Norwich Western Link

Environmental Statement

Chapter 12: Road Drainage and the Water Environment

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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
Bailey Bridge	The temporary bridge structure over the River Wensum connecting the temporary works platforms on either bank.
Conceptual site model (Groundwater)	A representation of the characteristics of the site in diagrammatic or written form that shows the possible pollutant linkages between contaminants, pathways and receptors.
Culvert	Arched, enclosed or piped structure constructed to carry water under roads, railways and buildings.
Flood Risk Assessment	As assessment that identifies and assesses the risk of flooding to and from a proposed development for all sources. It is a requirement under the national planning policy framework for all new developments that are in flood zone 2 or 3, are more than 1 hectare, land which has been identified by the Environment Agency as having critical drainage problems, land identified in a strategic flood risk assessment as being at increased flood risk in future or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.
Flood Zone	The classification of an area based on its risk of flooding from fluvial or tidal sources.

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.
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 found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers.
Groundwater Dependent Terrestrial Ecosystems	Wetlands which critically depend on groundwater flows and / or chemistries.
Groundwater Vulnerability Zone	Show the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within a single square kilometre.
Highways England Water Risk Assessment Tool	A Microsoft Excel application which has been developed to assess the acute and chronic pollution risks to the receiving watercourses and groundwater.
Hydraulic Model (Fluvial)	A software tool used to estimate water levels during a flood event based on topographical data of watercourse channels and the floodplain and flood event flows or rainfall data.

Term	Definition
Hydrology	The study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks. Hydrological inputs for the Proposed Scheme include the hydraulic modelling and conceptual modelling undertaken.
Nitrate Vulnerability Zone	Areas designated as being at risk from agricultural nitrate pollution.
Piles	Below ground vertical structures that are used to transfer loadings from structures at the surface to suitable load bearing ground.
Principal Aquifer	Have the potential to provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands.
River Basin Management Plan	Set out specific environmental objectives for rivers within a defined area and set out the steps required to meet the objectives.
River Wensum Viaduct	Viaduct crossing the River Wensum and floodplain. The multi-span bridge design includes piled piers within the floodplain.
Source Protection Zone	Zones which are designated for public drinking water supplies and show the risk associated with activities that have the potential to impact water quality.
Special Area of Conservation	Protects one or more special habitats and / or species, terrestrial or marine, as listed in the Habitats Directive.
Superficial Deposits	The youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 2.6 million years from the present.

Term	Definition
Surface Water Drainage Strategy	Demonstrates how surface water will be managed within a scheme so it does not increase flood risk elsewhere, how the scheme is compliant with the relevant legislation and manages risks to water quality.
Sustainable Drainage Systems (SuDS)	Approaches to manage surface water that take account of water quantity (flooding), water quality (pollution) biodiversity (wildlife and plants) and amenity.
Temporary Works Platform	The term to refers to the temporary platform located in the floodplain on either side of the River Wensum used to construct the River Wensum viaduct. The temporary works platform will support a temporary bailey bridge.
Water Framework Directive	The Water Framework Directive (WFD) (2000/60/EC) is a significant piece of legislation for improving the water environment. The WFD legislation is transposed into UK law under The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 407).
Water Framework Directive Assessment (WFDa)	WFDa is the abbreviation used for undertaking a WFD compliance assessment. A WFDa is undertaken to assess the potential impacts of development works on the quantity or quality elements of a waterbody, and whether the development works could lead to non-compliance with the objectives of the WFD.

12 Road Drainage and the Water Environment

12.1 Introduction

12.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Proposed Scheme upon the Road Drainage and the Water Environment.

12.1.2 This chapter describes the assessment methodology and the baseline conditions relevant to the assessment, which have been used to reach these conclusions, as well as a summary of the likely significant effects leading to the additional mitigation measures required to avoid, prevent, reduce or, if possible, offset any likely significant adverse effects, and the likely residual effects and any required monitoring after these measures have been employed. Opportunities for environmental enhancement, where such opportunities exist, are also discussed.

12.1.3 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES, with particular reference to **Chapter 10: Biodiversity** (Document Reference: 3.10.00), **Chapter 13: Geology and Soils** (Document Reference: 3.13.00), **Chapter 15: Climate Greenhouse Gasses** (Document Reference: 3.15.00) and **Chapter 18: Major Accidents and Disasters** (Document Reference: 3.18.00).

12.1.4 A number of appendices and figures have been produced to accompany this chapter including:

- Appendix 12.1: Drainage Network Water Quality Assessment (Document Reference: 3.12.01);
- Appendix 12.2: Flood Risk Assessment (Document Reference: 3.12.02);
- Appendix 12.3: Water Framework Directive Assessment (Document Reference: 3.12.03);

- Appendix 12.4: River Wensum Geomorphology Assessment (Document Reference: 3.12.04);
- Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report (Document Reference: 3.12.05);
- Appendix 12.6: Road Drainage and the Water Environment Consultation (Document Reference: 3.12.06);
- Appendix 12.7: Road Drainage and the Water Environment In-Combination Assessment (Document Reference: 3.12.07); and
- Appendix 12.8: Study Area Figure (Document Reference: 3.12.08).

12.1.5 **Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01) includes the assessment of the surface water drainage system using the Highways England Water Risk Assessment Tool (HEWRAT) to determine the potential effect of routine runoff on receiving watercourses.

12.2 Legislative Framework, Policy and Guidance

Legislative Framework

12.2.1 The applicable legislative framework is summarised as follows:

- The Water Environment (Water Framework Directive) (England and Wales) Regulations (the 'Water Framework Regulations') (2017) (**Ref. 12.1**);
- The Groundwater (Water Framework Directive) (England) Direction 2016 (**Ref. 12.2**);
- Flood and Water Management Act 2010 (**Ref. 12.3**);
- The Environmental Permitting (England and Wales) 2016 (**Ref. 12.4**); and
- Land Drainage Act 1991 (**Ref. 12.5**).

Policy

12.2.2 The applicable policies to the Proposed Scheme are summarised in Table 12-1 below.

Table 12-1 Summary of key policies

Policy	Comment
National Planning Policy Framework (NPPF) 2023 (**Ref. 12.6**)	Presents the Government's planning policies for England and Wales and how these are expected to be applied. Section 14 of the NPPF details the requirements for a Flood Risk Assessment (FRA). A FRA has been prepared to assess the risks of flooding to and from potential impacts of flooding from the Proposed Scheme and details the sequential suitability of the Proposed Scheme in terms of the Sequential and Exception Tests outlined in the NPPF. The assessment also details how climate change has been taken into account.
Joint Core Strategy for Broadland, Norwich and South Norfolk (2011) (**Ref. 12.7**)	The core strategy sets out the strategic policies for new development. Policy 1: Addressing climate change and protecting environmental assets outlines that development should be located to minimise flood risk, mitigating local risk through design including sustainable drainage systems. A FRA has been prepared to assess the risks of flooding to and from potential impacts of flooding from the Proposed Scheme.

Policy	Comment
Emerging Greater Norwich Local Plan (2021) (**Ref. 12.8**)	Broadland District Council, Norwich City Council and South Norfolk Council have, together with Norfolk County Council, prepared the Greater Norwich Local Plan (GNLP). The GNLP was submitted to the Secretary of State for examination in public on 30 July 2021 and is currently being examined. The GNLP will provide the strategy to meet the government requirements for growth in the Greater Norwich area to 2038. The development of the strategy recognises the requirements set out in the NPPF and considers the risk of flooding.

Guidance

12.2.3 The following guidance documents have been used during the preparation of this chapter:

- National Planning Practice Guidance for Flood Risk and Coastal Change (2022) (**Ref. 12.9**);
- LA 113 Road Drainage and the Water Environment (**Ref. 12.10**);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (2015) (**Ref. 12.11**);
- Norfolk Local Flood Risk Management Strategy (2015) (**Ref. 12.12**); and
- The Planning Inspectorate, Advice Note 18 The Water Framework Directive (**Ref. 12.13**).

12.3 Consultation, Scope, Methodology and Significance Criteria

Consultation Undertaken to Date

12.3.1 **Appendix 12.6 Road Drainage and the Water Environment Consultation** (Document Reference: 3.12.06); provides a summary of the consultation activities undertaken in support of the preparation of this assessment and supporting appendices. A detailed overview of the consultation undertaken is also provided within the standalone Flood Risk Assessment (**Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02)), Water Framework Directive Assessment (**Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03)) and the River Wensum Geomorphology Assessment (**Appendix 12.4: River Wensum Geomorphology Assessment** (Document Reference: 3.12.04)).

Scope of the Assessment

12.3.2 The scope of this assessment has been established through the EIA scoping process and consultation with the relevant authorities. A Scoping Opinion was sought on two occasions, in June 2020 (for which a Scoping Opinion was received 16 October 2020) and a Scoping Addendum which was submitted in July 2022 to take account of a localised alignment refinement (a response was received on the 27 September 2022). All Scoping Reports and Opinions are appended to **Chapter 5: Approach to EIA** (Document Reference: 3.05.00).

12.3.3 Table 12-2 accounts for any regulatory consultation undertaken in support of the preparation of this assessment and outlines where this is addressed in the chapter.

Table 12-2 Scoping Opinion Responses

Body / organisation	Comments provided in Scoping Response	Response to comments
Environment Agency	The Environment Agency will continue to work with the Applicant on the FRA, which should assess the flood risk of the Proposed Scheme; and support the proposal to submit a 1D-2D hydraulic model which will assess the current flood risk, take account of climate change and demonstrate that the Proposed Scheme will not increase flood risk extents or depths elsewhere.	**Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) details the assessment of local flood risks associated with the Proposed Scheme and consultation with the Environment Agency has been undertaken.
Environment Agency	The FRA should include a surface water drainage strategy to address local sources of flood risk (e.g. from ordinary watercourses, surface water flow, including impacts to overland flow paths), identify how surface water drainage will be managed on site, compliance with the SuDS hierarchy, any required mitigation measures and maintenance and management plan.	The **Drainage Strategy Report** (Document Reference: 4.04.00) provides a detailed description of the proposed surface water drainage strategy.
Environment Agency	Whilst the Scoping Report covers the surface water quality impacts of the Proposed Scheme during both construction and operation, in the assessment methodology there is no mention of containment or contingency for a road traffic accident leading to a spillage. Given the reference in other parts of the Chapter, it is wondered whether the omission in paragraph 10.4 is an error. This will need to be clarified in the ES. The WFD assessment referred to in the Scoping Report should include the River Tud and highlight the two key objectives of no deterioration in waterbody status and ultimate aim of improving all waterbodies to Good status.	**Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01) provides an assessment of the impacts of increased spillage risk on surface water bodies and groundwater receptors in Section 5. **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) includes the River Tud within the assessment.
Environment Agency	Regarding surface water resources the Scoping Report doesn't make reference to the use of water as resource during construction or operation therefore, it is presumed that no local water will be used or abstracted. This needs to be clarified in the ES and consideration should be given to the impact of water abstraction licenses, particularly abstraction points within close proximity to the Proposed Scheme. Measures to deliver Biodiversity Net Gain are supported. Regarding the reference to the River Wensum Restoration Strategy (in particular at 10.3.34), the Environment Agency highlight opportunities to address changes to the River should not be overlooked, because it does not necessarily mean that there are not potential improvements to be made to the morphology of the River.	The construction and operation of the Proposed Scheme does not require any surface water abstractions or local water resources. **Appendix 10.33: Biodiversity Net Gain Technical Report** (Document Reference: 3.10.33) provides details regarding the measures included as part of the Proposed Scheme in relation to biodiversity net gain.

Body / organisation	Comments provided in Scoping Response	Response to comments
Environment Agency	The scope for groundwater resources is generally considered appropriate and the Applicant is drawn to specific comment in the consultation response received from the Environment Agency. Paragraph 10.3.20 states that "A data request to determine any nearby licensed and unlicensed groundwater abstractions will be completed moving to ES Stage" The Broadland District Council Environmental Health Officer has requested to be consulted on this in order to assist in identifying private drinking water supplies in the vicinity. The Environment Agency advise that shallow groundwater is likely to be present in many places along the route of the Proposed Development, which could affect the viability of using simple infiltration features, SuDS features should be in accordance with CIRIA SuDS Manual and that direct discharge of potentially hazardous substances is not permitted.	**Appendix 12.6: Road Drainage and the Water Environment Consultation** (Document Reference: 3.12.06) details the consultation and data requests submitted to Broadland District Council. A request for information regarding local abstractions was submitted in November 2020. Groundwater abstractions within the Study Area are described in the baseline conditions in **Section 12.4**. The **Drainage Strategy report** (Document Reference: 4.04.00) provides a detailed description of the proposed surface water drainage strategy and the infiltration testing undertaken.

Elements Scoped into the Assessment

Construction Phase

12.3.4 The following elements are considered to have the potential to give rise to likely significant effects during construction of the Proposed Scheme and have therefore been considered within this assessment:

- Increased sedimentation of surface water features and increased pollution risk of surface water and groundwater features;
- Risk to WFD status including changes to the hydromorphological, physico-chemical and ecological quality of surface water features including shading effects and changes to floodplain connectivity;
- Changes to fluvial geomorphological processes and features of the River Wensum;
- Increased flood risk associated with construction works, construction phasing and temporary works;
- Routine runoff to groundwater affecting groundwater quality;
- Increased groundwater vulnerability with potential for groundwater pollution;
- Potential changes to groundwater flow and levels through temporary dewatering or temporary below ground structures forming groundwater flow barriers;
- Potential impacts on yields and water quality of local private abstractions; and
- Potential water quality and quantity impacts to Groundwater Dependent Terrestrial Ecosystems (GWDTEs).

Operation Phase

12.3.5 The following elements are considered to have the potential to give rise to likely significant effects during operation of the Proposed Scheme and have therefore been considered within this assessment:

- Polluted surface water runoff to surface water and groundwater features from routine runoff and accidental spillages;
- Permanent or long term risk to WFD status including changes to the hydromorphological, physio-chemical and ecological quality of water features including the shading effect of structures and floodplain fragmentation;
- Changes to fluvial geomorphological processes and features of the River Wensum;
- Changes to catchment hydrology;
- Flood risk to the Proposed Scheme and increased flood risk to people, property and infrastructure elsewhere;
- Increased rates and volumes of surface water runoff that could increase flood risk;
- Changed groundwater recharge due to increased hard surface area affecting groundwater levels and flow;
- Potential changes to groundwater flow and levels through groundwater discharges into cuttings, with subsequent effects on groundwater receptors;
- Groundwater flow obstruction due to permanent below ground structures (i.e., pilings, foundations and basin structures) with impacts on groundwater levels and flow (increasing groundwater flood risk);
- Potential impacts on groundwater abstractions (including private and public water supplies); and,

- Potential water quality and quantity impacts to Groundwater Dependent Terrestrial Ecosystems (GWDTEs).

Extent of the Study Area

12.3.6 The Study Area is defined by the likely reach of potential effects as a result of the Proposed Scheme and is based on professional judgement using knowledge and experience of similar schemes and current knowledge of the area.

