore, no long-term impact on aquatic flora at the WFD water body scale are foreseen.	**Road runoff and pollution risk** Fine sediment management - OM-RDWE-01; Pollution and spillages incidents - OM-RDWE-03; and Increase in overland flow - OM-RDWE-04.

Broadland Rivers Chalk & Crag

5.2.12 An assessment of the potential operational impacts on those activities and quality elements screened and scoped in for the Broadland Rivers Chalk & Crag water body are presented in **Table 5.8**.

Table 5.8 Potential operational impacts on the scoped in WFD groundwater quantitative and chemical quality elements on the groundwater Broadland Rivers Chalk and Crag (GB40501G400300) water body

WFD Quality Element	Potential Impact	Mitigation
Water balance	**Groundwater level and flow changes** The new road surface restricts infiltration of rainfall which should lead to a reduction of groundwater recharge and hence groundwater quantities. In reality, large sections of the proposed road generate run-off which would be treated and discharged to ground via infiltration basins. The future road surface is very small compared to the overall groundwater recharge area for the chalk aquifer and current groundwater recharge rates are not very high due to the superficial deposits. Therefore, a measurable change in groundwater levels and quantities is not predicted. Piles to support the future River Wensum Viaduct have the potential to create additional pathways for groundwater flow and could act as barriers for horizontal groundwater flow leading to an increased risk of groundwater flooding. Considering that the Ground Investigation information and the numerical groundwater modelling indicate an existing high hydraulic connectivity between surface water, shallow groundwater, and groundwater in the regional chalk aquifer this risk and predicted impacts are negligible. No increased risk of groundwater flooding is expected and no change to the water exchange between groundwater bodies and surface water bodies are predicted. The thin layer of engineered fill that remains in place after the construction of the Temporary Works Platform, was also found not predicted to alter groundwater levels in the area.	**Groundwater level and flow changes** Groundwater infiltration basins are already incorporated in the designs and requires no further mitigation. The River Wensum Crossing – Groundwater Modelling Report (Document reference: 3.12.05) presents the results of the assessments of the bridge piles, showing no significant impact of the piles.

WFD Quality Element	Potential Impact	Mitigation
General chemical test	**Road runoff and pollution risk** Road drainage Basins 3 and 4 are designed to discharge road runoff to the ground. Locally superficial deposits are expected to form localized perched water tables but in absence of the surface water feature eventually migrate vertically towards the chalk aquifer. The road drainage treatment train and natural attenuation processes within the superficial deposits would mitigate the risk of pollution of the regional chalk aquifer which has a groundwater table at greater depth. Compared to the current agricultural use of the area road runoff would have only minimal nutrient concentrations which should create a minor benefit in terms of groundwater quality. However, the magnitude of impacts is considered negligible at water body scale hence do not justify additional assessments. Road drainage infiltration basins in proximity to the River Wensum mainly use the shallow groundwater pathway via superficial deposits towards the River Wensum and therefore create only very limited interaction with the regional chalk aquifer.	**Road runoff and pollution risk** DNWQA report (Document reference: 3.12.01) provides further detail on road drainage impact assessment.
Saline intrusion	**Road runoff and pollution risk** The road drainage catchment of Basin 2 comprises most of the future River Wensum Viaduct surface area. Salt spraying during winters (for de-icing) has the potential to add a substantial salinity loading to the aquifer. A brackish groundwater plume could form over the years and create a long-term impact on groundwater quality. In addition to the specific catchment area the local groundwater conditions are characterised by a relatively flat hydraulic gradient in the chalk aquifer which reduces the dilution effect at this location.	**Road runoff and pollution risk** Future salt spraying for de-icing of the River Wensum Viaduct was assessed in the River Wensum Crossing – Groundwater Modelling Report (Document reference: 3.12.05). Applying typical salt spraying rates in the numerical model gradually created a very localised effect of rising chloride and salinity levels in the shallow and the chalk aquifer. This was concluded not to pose a risk to the overall water body or dependent surface water features. Additional mechanisms which were not considered in the modelling, should further reduce the impact. Regular flooding of the River Wensum's flood plain should have an additional dilution effect on chloride levels within the groundwater, removing substantial salt loadings during such events. The numerical model was based on conservative assumptions at the site and no mitigation has been proposed due to no risk to the waterbody.