12.3.7 The assessment of direct effects encompasses surface water features up to 1km from the Site Boundary. The other areas within the Red Line Boundary, located beyond the Site Boundary, have been considered qualitatively and it has been concluded that there are no significant effects which merit further assessment and as such these are not considered further beyond those which are considered in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02). This distance is considered appropriate and proportionate for the assessment of direct effects (i.e. associated with overland migration of pollutants directly to surface features, pollutants conveyed in drainage systems, and works within a river channel) due to the relatively flat and vegetated topography, vegetation removing sediment pollutants and upper soil filtration.

12.3.8 The assessment of indirect effects encompasses surface water features that have hydraulic connectivity with features within 1 kilometre from the Site Boundary. This includes watercourses and other water environment receptors that are located downstream, and that could be affected by pollutants conveyed by watercourses. The Study Area will depend on the likely magnitude of effect and sensitivity of downstream receptors, but a distance of approximately 5 kilometres is considered appropriate. The other areas within the Red Line Boundary, located beyond the Site Boundary, have been considered qualitatively and it has been concluded that there are no significant effects which merit further assessment and as such these are not considered further beyond those which are considered in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02).

12.3.9 The Study Area encompasses groundwater features and groundwater abstractions up to 1 kilometre from the Site Boundary. The other areas within the Red Line Boundary, located beyond the Site Boundary, have been considered qualitatively and it has been concluded that there are no significant effects which merit further assessment and as such these are not considered further beyond those which are considered in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02). This distance is appropriate and proportionate for the assessment of direct impacts from surface-borne pollutants migrating to groundwater features and groundwater flow and level changes. Groundwater receptors up to 3km distance from the Site Boundary were considered where hydraulic connectivity with the Proposed Scheme exists.

12.3.10 **Figure 12-1** in **Appendix 12.8: Study Area Figures** (Document Reference: 3.12.08) shows the Study Area and the surface water and groundwater receptors for the road drainage and the water environment. **Figure 12-1** does not show the Study Area for the assessment of flood risk which is described below.

12.3.11 The Study Area for the assessment of flood risk has been determined by including the Proposed Scheme and all potential receptors (land and property) that could be at risk of increased flood risk as a result of the Proposed Scheme. More details regarding the Study Area in relation to flood risk is detailed in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02).

Method of Baseline Data Collation

Desk Study

12.3.12 To inform the environmental assessment stage, a desk-based assessment of available resources has been undertaken:

- Environment Agency's online Flood Map for Planning (**Ref. 12.14**);
- Environment Agency's online Long Term Flood Risk map (**Ref. 12.15**);

- Environment Agency's online Catchment Data Explorer (**Ref. 12.16**);
- Anglian River Basin Management Plan (**Ref. 12.17**);
- Greater Norwich Area Level 1 Strategic Flood Risk Assessment (**Ref. 12.18**);
- Contemporary Ordnance Survey (OS) Mapping (**Ref. 12.19**);
- Environment Agency LiDAR Digital Terrain Model (**Ref. 12.20**);
- Flood Estimation Handbook Web Service (**Ref. 12.21**);
- British Geological Survey Geology Viewer (**Ref. 12.22**);
- British Geological Survey Geoindex (**Ref. 12.23**);
- The National River Flow Archive (NFRA) (**Ref. 12.24**);
- Private and licensed surface and groundwater abstractions, provided by Breckland and Broadland District Council (**Ref. 12.25**);
- River Wensum Restoration Strategy (**Ref. 12.26**);
- 1D-2D River Wensum Flood Modeller Pro Model (**Ref. 12.27**);
- Envirocheck Report (**Ref. 12.28**);
- Groundwater abstraction borehole data provided by the Environment Agency (**Ref. 12.29**);
- Wensum and Tud Catchment Numerical Model (**Ref. 12.30**);
- Ground and soil data was collected from geological mapping and results from the ground investigations works undertaken to support **Sub Appendix B: Ground Contamination Interpretive Report** (Document reference: 3.13.02b).
- Historical mapping (**Ref. 12.31**);
- Ecological and solar exposure data (**Ref. 12.32**);

- Land use data (**Ref. 12.33**);
- Designated areas data, available on Magic Map (**Ref. 12.34**);
- River Wensum Strategy (**Ref. 12.35**);
- Geomorphological appraisal of the River Wensum Special Area of Conservation (**Ref.12.36**);
- Environment Agency Ecology and Fish Data Explorer (**Ref. 12.37**); and
- Environment Agency Water Quality Data (**Ref. 12.38**).

Site Visit and Surveys

12.3.13 An initial site walkover was conducted in December 2019. The walkover included a rapid river survey to assess the current surface water features and geomorphological processes acting within the Study Area.

12.3.14 Stream reconnaissance surveys to support the WFDa were undertaken in December 2019, November 2020, July 2020, June 2021 and May 2022.

12.3.15 River Conditions Assessments (RCAs) were undertaken on the River Wensum and its tributaries, and the tributary of the River Tud and the Wensum in June / July 2021 and May 2022. These RCAs were conducted to inform the biodiversity net gain calculations and the WFDa.

12.3.16 Fish surveys were undertaken in August 2022, and aquatic macroinvertebrate surveys were undertaken in May 2022 and September 2022.

12.3.17 More information regarding the stream reconnaissance surveys, RCAs and aquatic ecological surveys is provided in the WFDa (**Appendix 12.3** (Document Reference: 3.12.03).

12.3.18 Ground Investigation undertaken in 2020 and 2022 provided surface water and groundwater levels to help with the assessment.

Assessment Methodology

12.3.19 The assessment has been undertaken in accordance with the DMRB (LA113) (**Ref. 12.10**) using the assessment criteria provided below. The assessment of

effects has been carried out by establishing the sensitivity of the receptor, magnitude of the potential impact and consequently determining the significance of the effect.

12.3.20 Table 12-3 below details the criteria for defining the sensitivity of each receptor and Table 12-4 below details the criteria for determining the magnitude of an impact. Typical examples are provided as informed by the guidance in DRMB (LA113). The assessment of potential effects to geomorphology receptors (**Appendix 12.4: River Wensum Geomorphological Assessment** (Document Reference: 3.12.04)) has expanded the criteria below to reflect the requirement for a bespoke geomorphological assessment. This is not reproduced here and reference should be made to **Appendix 12.4: River Wensum Geomorphological Assessment** (Document Reference: 3.12.04).

Table 12-3 Criteria for determining the sensitivity of the receptor

Sensitivity of Receptor	Definition of Sensitivity	Receptor	Typical Examples
Very High	Nationally significant attribute of high importance	Surface water	Watercourse having a WFD classification shown in a River Basin Management Plan (RBMP) and with Q95 > 1.0m3/s. Site protected / designated under EC or UK habitat legislation (SAC, SPA, SSSI, Ramsar site, salmonid water), or species protected by EC Legislation as described in LA 108 (Ref. 12.39).
Very High	Nationally significant attribute of high importance	Groundwater	Principal aquifer providing a regionally important resource and / or supporting a site protected under EC and UK Legislation protected site. Groundwater locally supports a GWDTE. Source Protection Zone (SPZ) 1.
Very High	Nationally significant attribute of high importance	Flood Risk	Essential infrastructure or highly vulnerable development as defined in the National Planning Practice Guidance for Flood Risk and Coastal Change (Ref. 12.9).
High	Locally significant attribute of high importance	Surface water	Watercourse having a WFD classification shown in a RBMP and with Q95 < 1.0m3/s. Species protected under UK Legislation as described in LA 108 (Ref. 12.39).
High	Locally significant attribute of high importance	Groundwater	Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE. SPZ 2.
High	Locally significant attribute of high importance	Flood Risk	More vulnerable development as defined in the National Planning Practice Guidance for Flood Risk and Coastal Change (Ref. 12.9).
Medium	Moderate quality and rarity	Surface water	Watercourse not having a WFD classification shown in a RBMP and with Q95 > 0.001m3/s.
Medium	Moderate quality and rarity	Groundwater	Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ 3.
Medium	Moderate quality and rarity	Flood Risk	Less vulnerable development as defined in the National Planning Practice Guidance for Flood Risk and Coastal Change (Ref. 12.9).

Sensitivity of Receptor	Definition of Sensitivity	Receptor	Typical Examples
Low	Lower quality	Surface water	Watercourse not having a WFD classification shown in a RBMP and with Q95 < 0.001m3/s.
Low	Lower quality	Groundwater	Unproductive strata.
Low	Lower quality	Flood Risk	Water compatible development as defined in the National Planning Practice Guidance for Flood Risk and Coastal Change (Ref. 12.9).

Table 12-4 Criteria for determining the magnitude of an impact

Impact Magnitude	Criteria	Receptor	Typical Examples
Major adverse	Results in loss of attribute and / or quality and integrity of the attribute.	Surface water	Failure of both acute-soluble and chronic-sediment related pollutants when using the HEWRAT and compliance failure with EQS values. Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). Loss or adverse change to a fishery. Loss of regionally important public water supply. Loss or extensive change to a designated nature conservation site. Reduction in water body WFD classification.
Major adverse	Results in loss of attribute and / or quality and integrity of the attribute.	Groundwater	Loss of, or adverse change to, an aquifer. Loss of regionally important public water supply. Potential high risk of pollution to groundwater from routine runoff - risk score >250 (Groundwater quality and runoff assessment). Calculated risk of pollution from spillages ≥2% annually (Spillage assessment). Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification. Loss or significant damage to major structures through subsidence or similar effects.

Impact Magnitude	Criteria	Receptor	Typical Examples
Major adverse	Results in loss of attribute and / or quality and integrity of the attribute.	Flood risk	Increase in peak flood level (>100mm).
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute.	Surface water	Failure of both acute-soluble and chronic-sediment related pollutants when using the HEWRAT but compliance with EQS values. Calculated risk of pollution from spillages ≥1% annually and <2% annually. Partial loss in productivity of a fishery. Degradation of regionally important public water supply or loss of major commercial / industrial / agricultural supplies. Contribution to reduction in water body WFD classification.
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute.	Groundwater	Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial / industrial / agricultural supplies. Potential medium risk of pollution to groundwater from routine runoff - risk score 150-250. Calculated risk of pollution from spillages ≥1% annually and <2% annually. Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification. Damage to major structures through subsidence or similar effects or loss of minor structures.
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute.	Flood risk	Increase in peak flood level (> 50mm).
Minor Adverse	Results in some measurable change in attributes, quality or vulnerability.	Surface water	Failure of either acute soluble or chronic sediment related pollutants when using the HEWRAT. Calculated risk of pollution from spillages ≥0.5% annually and < 1% annually. Minor effects on water supplies.

Impact Magnitude	Criteria	Receptor	Typical Examples
Minor Adverse	Results in some measurable change in attributes, quality or vulnerability.	Groundwater	Potential low risk of pollution to groundwater from routine runoff - risk score <150. Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. Minor effects on an aquifer, GWDTEs, abstractions and structures.
Minor Adverse	Results in some measurable change in attributes, quality or vulnerability.	Flood risk	Increase in peak flood level (> 10mm).
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.	Surface water	No risk identified by the HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <0.5%.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.	Groundwater	No measurable impact upon an aquifer and / or groundwater receptors and risk of pollution from spillages <0.5%.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.	Flood risk	Negligible change to peak flood level (≤ +/- 10mm).
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring.	Surface water	HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually).
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring.	Groundwater	Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually). Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding.
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring.	Flood risk	Creation of flood storage and decrease in peak flood level (> 10mm).

Impact Magnitude	Criteria	Receptor	Typical Examples
Moderate beneficial	Results in moderate improvement of attribute quality.	Surface water	HEWRAT assessment of both acute-soluble and chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually). Contribution to improvement in water body WFD classification.
Moderate beneficial	Results in moderate improvement of attribute quality.	Groundwater	Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). Contribution to improvement in water body WFD classification. Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification. Support to significant improvements in damaged GWDTE.
Moderate beneficial	Results in moderate improvement of attribute quality.	Flood risk	Creation of flood storage and decrease in peak flood level1 (> 50mm).
Major beneficial	Results in major improvement of attribute quality.	Surface water	Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. Improvement in water body WFD classification.
Major beneficial	Results in major improvement of attribute quality.	Groundwater	Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in water body WFD classification.
Major beneficial	Results in major improvement of attribute quality.	Flood risk	Creation of flood storage and decrease in peak flood level (> 100mm).
No change	No change	Surface water Groundwater Flood risk	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Significance Criteria

12.3.21 The significance level attributed to each effect has been assessed based on the sensitivity of the affected receptor(s) and the magnitude of change arising from the Proposed Scheme, as outlined in **Chapter 5: Approach to EIA** (Document Reference: 3.05.00). The sensitivity of the affected receptor is assessed on a scale of very high, high, medium and low, and the magnitude of change is assessed on a scale of major adverse, moderate adverse, minor adverse, negligible, minor beneficial, moderate beneficial and major beneficial as set out in **Chapter 5: Approach to EIA** (Document Reference: 3.05.00).

Effect Significance

12.3.22 The following terms have been used to define the significance of the effects identified and apply to both beneficial and adverse effects:

- **Large effect**: where the Scheme could be expected to have a substantial improvement or deterioration on receptors;
- **Moderate effect**: where the Scheme could be expected to have a noticeable improvement or deterioration on receptors;
- **Slight effect**: where the Scheme could be expected to result in a perceptible improvement or deterioration on receptors; and
- **Neutral**: where no discernible improvement or deterioration is expected as a result of the Scheme on receptors, including instances where no change is confirmed.

12.3.23 As set out in **Chapter 5: Approach to EIA** (Document Reference: 3.05.00), effects that are classified as **moderate or above** are considered to be **significant**. Effects classified as **below moderate** are considered to be **not significant**.

Assessment Methodology

12.3.24 This chapter is supported by five standalone documents as follows:

- **Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01);
- **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02);
- **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03);
- **Appendix 12.4: River Wensum Geomorphology Assessment** (Document Reference: 3.12.04); and
- **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05).

12.3.25 The methodologies undertaken for the appendices are detailed in the standalone reports.

12.4 Baseline Conditions

Surface Water Features

River Wensum

12.4.1 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 River Wensum flows in a south-east direction through the north of the Site Boundary and is designated as a main river under the jurisdiction of the Environment Agency.

12.4.2 The catchment area of the River Wensum, as measured at the gauging station Costessey Mill (NRFA Station Number 34004), is 571 km². The catchment landscape is predominantly rural with intensive arable farmland dominating the landscape and grazing marsh, fen, scrub, and scattered woodlands characterising the floodplains.

12.4.3 There is a gas main that crosses beneath the bed of the River Wensum approximately 450 metres downstream of the location of the Proposed Scheme viaduct crossing. The exact depth of the gas main has not been confirmed but headwall structures were visible during site walkovers suggesting the gas main may be relatively shallow.

12.4.4 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' (1992) (**Ref.12.40**).

12.4.5 The River Wensum is monitored against the objectives of the WFD. The reach within the Study Area is the River Wensum Upstream Norwich water body (GB105034055881); this lies within the Anglian River Basin District (RBD), the Broadland Rivers Management Catchment, and the Wensum Operational Catchment.

12.4.6 In accordance with WFD terminology, the River Wensum Upstream Norwich water body is designated as heavily modified and is currently achieving 'Moderate' status, comprising 'Moderate' ecological status and 'Fail' chemical status. The hydromorphological status is 'Supports Good' and hydrological regime currently is 'Does Not Support Good'. The reasons for not achieving Good status are stated as poor nutrient management, poor livestock management, sewage discharge, and groundwater abstraction. The water body status objective is to achieve Good by 2027.

12.4.7 The River Wensum Downstream Norwich water body (GB105034055882) is located approximately 13.5 kilometres downstream of the Study Area; this also lies within the Anglian 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 and risk of impacts as it is in hydraulic connectivity to the Study Area.

12.4.8 In accordance with WFD terminology, the River Wensum Downstream Norwich 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 stated as urbanisation - urban development, poor nutrient management, poor livestock management, sewage discharge, navigation, recreation, and groundwater abstraction. The water body status objective is to achieve 'Good' by 2027.

12.4.9 The floodplain of the River Wensum in the locality of the Proposed Scheme mostly comprises of managed grassland with areas of fen, wet grassland, woodland and wet woodland; and provides physical habitat to aquatic and terrestrial ecology and important connectivity with the River Wensum. The floodplain has historically been drained for agricultural purposes by series of Internal Drainage Board 'main drains' managed by Norfolk Rivers Internal Drainage Board (IDB). The largest of these drains is the ordinary watercourse WC5 that runs parallel to the River Wensum. The remainder bisect the floodplain before typically discharging into one of these larger watercourses. These watercourses are not monitored against the WFD but are in hydraulic connectivity with the River Wensum.

River Tud

12.4.10 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). The River Tud catchment is approximately 73.2km^2, extending from Daffy Green to the confluence with the River Wensum. The Q95 river flow (low flow parameter) is 0.073m³/s where the outfall from the A47 scheme discharges into the River Tud.

12.4.11 The River Tud is monitored against the objectives of the WFD. The River Tud water body (GB105034051000) is designated as heavily modified and lies within the Anglian RBD, 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. The Proposed Scheme lies within the River Tud Nitrate Vulnerable Zone (NVZ) for surface water.

12.4.12 In accordance with WFD terminology, the River Tud water body is currently performing at 'Moderate' status; comprising 'Moderate' ecological status and 'Fail' chemical status. The reasons for not achieving 'Good' status are stated as poor nutrient management, transport drainage, poor livestock management, and sewage discharge. The water body status objective is to achieve 'Good' by 2027.

Foxburrow Stream

12.4.13 Foxburrow Stream (a tributary of the River Tud) flows in a north to south-east direction, with the source of the watercourse approximately 1 km upstream of the Proposed Scheme. The Foxburrow Stream catchment comprises predominately rural and agricultural land, extending in the north-west to Ley's Farm. The catchment is approximately 3km² upstream from the Proposed Scheme. Foxburrow Stream discharges into the River Tud approximately 2 kilometres downstream of the Proposed Scheme. The Q95 river flow (low flow parameter) is 0.0051m³/s where the Proposed Scheme crosses the Foxburrow Stream.

12.4.14 Foxburrow Stream is classified as an ordinary watercourse and is under the jurisdiction of NCC as Lead Local Flood Authority (LLFA) for the area.

12.4.15 Foxburrow Stream is not monitored against the objectives of the WFD but is located within the River Tud water body (GB105034051000).

Surface Water Abstractions

12.4.16 Environment Agency surface water abstraction data indicates that there are six licensed surface water abstractions located within the Study Area. Five abstractions are from the River Wensum and one abstraction is from the River Tud. Five of the licenced surface water abstractions are for agricultural purposes and one for industrial, commercial and public services.

Groundwater Features

Geology

12.4.17 The main characteristics of the geology (superficial and bedrock) that underlies the Proposed Scheme are described in **Chapter 13: Geology and Soils** (Document Reference: 3.13.00) and considers both published information and the findings of the Ground Investigations.

12.4.18 The British Geological Survey (BGS) Geology map (**Ref. 12.22**) and Ground Investigation borehole logs show that the Site Boundary is underlain by superficial deposits including Head Deposits, Alluvium, River Terrace Deposits, Sheringham Cliffs Formation and Lowestoft Formation.

12.4.19 Head Deposits comprise stiff to very stiff, gravelly clay or beds of fine to medium sand with gravel inclusions. These deposits are found in localised areas around the northern end of the Proposed Scheme.

12.4.20 The Alluvium and River Terrace Deposits are located in the northern area of the Proposed Scheme in close proximity to the River Wensum. These deposits follow the approximate flow pathway and tributaries of the River Wensum. The alluvial deposits vary in composition between cohesive and granular units across the Proposed Scheme. Local alluvial deposits varied from peaty, very silty, clayey, slightly gravelly, fine to coarse sand and slightly

silty, sandy fine to coarse flint and chalk gravel. Borehole logs indicate a typical thickness of approximately 1m – 14m. The River Terrace Deposits comprise of silty gravelly sand, gravelly silty clay and clayey very gravelly fine to medium sand. Borehole logs indicate a variable unit thickness of up to approximately 10 metres.

12.4.21 The Sheringham Cliffs Formation is present across the majority of the Proposed Scheme. The BGS defines the Sheringham Cliffs Formation as a glaciogenic sequence containing nine distinctive lithofacies (member) units. Unit descriptions for the Sheringham Cliffs Formation are as followed: Dense to loose, slightly clayey, gravelly fine to coarse sand; slightly silty, slightly clayey fine to medium sand and very sandy clay. Borehole logs indicate a unit thickness between approximately 0.5m – 21m.

12.4.22 The Lowestoft Formation is defined by the BGS as 'extensive sheet of chalky till, together with outwash sands and gravels, silts and clays'. Lithological descriptions from borehole logs have been used to describe the heterogenous deposit. The composition varies between very sandy, slightly gravelly clay, slightly gravelly clay, very sandy clayey silt and sandy gravelly clay. A formation thickness between approximately 2m – 7m has been recorded.

12.4.23 The bedrock geology of the Site Boundary entirely comprises undifferentiated deposits of the White Chalk Subgroup and is defined by the BGS as '*Chalk with flints with discrete marl seams, nodular chalk, sponge-rich and flint seams throughout*'. The base of the White Chalk Subgroup was not determined by the BGS borehole logs. BGS Map Sheet 161 indicates a possible total thickness of 270 metres for the White Chalk Subgroup.

Aquifer Designation

12.4.24 The DEFRA Magic Map Webtool (**Ref 12.34**) has been used to assess the hydrogeology and assign Environment Agency aquifer designation to the onsite geology. The superficial geology (Alluvium and River Terrace Deposits) are designated by the Environment Agency as 'Secondary A Aquifers'. The Environment Agency defines Secondary 'A' Aquifers as "permeable layers

capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers". The superficial deposits are likely to store limited (due to the high proportions of silt and clay in the glacial till type deposits) to substantial (sand and gravel rich River Terrace Deposits) quantities of groundwater. The aquifer is also expected to provide baseflow to the River Wensum and the River Tud and provides groundwater recharge to the underlying Chalk aquifer.

12.4.25 The Sheringham Cliffs Formation, Lowestoft Formation and Head Deposits are designated by the Environment Agency as 'Secondary Undifferentiated Aquifers'. Assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. The Environment Agency defines 'Secondary B Aquifers' as "Predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers".

12.4.26 The White Chalk Subgroup is designated by the Environment Agency as a 'Principal Aquifer'. The Environment Agency defines a 'Principal Aquifer' as: "These 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. They may support water supply and / or river base flow on a strategic scale. In most cases, Principal Aquifers are aquifers previously designated as Major Aquifer". The chalk mostly has a high fracture permeability and has been used for groundwater abstraction in the regional area. The River Wensum and River Tud are assumed to be well hydraulically connected with the chalk aquifer, with parts of the baseflow for the rivers to be supplied by the chalk aquifer.

12.4.27 The BGS Hydrogeological Map Sheet 4 Northern East Anglia Sheet identifies a catchment divide in the Chalk aquifer located at the approximate centre of

the Proposed Scheme. This correlates with the local topography where the landscape slopes down to the north-east towards the River Wensum, and south-west towards the A47 and the River Tud. The groundwater level contours show evidence that the River Wensum and possibly the River Tud act as groundwater receptors for the Chalk aquifer. The rivers are assumed to be directly fed by the Chalk aquifer or through the hydraulically connected superficial deposits. Water level measurements in the area of the proposed River Wensum Viaduct also suggest that surface water occasionally provides additional groundwater recharge to the underlying aquifers, forming a robust surface water / groundwater level buffer system.

Source Protection Zones

12.4.28 The DEFRA Magic Map Webtool (**Ref 12.34**) indicates that the Proposed Scheme is located within a Groundwater Source Protection Zone 3 Total Catchment, with its related Inner Source Protection Zone 1 being located 1.3 kilometres south-east of the Proposed Scheme and located at Taverham. This is likely to be associated with a public water supply and likely targets the chalk aquifer. A Total Catchment Source Protection Zone 3 is defined as the area around a source within which all groundwater recharge is presumed to eventually be discharged at the source (assuming abstraction at maximum licensed rate). Another Inner Source Protection Zone 1 is located approximately 0.9 kilometres south-west of the Proposed Scheme, however, the Total Catchment Source Protection Zone 3 does not extend to the Proposed Scheme and is unlikely to be hydraulically connected to the Proposed Scheme due to the abstraction being on the southern side of the River Tud.

Groundwater Vulnerability

12.4.29 The Proposed Scheme is located within a Medium to High Groundwater Vulnerability Zone with a soluble rock risk. The vulnerability assigned to a geology is determined by its hydrogeological properties to allow surface contamination to enter, flow in and flow out of the aquifer. In addition, the entire site is also located in a Nitrate Vulnerability Zone (NVZ). The

Environment Agency defines a NVZ as '*Existing NVZ are the zones which apply from 1st January 2013 – 31st December 2016 and relate to surface and groundwaters, and also eutrophic waters. With relation to groundwater – water held underground in the soil or in pores and crevices in rock that has or could have if action is not taken, a nitrate concentration of >50mg/L*'. The Proposed Scheme is situated on agricultural and greenfield land.

Groundwater Levels

12.4.30 Discrete manual dip groundwater level data have been recorded at a number of onsite monitoring boreholes within the Proposed Scheme between 2020 and 2023, particularly during the winter. Groundwater levels during 2022 were recorded to be between 0.86mbgl – 20.15mbgl across the Proposed Scheme, where shallow groundwater levels tend to coincide with valley locations. Groundwater levels recorded during November 2020, March 2021 and January 2023 indicated groundwater at surface level within the River Wensum floodplain. There are also shallow groundwater levels present at the location of the proposed Tud Tributary culvert / Bat Underpass culvert (CU2), where there is a stream valley present. Groundwater levels at surface were often recorded at borehole BHR35, where this is situated adjacent to the Foxburrow Stream towards the southern end of the Proposed Scheme.

Private Groundwater Abstractions

12.4.31 Groundwater abstraction data has been provided by the Environment Agency and there are 6 private water supply permits within 1 kilometre of the Site Boundary. Table 12-5 presents more details to these private water supply permits, where only AL9 is situated within the Site Boundary and yields approx. 27m^3/d. These permits often represent multiple abstraction points in a similar area and the licensed limits range from approximately 6m^3/d (cubic metres per day) to 546m^3/d. Of these 6 private water supply permits, 1 permit is below 20m^3/d, 2 permits are between 20m^3/d and 100m^3/d and 3 permits are above 100m^3/d.

Table 12-5 Private Abstraction Licence Details

Name	Purpose	Target	Licensed Annual Yields (m^3/year)
AL1	Industrial, Commercial and Public Services	Chalk Aquifer	13,636
AL3	Agriculture	Chalk Aquifer	2,300
AL4	Agriculture	Chalk Aquifer	199,389
AL7	Agriculture	Chalk Aquifer	56,833
AL8	Agriculture	Chalk Aquifer	71,000
AL9	Agriculture	Chalk Aquifer	10,000

12.4.32 The Environment Agency also provided some details of 4 public water supply licenses within a 3km radius of the Proposed Scheme. The locations of these abstractions are confidential but are expected to be related to the Source Protection Zones described above. The combined licensed abstraction rate of the public water supplies is 19,317,000m^3/year (52,923m^3/d).

Groundwater Dependant Terrestrial Ecosystems (GWDTEs)

12.4.33 The only GWDTE within or within 1 kilometre of the Site Boundary is the River Wensum (SSSI and SAC). The floodplain associated with the River Wensum likely consist of ecosystems which are dependent on shallow groundwater. The River Wensum, the associated drainage features and the shallow groundwater here are likely to be hydraulically connected.

Groundwater Body – Water Framework Directive Status

12.4.34 The Environment Agency identifies the groundwater waterbody as the 'Broadland Rivers Chalk & Crag' on the Data Catchment Explorer (**Ref.**

12.16). The groundwater water body underlies the entire site. A summary of the WFD classification data is provided in Table 12-6.

Table 12-6 Groundwater Water Body WFD Classification

Attributes	**Description**
Waterbody ID	GB40501G400300
Waterbody Name	Broadland Rivers Chalk & Crag
Waterbody Type	Groundwater Body
Groundwater Area	3075.9km²
National Grid Ref.	TG5140908672
Description	The groundwater water body underlies the entire proposed scheme alignment. The northern area of the proposed alignment crosses the River Wensum. This includes the superficial Alluvium, River Terrace Deposits, Head and Sheringham Cliffs Formation, Lowestoft Formation and White Chalk Subgroup bedrock units. The Environment Agency has classified the superficial deposits as a Secondary A and Secondary Undifferentiated Aquifers. The White Chalk Subgroup bedrock is classified as Principal Aquifer.
Overall Status	Poor
Overall Status Objective	Good 2027

Attributes	Description
Overall Quantitative Status	Poor
Overall Quantitative Status Objective	Good 2021
Overall Chemical Status	Poor
Overall Chemical Status Objective	Good 2027
Protected Area Designation	Nitrates Directive (NVZ12GW010780, NVZ12GW010710, NVZ12GW010790 & NVZ12GW011710), Drinking water protected Area (UKGB40501G400300).
Reason for not achieving Good status	Groundwater Abstraction; Agricultural and Rural Land Management.
Waterbody Measures	Not applicable

Flood Risk

12.4.35 A detailed description of the baseline flood risk for all sources of flooding is included in the accompanying **Appendix 12.2 Flood Risk Assessment**

(Document Reference: 3.12.02). A summary of the fluvial, surface water and groundwater flood risks are presented below.

Fluvial Flooding

12.4.36 The Environment Agency's Flood Map for Planning shows that the River Wensum has a wide floodplain throughout the Study Area, where land currently lies in Flood Zones 2 and 3. Flood Zone 3 is classed as having a High Probability of flooding and is assessed as land having a 1 in 100 or greater annual probability of river flooding. Flood Zone 2 is classed as having a Medium Probability of flooding and is assessed as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding.

12.4.37 The floodplain of the River Wensum at the location of the Proposed Scheme is largely confined to the surrounding rural floodplain and open green space. The right bank of the floodplain is significantly wider, approximately 300m, and contains a network of drainage ditches. The left bank is constrained by high ground and the floodplain here is closer to 50 metre wide in comparison.