WFD Quality Element	Potential Impact	Mitigation
Dependent water body status	**Road runoff and pollution risk** Road drainage discharges to Basin 1 (via Northern Distributor Road Basin 2), Basin 2 and Basin A1067 are designed to discharge road runoff to ground. Groundwater within superficial deposits is expected to carry the discharge quickly towards the River Wensum. In the DNWQA report (Document reference: 3.12.01) modelling was undertaken for both discharge to ground and direct discharge to the River Wensum, taking the hydraulic connectivity of the groundwater and surface water receptors into account (i.e. River Wensum main receptor for shallow groundwater flow in the area). The calculations showed that pollution risks are low and therefore do not require additional mitigation. Impacts of salt spraying for de-icing of the future River Wensum Viaduct was assessed and presented in the River Wensum Crossing- Groundwater Modelling report. No further assessments or mitigations were found to be required.	**Road runoff and pollution risk** DNWQA report (Document reference: 3.12.01) presents simulation as discharge to the River Wensum, showing low risk of pollution. Similar future salt spraying for de-icing of the River Wensum Viaduct was assessed and showed no unacceptable impacts on the Wensum (River Wensum Crossing – Groundwater Modelling Report (Document reference: 3.12.05).)

5.3 Step 3: Review of Mitigation Measures to Deliver WFD Objectives

5.3.1 The high level WFD Mitigation Measures set out in the Anglian River Basin Management Plan (RBMP) 2015 RBMP (**Ref 2.10**) that are relevant to the Proposed Scheme are considered below. The Proposed Scheme must not prevent the achievement of these WFD mitigation measures in order to achieve WFD compliance.

Physical Modifications

5.3.2 Modifications to watercourses, including widening, deepening, and straightening have impacted upon the ecological status of water bodies. The proposed crossing of the River Wensum would not add further modification to the river channel in the form of physical modifications. The proposed Bailey bridge would be a temporary structure only, however the piles for the Bailey bridge would remain in situ below ground level due to the impracticalities of removal of the below ground piles. The footprint of these piles would unlikely impact upon the river functioning. The floodplain above ground would be reinstated following the removal of the above ground Bailey bridge.

5.3.3 The proposed River Wensum Viaduct would have piers set-back from the channel, located within the floodplain. Therefore, the River Wensum Viaduct would not directly introduce additional physical modification to the River Wensum channel and banks. Physical enhancements are proposed within the Red Line Boundary to off-set any potential adverse effects of the proposed crossing of the River Wensum; these include, reconnection of a historic meander, introduction of gravel features to replenish river bed substrate and introduction of large wood to enhance river flow characteristics. Other interventions such as livestock fencing and planting of native flora are also proposed. These enhancements would be detailed in the Landscape and Ecological Management Plan (LEMP), which defines how habitats and other ecological enhancements would be managed and maintained in the long-term.

5.3.4 On the Foxburrow Stream, approximately 72 metres of the watercourse would be realigned and the Tud tributary culvert / Bat underpass installed, which would directly introduce new physical modification to the watercourse. However, proposals to off-set this impact to physical habitat within the Red Line Boundary include; introduction of woody debris to enhance river flow characteristics, livestock fencing, planting of native trees and local macrophyte species, reprofiling of bank face and bank tops to reconnect floodplains and promote the formation of wetlands and wet woodlands, removal of existing redundant structures (such as culverts and dilapidated bridges) and the installation of wood dam analogues to diversify flows and create aquatic habitat.

5.3.5 Measures to address physical modification set out within the Anglian RBMP include improvements to the condition of the riparian zone and / or wetland habitats. The proposed off-setting includes improvements to the riparian zone, which aligns with this measure to address physical modification pressures. In addition, the proposed off-setting aligns as far as practicable with the WFD mitigation measures recommended by UKTAG Guidance (see Section 5.1). The proposed riparian enhancements are for off-setting impacts of the Proposed Scheme and for delivering BNG obligations for the water environment.

Managing Pollution from Waste Water

5.3.6 The Proposed Scheme would not introduce waste water into the environment; therefore the Proposed Scheme would not prevent the achievement of this WFD mitigation measure. In addition, the Proposed Scheme would not contribute towards the achievement of this WFD mitigation measure.