12.4.38 A review of the Chronology of British Hydrological Events (**Ref.12.41**) indicates that the largest flood on the Wensum occurred in 1912. More recently, a flood investigation report by NCC from 2014 (**Ref. 12.42**) indicates that two rainfall events occurred on the 27 May and 20 July 2014, resulting in the flooding of 80 properties within the Norwich urban area. Along the reach of interest, no flooding incidents have been reported. The baseline fluvial flood risk modelled for this watercourse is presented in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02).

12.4.39 The existing 1D-2D River Wensum hydraulic model was updated to provide a detailed and more robust assessment of the baseline and post-development assessment of flood risk to the Proposed Scheme and third parties. **Figure 3.1** in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02) provides a comparison between the Flood Zone 2 and the updated model extents at the location of the viaduct for the 1 in 1000 annual probability event. The 1 in 100 +44% annual probability event is very similar in magnitude

to the 1 in 1000 annual probability event albeit slightly larger. These two extents are therefore very similar in size.

12.4.40 The Environment Agency's Flood Map for Planning (**Ref. 12.14**) identifies Flood Zone 2 and 3 immediately downstream of the Proposed Scheme crossing of Foxburrow Stream. Flood Zone 2 and 3 are closely aligned in this location and constrained to the existing channel; this largely remains the case to the watercourse's confluence with the River Tud. The Flood Map for Planning does not extend upstream of the Proposed Scheme location, presumably because the upstream catchment is below the threshold typically used for the Flood map for Planning (c. 3-5km^2). The hydraulic modelling undertaken to support **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02) broadly mirrors the Environment Agency's Flood Zones and confirms that floodwater remains within the watercourse channel upstream of the Proposed Scheme.

12.4.41 A new model and associated hydrology for the Foxburrow Stream have been developed for the purposes of this study and are presented in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02)**.**

Surface Water Flood Risk

12.4.42 Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground but lies on or flows over the ground instead. In rural locations such as the site of the Proposed Scheme, it typically occurs when the underlying soils are saturated, with overland flows following topography and flowing downhill. Peaty soils which are naturally wet are noted to be present in the northern extent of the Site Boundary associated with the River Wensum and largely define Flood Zone 3 indicating a connection with soil hydrology. Further information is provided in **Chapter 13: Geology and Soils** (Document Reference: 3.13.00).

12.4.43 Surface water flooding has been assessed by review of the Environment Agency's Flood Risk from Surface Water maps (**Ref. 12.15**). Review of these maps indicates that there are pockets of high, medium and low flood risk from

surface water along the Proposed Scheme. High risk means that each year this area has a chance of flooding of greater than 1 in 30. Medium risk means that each year this area has a chance of flooding of between 1 in 100 and 1 in 30. Low risk means that each year this area has a chance of flooding of between 1 in 1000 and 1 in 100. Noteworthy areas of surface water flood risk are discussed in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02) and comprise two overland flows routes in the vicinity of Ringland Lane and Weston Road that are crossed by the alignment of the Proposed Scheme within the catchment of the River Wensum.

Flood Risk from Artificial Sources

12.4.44 The Environment Agency's Flood Risk from Reservoirs mapping indicates that the Proposed Scheme may be at risk of flooding in the event of reservoir failure from Haveringland Lake on the Trout Stream tributary of the River Wensum upstream of Attlebridge. The flood waters in the event of reservoir failure are indicated to follow the alignment of the River Wensum, with the mapped flood extents being broadly similar to the mapped Flood Zone 2 and Flood Zone 3 fluvial flood extents. This is discussed further in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02)**.**

Groundwater Flood Risk

12.4.45 Groundwater flooding occurs when the groundwater levels rise to within close proximity of ground level, either causing flood risk to underground structures or emerging and flowing across the ground's surface. Groundwater flooding is generally a result of extended periods of heavy rainfall associated with porous underlying geology, such as chalk, limestone and gravels.

12.4.46 The vicinity of the River Wensum, geology comprises predominantly Chalk bedrock overlain with permeable sands and gravel. This provides an efficient hydraulic link between the Principal Aquifer (Chalk) and the River Wensum and drainage channels in the floodplain of the river.

12.4.47 Mapping presented in the Greater Norwich SFRA (**Ref. 12.18**) includes the Environment Agency's Areas Susceptible to Groundwater Flooding dataset

and indicates that the vast majority of the Proposed Scheme is located within an area considered to be at very low risk of groundwater flooding. Only those areas of lower topography in close proximity to the River Wensum and the junction with the A47 (due to its proximity to the River Tud) are considered to have a higher risk of groundwater flooding.

Future Baseline

12.4.48 The most likely change in the baseline conditions in the future would be associated with an increase in peak river flows and peak rainfall intensity associated with the potential effects of climate change. The Environment Agency provide guidance on a range of potential climate change allowances dependant on the relevant river basin district and climate change probability. The Proposed Scheme is located within the Broadland Rivers Management Catchment. In this region it is predicted that by the 2080s peak river flows could increase by 11% (central allowance), 20% (higher central allowance) and 44% (upper end allowance). This may increase the frequency of flood risk to identified receptors and increase the extent of Flood Zones 2 and 3, resulting in a greater area of the Proposed Scheme at risk of fluvial flooding. The potential effects of climate change have been assessed in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02)**.**

12.4.49 The peak rainfall intensity may also increase as a result of climate change, which could potentially increase the risk of surface water flooding to the Proposed Scheme. The Environment Agency provides guidance on the central and upper end allowances for all of England. The total potential change anticipated up to the 2070s is 20 % (central allowance) and 45 % (upper end allowance). The potential effects of climate change have been assessed in **Appendix 12.2 Flood Risk Assessment** (Document Reference: 3.12.02) and considered in the design of the proposed surface water drainage system discussed in the **Drainage Strategy Report** (Document Reference: 4.04.00)**.**

12.4.50 The WFD is also likely to affect the future baseline of surface water and groundwater receptors. The WFD requires all waterbodies (including surface

water and groundwater) to achieve 'Good' overall status, or to experience no deterioration in status or potential status. The current WFD status for the surface water waterbodies located within the Study Area is 'Moderate', so improvement measures would be sought to bring the status from 'Moderate' to 'Good'.

12.4.51 It is expected that there would be no significant changes between current and future baseline for groundwater resources. The objectives of improving the WFD water body status (in particular the quantitative status) should result in the recovery of the water levels in the Chalk aquifer, i.e. baseline conditions may change to slightly higher groundwater level conditions in particular during drier periods.

12.4.52 Climate change may also affect groundwater levels of the shallow aquifers in particular in proximity to the surface water features which could results in an increased seasonal range of water levels and has the potential to increase the groundwater flood risk.

12.5 Sensitive Receptors

12.5.1 The following sensitive receptors have been assessed as shown in Table 12-7.

Table 12-7 Sensitive Receptors

Receptor	Sensitivity	Justification
River Wensum (including floodplain)	Very High	A main river under the jurisdiction of the Environment Agency. Current WFD classification is Moderate. River channel holds European designation as a SAC and UK designation as a SSSI. Floodplain provides physical habitat to aquatic and terrestrial ecology and important connectivity with the River Wensum.

Receptor	Sensitivity	Justification
River Tud	High	A main river and tributary of the River Wensum approximately 2km downstream of the crossing with Foxburrow Stream. Current WFD classification is Moderate. Not located within a SAC or SSSI. Q95 river flow of 0.073m³/s.
Foxburrow Stream	Medium	Ordinary watercourse under the jurisdiction of NCC as LLFA. Discharges to the River Tud approximately 2km downstream of the Proposed Scheme. Not monitored against the WFD and no known designations or species of importance. Q95 river flow of 0.0051m³/s.
IDB drains	Low	Drains and ditches providing a drainage function to floodplain within the Study Area. Not monitored against the WFD but in hydraulic connectivity with the River Wensum. Q95 river flow expected to be < 0.001m³/s.
Third Party Flood Risk Receptors	Low to High	Flood risk predominantly within rural areas with few properties identified to be located in close proximity to Flood Zone 3 and the local villages of Attlebridge and Ringland, upstream and downstream of the Scheme.
Proposed Scheme	Very High	In accordance with NPPF the Proposed Scheme is considered to be Essential Infrastructure and therefore allocated a sensitivity of Very High

Receptor	Sensitivity	Justification
Principal Aquifer and Source Protection Zone 3	High	The entire Proposed Scheme alignment is underlain by the White Chalk Subgroup Principal Aquifer. The aquifer is contributing to the River Wensum and River Tud baseflow and is protected by Total Catchment Source Protection Zone 3 (related to a public water supply). Public water supplies are considered as part of the Principal Aquifer and SPZ 3.
Secondary A Aquifers	Medium	The Proposed Scheme is underlain by Secondary A Aquifers of superficial Alluvium and River Terrace Deposits. The aquifers are expected to be contributing the river baseflow.
Secondary Undifferentiated Aquifer	Low	The Proposed Scheme is underlain by Secondary Undifferentiated Aquifer of superficial Head Deposits, Lowestoft Formation and Sheringham Cliffs Formation. The aquifers have only low water resource potential.
Groundwater Abstractions (excluding public water supplies)	Medium	Mainly small water supplies for agricultural use, including one which is situated within the Site Boundary.
Groundwater Dependent Terrestrial Ecosystems (GWDTEs)	Very High	GWDTEs are highly sensitive to any potential changes in the hydrogeology regime. The River Wensum and its floodplain is identified as a GWDTE.

12.6 Assessment of Potential Effects, Mitigation and Residual Effects

Construction Phase

12.6.1 The following forms of embedded mitigation have been considered within the construction phase assessment:

- **Appendix 3.1: Outline Construction Environmental Management Plan (OCEMP)** (Document Reference: 3.03.01) details mitigation measures that would manage environmental impacts during construction. **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) sets out how construction activities would be undertaken in accordance with appropriate good practice guidance, such as CIRIA's control of water pollution from construction sites (C532). **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) outlines the other licences and permits that may be required for the construction of the Proposed Scheme, although the application for any licences or permits is considered to be additional mitigation.
- Areas for temporary use during construction which include the construction compounds are generally located away from watercourses or identified overland flow routes. There are two small areas for temporary use located within the floodplain of the River Wensum and specific mitigation regarding the Temporary Works Platform is detailed within the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15). The areas for temporary use during construction are identified on **Figure 3.1** Red Line Boundary and Site Boundary Plan in **Appendix 3.3: Figures** (Document Reference: 3.03.02).
- The **Construction Surface Water Management Strategy** (Document Reference: 4.04.15) outlines the options for the proposed construction methodology for the permanent watercourse crossings.
- The construction of the viaduct will require temporary works within the active floodplain of the River Wensum. The design of the temporary

works is ongoing, however the core elements of the proposals are presented in **Appendix 12.2: Flood Risk Assessment Sub Appendix K: Design Drawings** (Document Reference: 3.12.02k). In brief the assessment has been based on a temporary works design consisting of the following:

- A raised working platform extending across the full width of the River Wensum floodplain constructed to a height sufficiently high to avoid overtopping in all flood events.
- A culvert to provide continued connectivity for WC5.
- Flood relief culverts within the River Wensum floodplain beneath the Temporary Works Platform to reduce the risk of flooding upstream.
- A bailey bridge to provide connectivity between the Temporary Works Platform on either side of the River Wensum.

Table 12-8 Assessment of potential effects on the River Wensum during construction activities

Description	**Potential effects on the River Wensum during construction activities**
Sensitive receptor	River Wensum (Very High Sensitivity)
Potential effects	Sedimentation Temporary increased sedimentation within the River Wensum could be caused by surface water runoff containing elevated levels of suspended particles that may result from land clearance, excavation, dewatering of excavations, wheel washings, areas of bare earth, construction materials such as aggregate and stockpiles of topsoil substances associated with temporary works. Runoff with high sediment loads may potentially have direct adverse impacts on the River Wensum through increasing turbidity (thus reducing light penetration and reducing plant growth), and by smothering vegetation and bed substrates (thus impacting on invertebrate and fish communities through the destruction of feeding areas, refuges and breeding and / or spawning areas). Organic sediments can also have indirect effects on physico-chemical properties such as dissolved oxygen demand and pH. A Temporary Works Platform is situated above the River Wensum floodplain and will be used to store materials and plant during the construction phase. The Temporary Works Platform will incorporate a temporary crossing of River Wensum using a bailey bridge. The proposed environmental enhancements within the floodplain of the River Wensum generally consist of planting in the floodplain and are expected to be undertaken in the dry. The construction of the gravel bars and riffles in the River Wensum generally involve the placing of material in the channel with some allowance for the River Wensum itself to naturally determine the final placement. The new meander will be constructed offline with the diversion of flows allowed once complete. Groundwater ingress is expected into the new meander channel and overpumping will be required to minimise water levels in the working area. Access matting will also be required across the floodplain for any plant required. The magnitude of the impact is likely to be greater when working in areas above and adjacent to the River Wensum and within the associated floodplain, and in periods of heavy rainfall. Sediment is likely to settle quickly during normal flow conditions but may be dispersed during larger flood flow events. The effects of increased sedimentation in construction runoff would reduce shortly after completion of the works when exposed areas of earth are resurfaced, reseeded or replanted. The mitigation measures detailed in Section 4.11 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and Section 4 of the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15) would reduce the risk of increased sedimentation and potential effects to the River Wensum. The sensitivity of the River Wensum is **Very High** and the magnitude of impact to water quality, prior to additional mitigation, is **Moderate Adverse** associated with the release of sediments. Therefore, there is likely to be a direct, temporary, cumulative, short term **Moderate** effect (significant) on the River Wensum prior to the implementation of additional mitigation measures.

Description	Potential effects on the River Wensum during construction activities
Potential effects	Pollution risks Increased pollution risks from spillage of fuels or other harmful substances associated with temporary works may migrate to the River Wensum. Hydrocarbons form a film on the surface of the water body, deplete oxygen levels and may be toxic to fish. Even at very low concentrations, the film may negatively affect the visual appearance of the water body. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter the River Wensum, adversely affecting the aquatic environment or contaminate surface water abstractions. A common source of pollution is from leaks and spillages of hydrocarbons from mechanical plant or storage vessels. Concrete and cement products can also pose a significant risk to the water environment and are highly alkaline and corrosive. Fish may be physically damaged, and their gills blocked, and both vegetation and the bed of the receiving water body may be smothered. For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the river, that a significant risk of acute toxicity would arise. Most of the areas for temporary use during construction are located away from the River Wensum and other watercourses or identified overland flow routes. There are two small areas for temporary use located within the floodplain of the River Wensum; specific mitigation regarding the Temporary Works Platform and Bailey bridge is detailed within Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and Section 4 of the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15). The sensitivity of the River Wensum is **Very High** and the magnitude of impact to water quality, prior to additional mitigation, is **Moderate Adverse** associated with the potential pollution risks. Therefore, there is likely to be a direct, temporary, cumulative, short term **Moderate** effect (significant) on the River Wensum prior to the implementation of additional mitigation measures. WFD and geomorphology The construction works could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the River Wensum. The WFDa concludes that 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. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The construction works, including increased sedimentation loading, could also lead to changes to the fluvial geomorphological processes and features of the River Wensum. **Appendix 12.4: River Wensum Geomorphology Assessment** (Document Reference: 3.12.04) concludes that the existing hydraulics and sediment dynamics of the River Wensum could change because of the temporary works structure, particularly for high magnitude / low likelihood flows. These changes would be highly localised to the temporary works area and be of minor localised and temporary impact only. Potential changes to the fluvial geomorphology are most likely to be restricted to high-magnitude flood events, which have a low likelihood of occurrence during the construction phase. Overall, the sediment regime and river morphology would remain constant for all investigated flows during the construction phase. Refer to **Appendix 12.4: River Wensum Geomorphology Assessment** (Document Reference: 3.12.04) for a detailed assessment of the fluvial geomorphological processes and features of the River Wensum. The sensitivity of the River Wensum is **Very High** and the magnitude of impact to WFD status, prior to additional mitigation, is **Negligible**. Therefore, there is likely to be a direct, temporary, cumulative, short term **Slight** effect (not significant) on the River Wensum prior to the implementation of additional mitigation measures.
Additional mitigation	Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) details the need for further consultation with the Environment Agency during the development of the FRAP application. Appropriate and site-specific method statements would be submitted which would reduce the risk of increased sedimentation and pollution risks and as a result potential effects to the River Wensum.

Description	Potential effects on the River Wensum during construction activities
Residual effects and monitoring	The sensitivity of the River Wensum is **Very High**, and the magnitude of effect, following mitigation, is **Minor Adverse**. Given the nature of the works and the proximity to the River Wensum, it is difficult to prevent all sedimentation or pollution risk during construction. Therefore, there is likely to be a direct, temporary, short term **Moderate** residual effect (significant) on the River Wensum following the implementation of additional mitigation measures. The effects on the River Wensum will be temporary and it is likely that it will take approximately 5 years for the re-establishment of the river environment and local quality following the main river works. Monitoring of water quality would be undertaken during and following the works as set out in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).

Table 12-9 Assessment of potential effects on the River Tud during construction activities

Description	Potential effects on the River Tud during construction activities
Sensitive receptor	River Tud (High Sensitivity)
Potential effects	Sedimentation and Pollution risks There are no works within or in close proximity to the watercourse. The nearest works are approximately 650m to the north of the River Tud. Due to the distance between the River Tud and the proposed construction activities and the measures outlined in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01), it is considered unlikely that sedimentation or pollution risks will directly impact the River Tud. There is an indirect risk that sedimentation and pollution could impact the River Tud via the construction of the surface water drainage system or works within the Foxburrow Stream which is a tributary of the River Tud and therefore hydraulically connected. Basin 6 outfalls into the A47 surface water drainage system which ultimately outfalls into the River Tud. Measures to reduce the impacts associated with sedimentation and pollution risks are including within Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and Section 4 of the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15) to reduce the impacts. The sensitivity of the River Tud is considered to be **High**, and the magnitude of impact, prior to additional mitigation is **Negligible**. Therefore, there is likely to be indirect, temporary, short to long-term negligible to **Neutral** effect (not significant) on the River Tud prior to the implementation of additional mitigation measures.
Potential effects	WFD The construction works could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the River Tud. The WFDa concludes that 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. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The sensitivity of the River Tud is considered to be **High**, and the magnitude of impact, prior to additional mitigation is **Negligible**. Therefore, there is likely to be indirect, temporary, short to long-term negligible to **Neutral** effect (not significant) on the River Tud prior to the implementation of additional mitigation measures.
Additional mitigation	No additional mitigation measures are proposed.

Description	Potential effects on the River Tud during construction activities
Residual effects and monitoring	The sensitivity of the River Tud is **High**, and the magnitude of impact, following additional mitigation, is **Negligible**. Therefore, there is likely to be indirect, temporary, short term **Neutral** residual effects (not significant) on the River Tud following the implementation of additional mitigation measures.

Table 12-10 Assessment of potential effects on the Foxburrow Stream during construction activities

Description	**Potential effects on the Foxburrow Stream during construction activities**
Sensitive receptor	Foxburrow Stream (Medium Sensitivity)
Potential effects	Sedimentation Temporary increased sedimentation within Foxburrow Stream could be caused by surface water runoff containing elevated levels of suspended particles that may result from land clearance, excavation, dewatering of excavations, wheel washings, areas of bare earth, construction materials such as aggregate and stockpiles of topsoil substances associated with temporary works. The proposed crossing of Foxburrow Stream will also require works to be undertaken within the watercourse channel and a section of the watercourse will require realignment through the proposed culvert structure beneath the Proposed Scheme. There is also a proposed outfall into Foxburrow Stream which will require some in channel works. Runoff with high sediment loads may potentially have direct adverse impacts on Foxburrow Stream through increasing turbidity, and by smothering vegetation and bed substrates (thus impacting on invertebrate communities through the destruction of feeding areas, refuges and breeding and / or spawning areas). Organic sediments can also have indirect effects on physico-chemical properties such as dissolved oxygen demand and pH. The magnitude of the impact is likely to be greater when working in areas within and adjacent to the Foxburrow Stream, and in periods of heavy rainfall. Sediment is likely to settle quickly during normal flow conditions due to the relatively flat channel gradient and small catchment, but may be dispersed during larger flood flow events. The effects of increased sedimentation in construction runoff would reduce shortly after completion of the works when exposed areas of earth are resurfaced, reseeded or replanted. The alignment of the Tud tributary culvert / Bat underpass culvert (CU2) at Foxburrow Stream connects to the existing alignment of the watercourse upstream and downstream of the Proposed Scheme. To construct this culvert in the dry will therefore either require the diversion of the existing stream flows during construction or offline construction with the eventual diversion of the watercourse onto a new alignment. As part of the environmental mitigation works, Foxburrow Stream is also being reprofiled for a distance of up to 590m and two existing structures are to be removed (a culvert and failed bridge). Flows are typically low on Foxburrow Stream and it is expected the reprofiling works can be undertaken on the bank and in the dry with no expected change to normal or flood flows. The works to remove the culvert and the failed bridge are situated within the channel and as such will require temporary diversion of flows. The culvert is located immediately downstream of the Tud tributary culvert / Bat underpass culvert (CU2) and as such it will be incorporated into those works. Options to divert the watercourse for the failed bridge could include coffer dams in the existing channel to control flows with the construction of a parallel temporary channel, or overpumping to convey the flows downstream. The mitigation measures detailed in Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and Section 4 of the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15) would further reduce the risk of increased sedimentation and potential effects to the Foxburrow Stream. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Moderate Adverse** associated with the release of sediments. Therefore, there is likely to be a direct, temporary, short to long-term slight **Moderate** (significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.

Description	Potential effects on the Foxburrow Stream during construction activities
Potential effects	Pollution risks Increased pollution risks from spillage of fuels or other harmful substances associated with temporary works may migrate to Foxburrow Stream. Hydrocarbons form a film on the surface of the watercourse, deplete oxygen levels and may be toxic to fish. Even at very low concentrations, the film may negatively affect the visual appearance of the watercourse. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter a water body, adversely affecting the aquatic environment. A common source of pollution is from leaks and spillages of hydrocarbons from mechanical plant or storage vessels. Concrete and cement products can also pose a significant risk to Foxburrow Stream and are highly alkaline and corrosive. Fish may be physically damaged, and their gills blocked, and both vegetation and the bed of the receiving water body may be smothered. For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity would arise in the receiving water. There are no areas for temporary use during construction located in close proximity to the Foxburrow Stream. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Moderate Adverse** associated with the potential pollution risks. Therefore, there is likely to be a direct, temporary, short to long-term slight **Moderate** (significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.
Potential effects	WFD The construction works could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the Foxburrow Stream and the WFD waterbody it is located within. The WFDa concludes that 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. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Negligible**. Therefore, there is likely to be a direct, temporary, short to long-term slight **Neutral** (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.
Additional mitigation	Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) details the need for further consultation with the LLFA during the development of the ordinary watercourse consent application. Appropriate and site-specific method statements would be submitted which would further reduce the risk of increased sedimentation and pollution risks and as a result potential effects to the Foxburrow Stream. This process is separate to the planning process.
Residual effects and monitoring	The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, following additional mitigation, is **Minor Adverse**. Given the nature of the works and the proximity to the Foxburrow Stream, it is difficult to prevent all sedimentation or pollution risk during construction. The effects on the Foxburrow Stream will be temporary and it is likely that it will take approximately 2 to 3 years for the re-establishment of the river environment and local quality following the river works. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** residual effect (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.

Table 12-11 Assessment of potential effects on the IDB drains during construction activities

Description	**Potential effects on the IDB drains during construction activities**
Sensitive receptor	IDB drains (Low Sensitivity)
Potential effects	Sedimentation Temporary increased sedimentation within the IBD drains caused by surface water runoff containing elevated levels of suspended particles may result from land clearance, excavation, dewatering of excavations, wheel washings, areas of bare earth, construction materials such as aggregate and stockpiles of topsoil substances associated with temporary works. The proposed crossing of WC5 will also require works to be undertaken within the watercourse channel and a section of the watercourse will require realignment through the proposed culvert structure beneath the southern maintenance track across within the floodplain of the River Wensum. Runoff with high sediment loads may potentially have direct adverse impacts on adjacent water bodies through smothering natural vegetation of the drains and bed substrates which may require additional maintenance in order to maintain the capacity of the drains. The magnitude of the impact is likely to be greater when working in areas within and adjacent to the IDB drains, and in periods of heavy rainfall. Sediment is likely to settle quickly due to the relatively flat channel gradients and small catchments. The source of risk of increased sedimentation in construction runoff would reduce shortly after completion of the works when exposed areas of earth are resurfaced, reseeded or replanted, although sediment may not be flushed through the drains in the same way that would be expected for a watercourse and therefore the impact may be of greater duration. The mitigation measures detailed in the OCEMP and further consultation with the IDB during the development of the ordinary watercourse consent applications would further reduce the risk of increased sedimentation and potential effects to the IDB drains. The mitigation measures detailed in Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and Section 4 of the **Construction Surface Water Management Strategy** (Document Reference: 4.04.15), would further reduce the risk of increased sedimentation and potential effects to the IDB drains including the culvert along WC5. This process is separate to the planning process. The sensitivity of the IDB drains is **Low** and the magnitude of impact, prior to mitigation, is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant) on the IDB drains prior to the implementation of additional mitigation measures.
Potential effects	Pollution risks Increased pollution risks from spillage of fuels or other harmful substances associated with temporary works may migrate to the IDB drains. Hydrocarbons form a film on the surface of the drain or smother vegetation. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter the IDB drains, adversely affecting the quality of the drains. Note that indirect impacts to the River Wensum are discussed in the River Wensum assessment section. A common source of pollution is from leaks and spillages of hydrocarbons from mechanical plant or storage vessels. Concrete and cement products can also pose a significant risk to the water environment and are highly alkaline and corrosive. For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity would arise in the receiving water. The sensitivity of the IDB drains is **Low** and the magnitude of impact, prior to mitigation, is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant) on the IDB drains prior to the implementation of additional mitigation measures.

Description	Potential effects on the IDB drains during construction activities
Potential effects	WFD The construction works could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the IDB drains and the WFD waterbody they are located within. The WFDa concludes that 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 **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) in place. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The sensitivity of the IDB drains is **Low** and the magnitude of impact, prior to mitigation, is **Negligible**. Therefore, there is likely to be a direct, temporary, short to long-term **Neutral** effect (not significant) on the IDB drains prior to the implementation of additional mitigation measures.
Additional mitigation	Culverting of WC5 will require temporary dewatering and diversion of a section of the existing watercourse. This will require a licence from the Environment Agency. As an IDB managed drain and given its proximity to the Wensum SSSI / SAC, it will also require IDB consent and engagement with Natural England consultation during the application as detailed in Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).
Residual effects and monitoring	The sensitivity of the IDB drains is **Low** and the magnitude of impact, following additional mitigation, is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant) on the IDB drains prior to the implementation of additional mitigation measures.

Table 12-12 Assessment of potential effects on flood risk receptors during construction activities

Description	Potential effects on flood risk receptors during construction activities
Sensitive receptor	Third party flood risk receptors (Low to High Sensitivity)
Potential effects	River Wensum and Floodplain The construction of the viaduct will require temporary works within the active floodplain of the River Wensum. The assessment has been based on a temporary works design consisting of the following for a duration of 3 years: • A raised working platform extending across the full width of the River Wensum floodplain constructed to 10.8m AOD, which is sufficiently high to avoid overtopping in all flood events. • A box culvert approximately 108m in length with internal dimensions 3m wide and 1m high to provide continued connectivity for WC5. • Flood relief culverts within the River Wensum floodplain beneath the Temporary Works Platform to reduce the risk of flooding upstream. • A bailey bridge to provide connectivity between the Temporary Works Platform on either side of the River Wensum. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the embedded mitigation in the form of the various bypass structures, both culverts and bailey bridge, are sufficient to prevent the temporary works platform flooding in the 1 in 1000 annual probability event. The temporary works are predicted to result in increases in water levels in the vicinity of the Proposed Scheme in all of the modelled flood events. There is a small predicted increase in water levels observed downstream of the working platform in the 1 in 100 annual probability flood event. This is observed within the existing floodplain as far as 800m downstream of the Ringland Lane crossing and affects the gas main. There is also a predicted increase in water levels observed immediately upstream of the working platform in the 1 in 100 annual probability flood event with depths increasing by 0.42m within the existing floodplain. The receptors downstream have a sensitivity of **Low** (the golf course) to **High** (gas main). The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). The receptors upstream have a sensitivity of **Medium** (agricultural land and local access tracks). The magnitude of impact is **Major Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant). Taking into account changes to the probability and consequence of flooding in these localised areas, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors. **Appendix 12.2: Flood Risk Assessment** (Document Reference:3.12.02) presents the full assessment of the impacts to the flood risk receptors during the construction of the Proposed Scheme.

Description	Potential effects on flood risk receptors during construction activities
Potential effects	Reservoir Flood Risk Flood risk from reservoirs has been assessed using the Wensum hydraulic model. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that there is no additional flood risk during construction to the Proposed Scheme or third parties from reservoir flooding than compared to the fluvial flood risk for the River Wensum. The receptors downstream have a sensitivity of **Low** (the golf course) to **High** (gas main). The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). The receptors upstream have a sensitivity of **Medium** (agricultural land and local access tracks). The magnitude of impact is **Major Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant). Taking into account changes to the probability and consequence of flooding in these localised areas, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors. **Appendix 12.2: Flood Risk Assessment** (Document Reference:3.12.02) presents the full assessment of the impacts to the flood risk receptors during the construction of the Proposed Scheme.
Potential effects	Foxburrow Stream The alignment of the proposed culvert at Foxburrow Stream connects to the existing alignment of the watercourse upstream and downstream of the Proposed Scheme. Construction of the culvert will require the diversion of the existing stream flows during construction. The construction methodology will be agreed with the LLFA during the consenting process. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that proposals can be developed for a diversion that can convey flows in the 1 in 100 annual probability event and in the 1 in 1000 annual probability event in a controlled manner past the site at the same rate as existing. In this way flood risk to the Proposed Scheme will be constrained to the footprint of the watercourse diversion. Similarly, construction offline will retain flood risk to the footprint of the existing watercourse. There is a slight reduction in length of Foxburrow Stream associated with the Proposed Scheme by virtue of the removal of a small meander and it is assumed the diversion of the watercourse will similarly have a reduced length. The assessment in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) of changes in downstream flows associated with the Proposed Scheme confirms this reduction is insufficient to change flows. The receptors within the Study Area have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors.