5.3.7 Waste water produced during the construction phase would be managed through the OCEMP and waste water would not be discharged into the water environment.

Managing Pollution from Towns, Cities and Transport

5.3.8 Road runoff may carry various pollutants that are harmful to the water environment. The drainage strategy for the Proposed Scheme contains treatment trains to manage pollution risk to the water environment. The Proposed Scheme would therefore not prevent the achievement of this WFD mitigation measure and would not further contribute to the delivery of this mitigation measure.

5.3.9 Salt spraying impacts have been assessed in detail for the River Wensum Viaduct. Measures to reduce future salt spraying use are recommended to minimize a localized long-term impact on groundwater quality. These measures include the growing use of alternative de-icing products to replace salt and optimisation of de-icing using modern meteorological monitoring and warning equipment, also to adapt to likely future milder winters due to climate change.

5.3.10 Measures to manage pollution from towns, cities and transport as set out within the Anglian RBMP include reducing diffuse pollution pathways, mitigate / remediate diffuse pollution impacts on receptor and reduce diffuse pollution at source. The drainage strategy of the Proposed Scheme would control the risk of pollution from road runoff. Therefore, the Proposed Scheme would not prevent the achievement of this WFD mitigation measure or contribute to its delivery.

Managing Pollution from Rural Areas

5.3.11 Pollution from rural areas including agriculture, roads, recreational land use and the use of pesticides and fertilisers can harm the water environment. During construction, the Proposed Scheme would manage the risk of pollution through the OCEMP. During operation, road drainage would be managed through the drainage strategy and treatment trains to manage the risk of pollution from roads.

5.3.12 Measures to address pollution from rural areas as set out within the Anglian RBMP include reducing diffuse pollution at source and mitigate / remediate diffuse pollution impacts on receptors. The OCEMP and drainage strategy for the Proposed Scheme aligns with these measures and would not prevent the achievement of these measures but equally the Proposed Scheme would not contribute towards the delivery of these WFD mitigation measures.

Changes to Natural Flow and Levels of Water

5.3.13 Changes in water levels from regulation, abstraction and discharges can be harmful to the water environment. The dewatering activities required for the Proposed Scheme during the construction phase would be temporary in nature and therefore are not anticipated to have long-term effects.

5.3.14 Piling activities could locally alter groundwater connectivity, however the impacts would be highly localised and not anticipated to have impacts at the water body scale.

5.3.15 The Proposed Scheme does not extend into the Chalk aquifer hence no significant groundwater discharges are expected which would affect the quantitative status of the groundwater waterbody. Discharges from road runoff would be insufficient to cause alteration to water levels at the WFD water body scale.

5.3.16 The Proposed Scheme would therefore not prevent the achievement of this WFD mitigation measure, neither would it contribute towards the delivery of this mitigation measure.

Managing Invasive Non-native Species

5.3.17 INNS can cause damage to watercourses resulting in bank erosion and increasing flood risk. During construction, there is a risk of transferring INNS to new sites and introducing new INNS. There is a legal obligation to control the spread of INNS under the Wildlife and Countryside Act 1981 and measures set out in the OCEMP would be in place to prevent the spread and / or introduction of INNS within the Study Area.

5.3.18 As part of the enhancement plans, the absence of INNS would be maintained on watercourses and riparian zones within enhancement areas.

5.3.19 Mitigation measures to manage INNS as set out within the Anglian RBMP include mitigation, control, and eradication to reduce the extent and rapid response to reduce the risk of establishment. The measures in the OCEMP to control the spread of INNS aligns with this mitigation measure.

5.4 Step 4: Assessment of the Proposed Scheme against WFD Objectives

5.4.1 The WFD compliance assessment for the Proposed Scheme is summarised below for the potentially impacted WFD water bodies.

Does the Proposed Scheme cause Deterioration in the Ecological Potential or Status of a Body of Surface or Groundwater?

Biological Quality Elements

5.4.2 The construction and operation of the Proposed Scheme is not expected to produce a long-term deterioration of biological elements in the potentially impacted WFD water bodies.

Physico-chemical Quality Elements

5.4.3 The construction and operation of the Proposed Scheme is not expected to produce a long-term deterioration of the thermal, oxygenation, acidification, and nutrient conditions in the potentially impacted WFD water bodies.