Description	Potential effects on flood risk receptors during construction activities
Potential effects	Management of Overland Flows **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) identifies two notable overland flow routes that are crossed by the Proposed Scheme. They are located adjacent to Ringland Lane and at the crossing with Weston Road. The management of overland flows during construction, including these existing notable flow routes, will be developed by the contractor prior to relevant works commencing. The PEDs, as set out in the drainage strategy, will be installed at the start of the construction phase. As such overland flow path drainage routes during construction will be consistent with the Proposed Scheme post development. These will divert flows to either WC5 in the River Wensum floodplain, Ringland Lane, Foxburrow Stream, Foxburrow Stream tributary, to the north of the A1067 Fakenham Road / NWL roundabout and at either end of the Proposed Scheme. The potential effects for the River Wensum and Foxburrow Stream are already discussed. For Ringland Lane overland flow path further embedded mitigation in the form of an attenuation feature upstream of Basin 3 is included in the surface water management network. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the width of the Ringland Lane overland flow path is sufficient to manage flows past the site in a controlled manner if required during the construction of the PED network. The proposed PED network is of sufficient capacity to convey the 1 in 100 annual probability plus 45% climate change event (based on rainfall intensity requirements) past the site and so once this is installed all flows will be managed appropriately during the remainder of the construction period. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that it should be possible to construct the Foxburrow Stream tributary and A1067 Fakenham Road culverts in the dry. The receptors within the Study Area have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors.
Potential effects	Groundwater Impacts on groundwater levels and flow from temporary dewatering of excavations and installation of below ground structures forming groundwater flow barriers are discussed separately in **Table 12.15**. The Temporary Works Platform for the River Wensum Viaduct construction requires comprehensive and deep temporary sheet piling which will result in groundwater level rise. Drainage to mitigate this rise is incorporated in the design and will keep the impact limited to the temporary works area. Risk of groundwater flooding during excavations would be managed through the controls and measures within **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) and a Dewatering Management Plan (DMP). The receptors within the Study Area have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors.
Additional mitigation	There is a residual risk associated with the exposure of the gas main located downstream of the viaduct location. This increase is not considered to pose increased erosional risk when compared to baseline velocities predicted during the same magnitude event. The management of this residual risk will need to be agreed with National Grid.

Description	Potential effects on flood risk receptors during construction activities
Residual effects and monitoring	The receptors within the Study Area have a sensitivity of **Low** to **High.** The magnitude of impact associated with the River Wensum Floodplain and reservoir flood risk is **Major Adverse**. The magnitude of impact associated with the other sources of flood risk is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant) associated with the River Wensum floodplain and reservoir flood risk and a direct, temporary, short to long-term **Slight** effect (not significant) associated with the other sources of flood risk. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors.

Table 12-13 Assessment of potential effects on Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 during construction activities

Description	Potential effects on the Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 during construction activities
Sensitive receptor	Principal Aquifer (White Chalk Subgroup and supports public water supplies) and Source Protection Zone 3 (High Sensitivity)
Potential effects	Changes to groundwater levels and flows The proposed piles for bridges, in particular the River Wensum Viaduct are expected to penetrate the Principal Aquifer and the groundwater associated with the Source Protection Zone 3. This may require temporary dewatering which would affect only shallow groundwater resources and would have only a temporary and local effect. The piles are not expected to create additional groundwater flow pathways near the River Wensum as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers. Temporary drainage is included in the design to mitigate the risk of groundwater flooding. The sheet piles associated with the Temporary Works Platform will be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The sensitivity of Principal Aquifer and Source Protection Zone 3 is **High**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be a direct, temporary, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of additional mitigation measures. Changes to groundwater quality During site preparation works and construction there would be vehicles including plant and machinery regularly using and parking within the Study Area (primarily within site compounds). This activity, along with the storage of any construction plant fuels, oils or chemicals would generate the potential for fuel / oil leaks from vehicles, storage containers or refuelling points, which may result in discharging contamination to ground. This could result in pollution entering the Principal Aquifer through the hydraulically connected superficial deposits. Potential release of fine sediment from construction activities including piling could also impact upon existing baseline groundwater quality. Pollution prevention measures outlined in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) will minimize the risk of pollution and apart from piling all other construction activities are not taking place within the Chalk aquifer. The sensitivity of Principal Aquifer and Source Protection Zone 3 is **High**. The impacts on groundwater quality are expected to be of **Negligible** magnitude, therefore, there is likely to be a direct, temporary, short term **Slight** effect (not significant) prior to the implementation of additional mitigation measures.
Additional mitigation	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.
Residual effects and monitoring	The sensitivity of the Principal Aquifer and Source Protection Zone 3 is **High**, and the magnitude of effects, following additional mitigation, are **Negligible**. Therefore, there is likely to be a direct, temporary, short term **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12-14 Assessment of potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during construction activities

Description	**Potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during construction activities**
Sensitive receptor	Secondary A Aquifers (Alluvium and River Terrace Deposits) (Medium Sensitivity) and Secondary Undifferentiated Aquifers (Sheringham Cliffs Formation, Lowestoft Formation and Head Deposits) (Low Sensitivity)
Potential effects	Changes to groundwater levels and flows The proposed below ground structures (i.e. Tud Tributary culvert / Bat Underpass culvert (CU2)) and piles for bridges, in particular the River Wensum Viaduct but also the proposed green bridges and temporary Bailey Bridge are expected to intercept Secondary A Aquifers. This may require temporary dewatering within the shallow aquifers but would have only a temporary and local effect. The piles are not expected to create additional groundwater flow pathways near the Wensum as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Secondary A Aquifers and Secondary Undifferentiated Aquifers and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers. Temporary drainage is included in the design to mitigate the risk of groundwater flooding. The sheet piles associated with the Temporary Works Platform will be removed after construction. Excavations related to road cuttings, temporary works platforms or construction of drainage related features along the scheme may require temporary groundwater dewatering. Excavations could cause temporary discharge of groundwater, therefore temporary dewatering licenses and discharge permits will be required. Cuttings along the scheme are not expected to penetrate permanent groundwater tables but may intercept localized perched groundwater tables. The sensitivity of secondary A Aquifers and Secondary Undifferentiated Aquifers is **Medium** and **Low**, respectively. The impacts on groundwater levels and flow are expected to be of **Minor Adverse** magnitude, therefore there is likely to be a direct, temporary, short term **Neutral** to **Slight** effect (not significant) prior to the implementation of additional mitigation measures. Changes to groundwater quality During site preparation works and construction there would be vehicles including plant and machinery regularly using and parking within the Study Area (primarily within site compounds). This activity, along with the storage of any construction plant fuels, oils or chemicals would generate the potential for fuel / oil leaks from vehicles, storage containers or refuelling points, which may result in discharging contamination to ground. This could result in pollution entering the Secondary A and Secondary Undifferentiated Aquifers. Potential release of fine sediment from construction activities, including piling could also impact upon existing baseline groundwater quality of these aquifers. However, the embedded mitigation measures should be sufficient to mitigate this risk effectively. Where soil stripping, stock piling and / or excavations are proposed, aquifer overburden will be reduced / removed which could lead to a temporarily increased groundwater vulnerability during the construction phase. Foundation piling and earthworks also have the potential to generate turbidity within groundwater. The porous nature of the strata and pollution prevention measures outlined in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) will minimize the risk of pollution. The sensitivity of Secondary A Aquifers and Secondary Undifferentiated Aquifers is **Medium** and **Low**, respectively. The impacts on groundwater quality are expected to be of **Minor Adverse** magnitude, therefore, there is likely to be a direct, temporary, short term **Neutral** to **Slight** effect (not significant) prior to the implementation of additional mitigation.

Description	Potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during construction activities
Additional mitigation	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment if needed. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.
Residual effects and monitoring	The sensitivity of Secondary A Aquifers are **Medium**, and Secondary Undifferentiated Aquifers are **Low**, and the magnitude of effect, following additional mitigation, is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short-term slight or **Neutral** to **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12-15 Assessment of potential effects on private groundwater abstractions during construction activities

Description	**Potential effects on private groundwater abstractions during construction activities**
Sensitive receptor	Private Groundwater Abstractions (Medium Sensitivity)
Potential effects	Changes to groundwater levels and flows The proposed piles, in particular the River Wensum Viaduct and the proposed green bridges are expected to intercept the underlying aquifers. This may require temporary dewatering which would affect only shallow groundwater resources and would have only a temporary and local effect. All abstraction boreholes are located at least 1km away from the proposed piles and the dewatering is unlikely to impact these abstractions. Excavations related to road cuttings, temporary works platforms or construction of drainage related features along the scheme may require temporary groundwater dewatering. Cuttings along the scheme are not expected to penetrate any permanent groundwater tables but may intercept perched groundwater tables, therefore no impacts to abstractions are expected as abstractions within 1km of the Proposed Scheme all target the deeper chalk aquifer. The sensitivity of private groundwater abstractions is **Medium**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, temporary, short term **Slight** effect (not significant) prior to the implementation of additional mitigation. Changes to groundwater quality During site preparation works and construction there would be vehicles including plant and machinery regularly using and parking within the Study Area (primarily within site compounds). This activity, along with the storage of any construction plant fuels, oils or chemicals would generate the potential for fuel / oil leaks from vehicles, storage containers or refuelling points, which may result in discharging contamination to ground. Potential release of fine sediment from construction activities including piling could also impact upon existing baseline ground water quality. This could result in pollution entering the Principal Aquifer, which is hydraulically connected to the groundwater abstractions targeting the Principal Aquifer. Foundation piling and earthworks also have the potential to generate turbidity within groundwater. Considering the distance of groundwater abstractions and pollution prevention measures to be outlined in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) the risk of pollution of the groundwater abstractions is very unlikely. The sensitivity of private groundwater abstractions is **Medium**. The impacts on groundwater quality are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, temporary, short term **Slight** effect (not significant) prior to the implementation of additional mitigation. For impacts to public water supplies during construction activities refer to **Table 12.13**.
Additional mitigation	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.
Residual effects and monitoring	The sensitivity of groundwater abstractions is **Medium**, and the magnitude of effect, following additional mitigation, is **Negligible**. Therefore, there is likely to be an indirect, temporary, short term **Neutral** to **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12-16 Assessment of potential effects on GWDTEs during construction activities

Description	**Potential effects on GWDTEs during construction activities**
Sensitive receptor	Groundwater Dependent Terrestrial Ecosystems (GWDTEs) – River Wensum SAC and connected habitats (Very High Sensitivity)
Potential effects	Changes to groundwater levels and flows The proposed piles, in particular the River Wensum Viaduct and the temporary Bailey bridge are expected to intercept groundwater which naturally flows towards the River Wensum. This may require temporary dewatering which would affect only shallow groundwater resources and would have only a temporary and local effect. The piles are not expected to create additional groundwater flow pathways as vertical connectivity between the various strata is already in place under natural conditions. This is therefore unlikely to affect groundwater dependant habitats associated with the River Wensum. Excavations and infilling related to the Temporary Works Platform or construction of drainage features related to the River Wensum Viaduct construction may require temporary groundwater dewatering and create permanent alterations of near surface groundwater flow. Construction dewatering has only a temporary local effect considering the shallow depths of the excavations. Altered shallow groundwater pathways in the area of the Temporary Works Platform with remaining fill material will have a local permanent effect but similar to the existing field drains affect groundwater levels only under high groundwater table conditions to reduce flooding risks. Therefore, the overall water balance of the River Wensum SAC and the hydrogeological setup of the area are not going to be altered. The sensitivity of the River Wensum SAC is **Very High**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, temporary to long term, **Slight** effect (not significant) prior to the implementation of additional mitigation. Changes to groundwater quality Any introduction of contamination to the aquifer will decrease groundwater quality, potentially impacting the Principal and Secondary Aquifers and all direct and indirect receptors linked to groundwater such as the River Wensum (SSSI and SAC). During site preparation works and construction there would be vehicles including plant and machinery regularly using and parking within the Study Area (primarily within site compounds). This activity, along with the storage of any construction plant fuels, oils or chemicals would generate the potential for fuel / oil leaks from vehicles, storage containers or refuelling points, which may result in discharging contamination to ground. This could also affect the chemical and physico-chemical quality of the water environment and be toxic to the GWDTEs associated with the River Wensum. Potential release of fine sediment from construction activities including piling could also impact upon existing baseline ground water quality. Foundation piling and earthworks also have the potential to generate turbidity within groundwater. Pollution prevention measures outlined in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) will minimize the risk of pollution. Different to direct surface water pollution, pollution via the groundwater pathway provides some attenuation and extra time for interventions to mitigate impacts on the River Wensum. The sensitivity of the River Wensum SAC is **Very High**. The impacts on groundwater quality are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, temporary, short term **Slight** effect (not significant) prior to the implementation of additional mitigation.

Description	Potential effects on GWDTEs during construction activities
Additional mitigation	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.
Residual effects and monitoring	The sensitivity of the River Wensum SAC is **Very High**, and the magnitude of effect, following additional mitigation, is **Negligible**. Therefore, there is likely to be an indirect, temporary, short term **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Operation Phase

12.6.2 The following forms of embedded mitigation have been considered within the operation phase assessment:

- River Wensum Viaduct, culvert (MA1) which will carry the southern maintenance track across WC5 and a culvert across Foxburrow Stream.
- The measures outlined in **Environmental Enhancements of the Proposed Scheme Overview** (Document Reference: 3.12.02m).
- **Drainage Strategy Report** (Document Reference: 4.04.00) including management of overland flows and treatment measures of surface water runoff.

Table 12.17 – Assessment of potential effects on the River Wensum during operation

Description	Potential effects on the River Wensum during operation
Sensitive receptor	River Wensum (Very High Sensitivity)
Potential effects	Pollution Risks The **Drainage Strategy Report** (Document Reference: 4.04.00) includes five infiltration basins which discharge to ground. There are no proposed outfalls to the River Wensum or to watercourses upstream of the River Wensum. Due to the high connectivity between surface water in the River Wensum, shallow groundwater in superficial deposits and the deeper Chalk aquifer in proximity of the Wensum, **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) assessed potential risk of pollutants migrating towards the River Wensum via groundwater flow. The assessment applied HEWRAT and treated the discharge as a point source surface water outfall to the River Wensum. A cumulative assessment of all discharge via groundwater was also considered. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) concluded that the assessment passed HEWRAT with the inclusion of the proposed treatment measures. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) also concluded that the Proposed Scheme passed the spillage risk assessment. Impacts in relation to salt migration are found in **Table 22** to **Table 24** below and **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05) which assess the impacts in relation to salt migrating to the underlying groundwater receptors. Salt migrates via a groundwater pathway only and not via surface water receptors. The sensitivity of the River Wensum is **Very High** and the magnitude of impact, prior to additional mitigation, is **Negligible**. Therefore, there is likely to be a direct, permanent, long-term **Slight** effect (not significant) on the River Wensum prior to the implementation of additional mitigation measures. WFD and geomorphology Environmental enhancement proposals include grassland creation in the River Wensum floodplain, riparian planting along the banks of the River Wensum and floodplain drains and the creation of gravel bars and riffles and reinstatement of an old meander in the River Wensum itself. The scheme could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the River Wensum. The WFDa concludes that the assessment of potential impacts against WFD quality elements, WFD status and objectives concludes that no deterioration is anticipated as a result of the Proposed Scheme. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The scheme could also lead to changes to the fluvial geomorphological processes and features of the River Wensum. The proposed viaduct locates piers within the floodplain of the River Wensum but not within the watercourse channel. The piers will be located at least 8m from the top of bank of the channel. The River Wensum Geomorphology Assessment concludes that the Proposed Scheme is not expected to alter geomorphological processes or result in changes to geomorphology receptors. Refer to **Appendix 12.4: River Wensum Geomorphology Assessment** (Document Reference: 3.12.04) for a detailed assessment of the fluvial geomorphological processes and features of the River Wensum. The sensitivity of the River Wensum is **Very High** and the magnitude of impact, prior to additional mitigation, is **Negligible**. Therefore, there is likely to be a direct, permanent, long-term **Slight** effect (not significant) on the River Wensum prior to the implementation of additional mitigation measures.
Additional mitigation	There are no additional mitigation measures proposed.

Description	Potential effects on the River Wensum during operation
Residual effects and monitoring	The sensitivity of the River Wensum is **Very High**, and the magnitude of effect, following mitigation, is **Negligible**. Therefore, there is likely to be a direct, permanent, long-term **Slight** residual effect (not significant) on the River Wensum following the implementation of additional mitigation measures.

Table 12.18 – Assessment of potential effects on the River Tud during operation

Description	Potential effects on the River Tud during operation
Sensitive receptor	River Tud (High Sensitivity)
Potential effects	Pollution risks The surface water drainage strategy includes one outfall which discharges into the A47 surface water drainage system that in turn discharges to the Tud. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) uses the HEWRAT assessment tool to assess the risks to water quality during operation of the Proposed Scheme. Prior to the inclusion of mitigation measures, the outfall passed the assessment of acute impacts of soluble pollutants (zinc and copper) and long term impacts to the receiving water environment against the EQS threshold values set out under the WFD. This indicates that the proposed mitigation measures go beyond the minimum standards required to pass the HEWRAT assessment for these parameters. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) also concluded that the Proposed Scheme passed the spillage risk assessment. The sensitivity of the River Tud is considered to be **High**, and the magnitude of impact, prior to additional mitigation is **Negligible**. Therefore, there is likely to be indirect, permanent, long-term **Neutral** effect (not significant) on the River Tud prior to the implementation of additional mitigation measures. WFD The operation of the Proposed Scheme could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the River Tud. The WFDa concludes that the assessment of potential 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. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The sensitivity of the River Tud is considered to be **High**, and the magnitude of impact, prior to additional mitigation is **Negligible**. Therefore, there is likely to be indirect, permanent, long-term **Neutral** effect (not significant) on the River Tud prior to the implementation of additional mitigation measures.
Additional mitigation	There are no additional mitigation measures proposed.
Residual effects and monitoring	The sensitivity of the River Tud is **High**, and the magnitude of impact, following additional mitigation, is **Negligible**. Therefore, there is likely to be indirect, permanent, long-term **Neutral** residual effects on the River Tud (not significant) following the implementation of additional mitigation measures.

Table 12.19 – Assessment of potential effects on the Foxburrow Stream during operation

Description	Potential effects on the Foxburrow Stream during operation
Sensitive receptor	Foxburrow Stream (Medium Sensitivity)
Potential effects	Pollution risks The surface water drainage strategy includes one outfall which discharges into the Foxburrow Stream. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) assesses uses the HEWRAT assessment tool to assess the risks to water quality during operation of the Proposed Scheme. Prior to the inclusion of mitigation measures, the outfall passed the assessment of acute impacts of soluble pollutants (zinc and copper) and long term impacts to the receiving water environment against the EQS threshold values set out under the WFD. This indicates that the proposed mitigation measures go beyond the minimum standards required to pass the HEWRAT assessment for these parameters. **Appendix 12.1: Drainage Network Quality Assessment** (Document Reference: 3.12.01) also concluded that the Proposed Scheme passed the spillage risk assessment. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Negligible**. Therefore, there is likely to be a direct, permanent, long term **Neutral** effect (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures. Foxburrow Culvert A culvert approximately 50m long will be installed across Foxburrow Stream. Upstream and downstream of the culvert approximately 72m of the Foxburrow Stream will be straightened. The culvert will have a 500mm deep natural bed in its invert. The over-sizing of the culverts will allow for maximum light penetration to encourage fish and mammal passage. A mammal ledge is also included within the design. The culverts sizing will allow for the formation of a low-flow channel. However, proposals to offset this impact 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. The hydraulic modelling of the Foxburrow Stream indicated negligible change in fluvial dynamics between baseline and operation. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Slight Adverse**. Therefore, there is likely to be a direct, permanent, long term **Slight** effect (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures. WFD The operation of the Proposed Scheme could pose a risk to the deterioration of the WFD status including changes to the hydromorphological, physico-chemical and ecological quality of the Foxburrow Stream and the waterbody it is located within. The WFDa concludes that the assessment of potential 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. Refer to **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03) for the full assessment of the Proposed Scheme against the WFD. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Negligible**. Therefore, there is likely to be a direct, permanent, long term **Neutral** effect (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.

Description	Potential effects on the Foxburrow Stream during operation
Potential effects	Changes in catchment hydrology The **Drainage Strategy Report** (Document Reference: 4.04.00) provides information about the existing drainage catchments within the vicinity of the Proposed Scheme and how these have been considered in the design of the drainage strategy. Existing catchments will be maintained as far as practicable to limit changes to catchment hydrology. The Proposed Scheme will cause a slightly greater proportion of the catchments draining to Foxburrow Stream to discharge further upstream of the current regime. Diverting a greater proportion of flow into the reach / flow path upstream of the Proposed Scheme has the potential to increase flood risk on the upstream face of the Proposed Scheme before flows enter the respective culverts. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) has assessed these changes and concludes for the Foxburrow Stream the flooding is constrained to the channel and as such there is no change in flood extent or associated flood risk (noting that the modelling of the proposed culvert considered this change). The change in flows will however not affect the frequency of flooding as Ringland Lane is an existing flow path. The overall flood risk following the construction of the scheme is therefore considered to remain unchanged from existing. The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, prior to mitigation, is **Slight Adverse**. Therefore, there is likely to be a direct, permanent, long term **Slight** effect (not significant) on the Foxburrow Stream prior to the implementation of additional mitigation measures.
Additional mitigation	No additional mitigation is proposed.
Residual effects and monitoring	The sensitivity of the Foxburrow Stream is **Medium** and the magnitude of impact, following mitigation, is **Slight Adverse**. Therefore, there is likely to be a direct, permanent, long term **Slight** effect (not significant) on the Foxburrow Stream following the implementation of additional mitigation measures.

Table 12.20 – Assessment of potential effects on the IDB drains during operation

Description	**Potential effects on the IDB drains during operation**
Sensitive receptor	IDB drains (Low Sensitivity)
Potential effects	Pollution risks There are no proposed outfalls to the IBD drains or to watercourses upstream. Therefore, there are no pollution risks to the IBD drains during the operation of the Proposed Scheme. Culvert crossing A culvert (MA1) will carry the southern maintenance track across WC5 within the floodplain of the River Wensum. This culvert will be 12m in length a consist twin box culverts 1.5m high and 3.3m wide with approximately 300mm sediment in the base. 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 will lessen the negative effects of the culvert on fish fauna as detailed in **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03). The sensitivity of the IDB drains is **Low** and the magnitude of impact, prior to mitigation, is **Slight Adverse**. Therefore, there is likely to be a direct, permanent, long term **Neutral** effect (not significant) on the IDB drains prior to the implementation of additional mitigation measures.
Additional mitigation	There are no additional mitigation measures proposed.
Residual effects and monitoring	The sensitivity of the IDB drains is **Low** and the magnitude of impact, following mitigation, is **Slight Adverse**. Therefore, there is likely to be a direct, permanent, long term **Neutral** effect (not significant) on the IDB drains.

Table 12.21 – Assessment of potential effects on flood risk receptors during operation

Description	Potential effects on flood risk receptors during operation
Sensitive receptor	Third party flood risk receptors (Low to High Sensitivity) Proposed Scheme (Very High Sensitivity)
Potential effects	River Wensum and floodplain The Proposed Scheme incorporates embedded flood risk mitigation in the form of a viaduct over the River Wensum floodplain. The embankments for the Proposed Scheme are located outside of the 1 in 100 plus climate change flood extent. The proposed viaduct includes piers located within the floodplain but not within the channel of the River Wensum. An access track crosses the River Wensum floodplain and culvert MA1 carries this across watercourse WC5. Hydraulic modelling of the Proposed Scheme demonstrates that the proposed viaduct over the River Wensum manages flood risk to both the Proposed Scheme and to third parties in the near vicinity. There is little to no change to the flood extent and the flood hazard for the area remains unchanged. A review of the flood risk receptors that could be impacted by the local increase in water levels confirms that, in all events up to the 1 in 100 annual probability flood event plus 44% climate change allowance, only agricultural land is affected. There is no increased risk to property or infrastructure. There is no change to flood risk downstream of the Proposed Scheme. Environmental mitigation proposals have not been developed in detail at this stage but include grassland creation in the River Wensum floodplain, riparian planting along the banks of the River Wensum and floodplain drains and the creation of gravel bars and riffles and reinstatement of an old meander in the River Wensum itself. The proposed environmental enhancements are located in the floodplain of the River Wensum and will be inundated during flood events. These enhancements will increase upstream water levels but are themselves considered to be water compatible. The environmental mitigation proposals are predicted to result in increases in water levels upstream of the Proposed Scheme in the 1 in 100 annual probability flood event plus 44% climate change allowance with depths increasing by 0.6m within the existing floodplain. The receptors upstream have a sensitivity of **Medium** (agricultural land and local access tracks). The magnitude of impact is **Moderate Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant). Taking into account changes to the probability and consequence of flooding in these localised areas, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The other third party flood risk receptors within the Study Area have a sensitivity of **Low**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme. **Appendix 12.2: Flood Risk Assessment** (Document Reference:3.12.02) presents the full assessment of the impacts to the flood risk receptors during the construction of the Proposed Scheme.

Description	Potential effects on flood risk receptors during operation
Potential effects	Foxburrow Stream Foxburrow Stream requires a culvert structure to allow passage of flows from upstream to downstream of the Proposed Scheme. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the culvert has sufficient capacity to accommodate all modelled flood events. The third party flood risk receptors have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.
Potential effects	Reservoir Flood Risk Flood risk from a breach of the Haveringland Lake embankment was assessed in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) to understand the potential changes in velocities past the viaduct piers and the requirements for scour protection. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the risk of flooding from a reservoir flood breach is considered to be less than the 1 in 100 plus 44% climate change annual probability event associated with the River Wensum. The receptors upstream have a sensitivity of **Medium** (agricultural land and local access tracks). The magnitude of impact is **Moderate Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant). Taking into account changes to the probability and consequence of flooding in these localised areas, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The other third party flood risk receptors within the Study Area have a sensitivity of **Low**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.

Description	Potential effects on flood risk receptors during operation
Potential effects	Groundwater Flood Risk The impact of the River Wensum viaduct foundations has been assessed using detailed groundwater modelling. This has confirmed groundwater levels following construction would be comparable to existing. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the Proposed Scheme will not impede existing groundwater flows and so there are no changes to existing groundwater flood risk in the vicinity of the Proposed Scheme. The third party flood risk receptors have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.
Potential effects	Overland Flows The PED network collects the overland flows from upstream of the Proposed Scheme and conveys them downstream of the Proposed Scheme as per the current situation. A standalone hydraulic model has been developed for the Ringland Lane overland flow path. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that the PED network and culverts are of a sufficient size to convey the 1 in 100 plus 45% climate change annual probability event. The Proposed Scheme will increase flood depths to agricultural land and Ringland Lane upstream of the attenuation feature in the 1 in 100 annual probability event and above. The Proposed Scheme will decrease flood depths to The Keeper and the Dell (wedding venue) located to the north of Ringland in all modelled flood events. Details of the design of the culverts for the Foxburrow Stream tributary (culverts C-16-C-2.000, C-16-C-3.000 and C-16-C-4.000) and A1067 Fakenham Road (culvert C-03-A-1.000) overland flow paths are presented in the **Drainage Strategy Report** (Document Reference: 4.04.00). The design is sufficient to convey the 1 in 100yr plus 45% climate change event (based on rainfall intensity requirements) past the site with an allowance of 10% loss of capacity for sedimentation. The third party flood risk receptors have a sensitivity of **Medium** (agricultural land and Ringland Lane). The magnitude of impact is **Moderate Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the construction works will have a negligible increase in flood risk to third party receptors. The third party flood risk receptor to the north of Ringland (wedding venue) has a sensitivity of **High**. The magnitude of impact is **Moderate Beneficial**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate Beneficial** effect (not significant). The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.

Description	Potential effects on flood risk receptors during operation
Potential effects	Surface Water Flood Risk The **Drainage Strategy Report** (Document Reference: 4.04.00) details the surface water drainage strategy for the Proposed Scheme. The surface water drainage strategy has been designed using a 45% climate change allowance and will attenuate flows up to the 1 in 100 annual probability event with climate change. The Proposed Scheme is therefore not predicted to increase flood risk elsewhere associated with an increase in scheme-generated surface water runoff. The third party flood risk receptors have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.
Potential effects	Changes in catchment hydrology The **Drainage Strategy Report** (Document Reference: 4.04.00) provides information about the existing drainage catchments within the vicinity of the Proposed Scheme and how these have been considered in the design of the drainage strategy. Existing catchments will be maintained as far as practicable to limit changes to catchment hydrology. The Proposed Scheme will cause a slightly greater proportion of the catchments draining to Foxburrow Stream and the Ringland Lane overland flow path to discharge further upstream of the current regime. Diverting a greater proportion of flow into the reach / flow path upstream of the Proposed Scheme has the potential to increase flood risk on the upstream face of the Proposed Scheme before flows enter the respective culverts. **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) has assessed these changes and this is described above. The overall flood risk following the construction of the scheme is therefore considered to remain unchanged from existing. The third party flood risk receptors have a sensitivity of **Low** to **High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors. The Proposed Scheme has a sensitivity of **Very High**. The magnitude of impact is **Negligible Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Slight** effect (not significant). Taking into account changes to the probability and consequence of flooding, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to the Proposed Scheme.
Additional mitigation	**Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that no additional mitigation is required.