Hydromorphological Quality Elements

5.4.4 The construction and operation of the Proposed Scheme is not expected to produce a long-term impact on quantity and dynamics of water flow, river continuity, river depth and width variation, structure and substrate of the river bed, structure of the riparian zone in this WFD water body. This conclusion is supported by the results presented in **Appendix 12.4: - River Wensum Geomorphology Assessment** of **Chapter 12 – Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.04) and the hydraulic modelling of the Foxburrow Stream (see **Sub**

Appendix C: Foxburrow Stream Geomorphology Assessment
(Document Reference: 3.12.03c))

Groundwater Quality Elements

5.4.5 The construction and operation of the Proposed Scheme is not expected to produce a long-term deterioration of groundwater elements in the potentially impacted WFD water body.

Does the Proposed Scheme Compromise the Ability of the Water Body to Achieve Good Ecological Status or Potential?

Biological Quality Elements

5.4.6 The absence of long-term deterioration on the biological elements at the water body scale ensures that the ability of the water body to achieve Good Ecological Potential / Status remains unchanged.

Physico-chemical Quality Elements

5.4.7 The absence of long-term deterioration on the physico-chemical elements at the water body scale ensures that the ability of the water body to achieve Good Ecological Potential / Status remains unchanged.

Hydromorphological Quality Elements

5.4.8 The absence of long-term deterioration on the hydromorphological elements at the water body scale ensures that the ability of the water body to achieve Good Ecological Potential / Status remains unchanged.

Groundwater Quality Elements

5.4.9 The scale of potential impacts of the Proposed Scheme to the groundwater WFD water body are negligible. Therefore, the Proposed Scheme does not compromise the ability of the water body to achieve its status objectives.

Does the Proposed Scheme Comply With Objectives and Standards for Protected Areas within the Potentially Impacted Water Bodies?

Biological Quality Elements

5.4.10 The absence of long-term deterioration on the biological elements at the water body scale and significant negative impacts to qualifying features of the River Wensum SAC ensures that the Proposed Scheme would not have a significant negative impact upon the River Wensum SAC or any other Protected Area within the water bodies assessed.

Physico-chemical Quality Elements

5.4.11 The absence of long-term deterioration on the physico-chemical elements at the water body scale and of significant negative impacts to the River Wensum, its floodplain or any hydrologically connected watercourses ensures that the Proposed Scheme would not have a significant negative impact upon the River Wensum SAC or any other Protected Area within the water bodies assessed.

Hydromorphological Quality Elements

5.4.12 The absence of long-term deterioration on the hydromorphological elements at the water body scale and of significant negative impacts to the River Wensum, its floodplain or any hydrologically connected watercourses ensures that the Proposed Scheme would not have a significant negative impact upon the River Wensum SAC or any other Protected Area within the water bodies assessed.

Groundwater Quality Elements

5.4.13 The scale of potential impacts of the Proposed Scheme to the groundwater WFD water body are negligible. Therefore, the Proposed Scheme complies with the objectives and standards of groundwater related Protected Areas.

Does the Proposed Scheme Cause a Permanent Exclusion or Compromise Achievement of the WFD Objectives (e.g., Mitigation Measures) in other Water bodies within the same RBD?

Biological Quality Elements

5.4.14 The absence of long-term deterioration on the biological elements at the water body scale ensures that no impact occur on the WFD objectives of other water bodies within the same RBD.

Physico-chemical Quality Elements

5.4.15 The absence of long-term deterioration on the physico-chemical elements at the water body scale ensures that no impact occur on the WFD objectives of other water bodies within the same RBD.

Hydromorphological Quality Elements

5.4.16 The absence of long-term deterioration on the hydromorphological elements at the water body scale ensures that no impact occur on the WFD objectives of other water bodies within the same RBD.

Groundwater Quality Elements

5.4.17 The scale of potential impacts of the Proposed Scheme to the groundwater WFD water body are negligible. Therefore, the Proposed Scheme would not compromise WFD objectives of other water bodies.

Does the Proposed Scheme Contribute to the Delivery of the WFD Objectives (e.g., Mitigation Measures)?

5.4.18 Yes, although the Proposed Scheme does not contribute directly to the WFD objectives, it is aiming to deliver a minimum 10% uplift in river units as part of the BNG metric. Hence, it indirectly contributes to the WFD objectives. Further information on the BNG using the RCA methodology is provided in the Biodiversity Net Gain Assessment Report **(Appendix 10.3: Biodiversity Net Gain Technical Report** of **Chapter 10 - Biodiversity** of the Environmental Statement (Document Reference: 3.10.33)).

5.4.19 In addition, for groundwater, the Proposed Scheme would result in a reduction of agricultural land use, which is the main source of nutrients within the groundwater. The reduction in nutrients would only be very minor and not significant.

5.5 Step 5: Assessment of the Proposed Scheme against other EU Legislation

5.5.1 Article 4.9 of the WFD requires that "Member States shall ensure that the application of the new provisions guarantees at least the same level of protection as the existing Community legislation."

5.5.2 The Nitrates Directive is relevant to the assessment of new modifications. Any potential change in the nutrient dynamics due to the Proposed Scheme is most likely due to changes in the sediment regime. No sources of nitrates would be introduced to the water body as part of the Proposed Scheme. Therefore, no separate assessment is required for nitrates.

6 Conclusion

6.1.1 This WFD assessment has been produced as an appendix to **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.00) for the Planning Application for the Proposed Scheme. The Proposed Scheme has the potential to impact upon the following surface water WFD water bodies:

- Wensum US Norwich (GB105034055881);
- Wensum DS Norwich (GB105034055882); and
- River Tud (GB105034051000).

6.1.2 In addition, the following groundwater WFD water body is potentially impacted by the Proposed Scheme:

- Broadland Rivers & Crag (GB40501G400300)

6.1.3 The assessment of potential construction impacts against WFD quality elements, WFD status and objectives concludes that no deterioration is anticipated as a result of the Proposed Scheme with embedded construction methodology and the OCEMP in place.

6.1.4 The 2D hydraulic modelling of the River Wensum during the construction phase (**Appendix 12.4 - River Wensum Geomorphology Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.04)) revealed only localised potential impacts to the river hydraulics with conditions returning to baseline within approximately 175m downstream of the construction zone. Potential alteration to river dynamics were also primarily limited to high magnitude flow events, which have a low likelihood of occurrence during the temporary construction phase.

6.1.5 The assessment of potential operation impacts against WFD quality elements, WFD status and objectives concludes that no deterioration is anticipated as a result of the Proposed Scheme with embedded mitigation in place. In addition, the Proposed Scheme would aim to deliver a minimum of 10% BNG uplift in river units for the BNG metric. Therefore, not only would potential impacts be off-set, but also enhancements would be delivered, which also align with objectives set for the River Wensum to improve its condition.

6.1.6 The 2D hydraulic modelling of the River Wensum during the operation phase (**Appendix 12.4 - River Wensum Geomorphology Assessment** of **Chapter 12: Road Drainage and the Water Environment** of the Environmental Statement (Document Reference: 3.12.04)) revealed imperceptible change between baseline and operation. This includes sensitivity testing for potential shading effects that may result in a reduction of bed roughness.

6.1.7 The hydraulic modelling of the Foxburrow Stream indicated negligible change in fluvial dynamics between baseline and operation.

6.1.8 The results of the shading assessment, presented in Norwich Western Link: Solar Exposure Analysis **(Ref 2.6)** conclude that the solar exposure changes as a result of the River Wensum Viaduct and temporary crossing would be localised to the areas beneath the two structures, and are unlikely to affect the macrophyte community as a whole. It is unlikely that the proposed River Wensum Viaduct would result in an overall loss of macrophytes as shade tolerant species are still likely to grow, with species less tolerant to shade eventually replaced. The installation of the temporary crossing is likely to result in a localised, temporary loss of the macrophyte community within its immediate vicinity. However, as the temporary crossing is transient in nature, no long-term vegetation loss is anticipated.

6.1.9 For groundwater, no construction phase impacts are anticipated with the OCEMP measures in place.

6.1.10 During operation, this assessment concludes that the Proposed Scheme would not impact on the WFD status or objectives of the Broadland Rivers & Crag groundwater WFD water body.

6.1.11 Furthermore, the Proposed Scheme would not prevent the achievement of the wider WFD objectives in the Anglian RBMP and is not predicted to have an impact on any other water body within the Anglian RBD. The Proposed Scheme would also not prevent the achievement of actions or mitigation measures developed to achieve good status / potential.

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