Description	Potential effects on flood risk receptors during operation
Residual effects and monitoring	The receptors within the Study Area have a sensitivity of **Low** to **Very High**. The magnitude of impact associated with the River Wensum Floodplain, reservoir flood risk and overland flows is **Major Adverse**. The magnitude of impact associated with the other sources of flood risk is **Minor Adverse**. Therefore, there is likely to be a direct, temporary, short to long-term **Moderate** effect (not significant) associated with the River Wensum Floodplain and a direct, temporary, short to long-term **Slight** effect (not significant) associated with the other sources of flood risk. Taking into account changes to the probability and consequence of flooding in these localised areas, **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) demonstrates that the Proposed Scheme will have a negligible increase in flood risk to third party receptors.

Table 12.22 – Assessment of potential effects on Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 during scheme operation

Description	Potential effects on the Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 during scheme operation
Sensitive receptor	Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 (High Sensitivity)
Potential effects	Changes to groundwater levels and flows The new road surface restricts infiltration of rainfall which could lead to a reduction of groundwater recharge and hence groundwater levels. However, large sections of the proposed road generate run-off which will be treated and discharged to ground via infiltration basins. The future road surface area is very small compared to the overall groundwater recharge area of the regional Chalk aquifer and current groundwater recharge rates are not high due to the superficial deposits. Therefore, a measurable change in groundwater levels is not predicted. Below ground structures (including piles) in the River Wensum valley have the potential to create additional pathways for groundwater flow and could act as a barrier to horizontal groundwater flow, potentially leading to increased groundwater flooding risks. Surface water levels and groundwater levels obtained as part of the Ground Investigation indicate a high hydraulic connectivity between surface water, shallow groundwater and groundwater within the regional Chalk aquifer. Groundwater numerical modelling assessed the impact of the River Wensum Viaduct piles on groundwater flow (**Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05)), where the piles were found to have a very minor impact on groundwater flow. The Ground Investigation information and numerical model results indicate that no increased risk of groundwater flooding is expected and no change to the interaction between groundwater and surface water bodies are expected. Most other below ground structures are small or do not intercept groundwater, therefore are unlikely to impact the Principal Aquifer. The proposed Tud Tributary culvert / Bat Underpass culvert (CU2) is situated below groundwater; however, it is unlikely to have any significant impacts on the Principal Aquifer. The sensitivity of the Principal Aquifer and Source Protection Zone 3 is **High**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be a direct, long term, cumulative, **Slight** effect (not significant) prior to the implementation of additional mitigation. Changes to groundwater quality There is a risk of contaminated highway runoff and from accidental spillages from the Proposed Scheme, infiltrating into the aquifer via the road drainage system. The risk comes from surface contamination sources, such as accidental vehicle spillages or fluid leakages, or routine highway runoff which may be mildly contaminated and migrate via infiltration basins into the ground. **Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01) concluded that the proposed treatment will be sufficient to mitigate these risks and the less permeable layers within the superficial deposits will offer additional protection to the underlying Principal Aquifer. The road drainage catchment of Basin 2 comprises most of the future River Wensum Viaduct surface area. Salt spreading during winters (for de-icing) has the potential to add 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. A detailed assessment and modelling of the impacts form salt spraying is provided in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05), concluding a local impact underneath and downstream of the infiltration basins.

Description	Potential effects on the Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 during scheme operation
Potential effects	Basin 3 and 4 are situated on thin superficial deposits (approx. 2m to 3m thickness), where the proposed basins may reduce the thickness of the superficial deposits here. The groundwater table in the Chalk was measured to be approximately 7m to 8m below the base of both proposed basins. Road drainage will discharge into superficial deposits supporting shallow perched groundwater flow but in absence of a continuous surface water feature will eventually migrate into the Chalk aquifer, as currently happening to natural overland flows. Whereas some local increase in groundwater salinity is expected the reduction of nutrient loading compared to the current groundwater recharge from agricultural used areas provides a slight improvement of the groundwater quality. The sensitivity of Principal Aquifer and Source Protection Zone 3 is **High**. The impacts on groundwater quality are expected to be of **Minor Adverse** magnitude (driven by local salt spraying impacts on groundwater quality), therefore, there is likely to be direct, cumulative, long-term **Slight** effect (not significant) prior to the implementation of additional mitigation.
Additional mitigation	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting groundwater, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation, before the drainage system can be used again. Future salt spraying for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.
Residual effects and monitoring	The sensitivity of the Principal Aquifer and Source Protection Zone 3 is **High**, and the magnitude of effect, following mitigation, is **Minor Adverse**. There is likely to be a direct, cumulative, long term **Slight** adverse residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12.23 – Assessment of potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during operation

Description	Potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during operation
Sensitive receptor	Secondary A Aquifers (Alluvium and River Terrace Deposits) (Medium Sensitivity) and Secondary Undifferentiated Aquifers (Sheringham Cliffs Formation, Lowestoft Formation and Head Deposits) (Low Sensitivity)

Description	Potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during operation
Potential effects	Changes to groundwater levels and flows A minor change in groundwater recharge pattern is expected due to the increase in hard surface area. However, road drainage discharge to infiltration basins for a major part of the Proposed Scheme and the only local presence of shallow groundwater bodies results in no overall change to the hydrogeological setting. Below ground structures (including piles) have the potential to create additional pathways for groundwater flow and could act as a barrier to horizontal groundwater flow, potentially leading to increased groundwater flooding risks. Ground Investigation information from the River Wensum valley indicates a high hydraulic connectivity between surface water, shallow groundwater and groundwater within the regional Chalk aquifer. Groundwater numerical modelling assessed the impact of the Wensum Viaduct piles on groundwater flow (**Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05)), where the piles were found to have a very minor impact on groundwater flow and levels. The Ground Investigation information and numerical model results indicate that no increased risk of groundwater flooding is expected and no change to the interaction between groundwater and surface water bodies are expected. Other below ground structures are small or do not intercept groundwater, therefore are unlikely to impact the groundwater levels and flows in the Secondary A and Undifferentiated Aquifer. The proposed Tud Tributary culvert / Bat Underpass culvert (CU2) is situated below groundwater; however, it is unlikely to have any significant impacts on the Secondary A and Undifferentiated Aquifer as groundwater is expected to flow around the structure. Cuttings could permanently lower groundwater levels or cause discharge on to the road surface. However, the proposed cuttings are not expected to intercept permanent groundwater tables (potentially only some perched water / pockets of water), and therefore are unlikely to impact these aquifers. A thin layer of permanently remaining engineered fill required for the construction of the River Wensum Viaduct Temporary Works Platform is expected to have only a very localised effect on groundwater levels and flow (**Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05)). The sensitivity of Secondary A Aquifers and Secondary Undifferentiated Aquifers is **Medium** and **Low**, respectively. The impacts on groundwater levels and flow are expected to be of **Minor Adverse** magnitude, therefore there is likely to be a direct, permanent, cumulative, short to long term **Neutral** to **Slight** effect (not significant) prior to the implementation of additional mitigation measures. Changes to groundwater quality There is a risk of contaminated routine highway runoff and from accidental spillages from the road, infiltrating into the aquifer. The risk comes from surface contamination sources, such as accidental vehicle spillages or fluid leakages, or routine highway runoff which may be mildly contaminated. The potential impacts from the road drainage have been assessed in **Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01) and showed risks to be low. Impacts from future salt spreading (de-icing during winters) on groundwater quality has been assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05) and found that salt spraying impacts groundwater quality only at local level. The sensitivity of Secondary A Aquifers and Secondary Undifferentiated Aquifers is **Medium** and **Low**, respectively. The impacts on groundwater quality are expected to be of **Minor Adverse** magnitude, therefore, there is likely to be direct, permanent, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of additional mitigation.

Description	Potential effects on Secondary A Aquifers and Secondary Undifferentiated Aquifers during operation
Additional mitigation	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation may be required in such an event to close manual penstocks and implement a clean-up operation, before the drainage system can be used again. Future salt spreading for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.
Residual effects and monitoring	The sensitivity of Secondary A Aquifer is **Medium**, and Secondary Undifferentiated Aquifer is **Low**, and the magnitude of effect, following mitigation, is **Minor Adverse**. Therefore, there is likely to be a direct, permanent, short to long term **Neutral** to **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12.24 – Assessment of potential effects on private groundwater abstractions during operation

Description	**Potential effects on private groundwater abstractions during operation**
Sensitive receptor	Private Groundwater Abstractions (Medium Sensitivity)
Potential effects	Changes to groundwater levels and flows Measurable change in groundwater levels and quantities are not predicted, therefore no impacts on nearby private groundwater abstractions are expected. The sensitivity of private groundwater abstractions is **Medium**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, permanent, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of mitigation. Changes to groundwater quality There is a risk of contaminated highway runoff and from accidental spillages from the new development, infiltrating into the aquifer. The risk comes from surface contamination sources, such as accidental vehicle spillages or fluid leakages, or routine highway runoff which may be mildly contaminated. The proposed drainage design is considered sufficient to mitigate these risks and the less permeable layers within the superficial deposits may offer some additional protection to the underlying Principal Aquifer (expected target for all nearby private groundwater abstractions). The sensitivity of private groundwater abstractions is **Medium**. The impacts on groundwater quality are expected to be of **Negligible** magnitude, therefore, there is likely to be indirect, permanent, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of additional mitigation. For impacts to public water supplies during operation of the Proposed Scheme refer to **Table 12.22**.
Additional mitigation	In the event of a spillage of pollutants on the Proposed Scheme, the spillage could migrate via the drainage system towards the infiltration basins and then into the ground. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation before the drainage system can be used again.
Residual effects and monitoring	The sensitivity of groundwater abstractions is **Medium**, and the magnitude of effect, following mitigation, is **Negligible**. Therefore, there is likely to be an indirect, permanent, short term neutral or **Slight** residual effect on the receptor (not significant) following the implementation of additional mitigation.

Table 12.25 – Assessment of potential effects on GWDTEs during operation

Description	**Potential effects on GWDTEs during operation**
Sensitive receptor	Groundwater Dependent Terrestrial Ecosystems (GWDTEs) – River Wensum SAC and related habitats (Very High Sensitivity)
Potential effects	Changes to groundwater levels and flows River Wensum Viaduct piled foundations or other changes to the ground conditions near the River Wensum (e.g. temporary works engineered fill, drainage or Bailey Bridge piles) are expected to affect shallow groundwater levels and flows only very locally in line with natural conditions and current land use impacts. Impacts on the overall water balance related to the River Wensum SAC are not expected. The sensitivity of the River Wensum GWDTE is **Very High**. The impacts on groundwater levels and flow are expected to be of **Negligible** magnitude, therefore, there is likely to be a direct, permanent, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of additional mitigation. Changes to groundwater quality Impacts from highways run-off on groundwater and surface water quality have been assessed in **Appendix 12.1: Drainage Network Water Quality Assessment** (Document Reference: 3.12.01) and concluded a low risk of impact. Impacts from future salt spreading (de-icing during winters) on groundwater quality have been assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05) and concluded that impacts on the River Wensum were minimal. The sensitivity of the River Wensum GWDTE is **Very High**. The impacts on river quality are expected to be of **Negligible** magnitude, therefore, there is likely to be an indirect, permanent, cumulative, short to long-term **Slight** effect (not significant) prior to the implementation of mitigation.
Additional mitigation	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation before the drainage system can be used again. Future salt spraying for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.
Residual effects and monitoring	The sensitivity of the River Wensum GWDTE is **Very High**, and the magnitude of effect, following mitigation, is **Negligible**. Therefore, there is likely to be an indirect, permanent, short to long-term **Slight** adverse residual effect on the receptor (not significant) following the implementation of additional mitigation.

Assessment against Future Baseline

12.6.3 The Anglian River Basin Management Plan (RBMP) 2015 RBMP sets out high level WFD Mitigation Measures that are relevant to the Proposed Scheme. The Proposed Scheme does not prevent the achievement of the wider WFD mitigation measures. This is detailed in **Appendix 12.3: Water Framework Directive Assessment** (Document Reference: 3.12.03).

In-combination Climate Change Impacts

12.6.4 In-combination climate change impact assessment considers the extent to which climate change may alter the effects which have already been identified within this ES chapter. Further details on in-combination climate change impacts are detailed within **Chapter 16: Climate - Climate Resilience** (Document Reference: 3.16.00).

12.6.5 The summary of the in-combination assessment of climate change impacts in relation to the water environment is detailed in Table 12-26 below.

Table 12.26 – Climate Change Impacts

Climate Hazard	Receptor	Likely Impact(s)	Mitigation Required
An increase in peak rainfall levels and river flood levels	Flood risk receptors	This may increase the frequency of flood risk to identified receptors and increase the extent of Flood Zones 2 and 3, resulting in a greater area of the Proposed Scheme at risk of fluvial flooding. The peak rainfall intensity may also increase as a result of climate change, which could potentially increase the risk of surface water flooding to the Proposed Scheme.	The potential effects of climate change have been assessed in **Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) and no additional mitigation is required.

12.7 Opportunities for Environmental Enhancement

12.7.1 Offsetting mitigation measures are outlined in **Environmental Enhancements of the Proposed Scheme Overview** (Document Reference 3.12.02m). Proposals 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.

12.7.2 The proposed environmental enhancements within the floodplain of the River Wensum generally consist of planting in the floodplain. Gravel bars and riffles in the River Wensum will also be constructed which will generally involve the placing of material in the channel with some allowance for the River Wensum itself to naturally determine the final placement.

12.8 Cumulative Effects

12.8.1 Cumulative effects for the Road Drainage and Water Environment have been assessed within **Chapter 20: Cumulative Assessment** (Document Reference: 3.20.00). **Appendix 12.7: Road Drainage and the Water Environment In-Combination Assessment** (Document Reference: 3.12.06) details the in-combination assessment for the committed developments.

12.9 Difficulties and Uncertainties

12.9.1 The work undertaken to provide the basis of this assessment and the standalone supporting assessments comprised a study of available documented information from a variety of sources and discussions with relevant authorities. Ground Investigation information has been used but during construction local conditions could vary but are not expected to affect the assessment outcomes. Groundwater data of limited temporal and spatial extend was used to develop this assessment due to the ongoing site investigation works restricting the available geotechnical data and short time frames available to collect groundwater data.

12.10 Summary

12.10.1 Table 12-27 provides a summary of the findings of the assessment.

Table 12.27 – Summary of Road Drainage and Water Environment Effects

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Construction Phase River Wensum (Very High Sensitivity)	Sedimentation Pollution risks Changes to WFD and geomorphology	Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) details the need for further consultation with the Environment Agency during the development of the FRAP application. Appropriate and site-specific method statements would be submitted which would reduce the risk of increased sedimentation and pollution risks and as a result potential effects to the River Wensum.	Moderate Adverse residual effect (significant) in relation to sedimentation and pollution risks T / D / ST Slight Adverse residual effect (not significant) in relation to changes to WFD and geomorphology T / D / ST	Monitoring of water quality would be undertaken during and following the works as set out in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).
Construction Phase River Tud (High Sensitivity)	Sedimentation Pollution risks Changes to WFD	No additional mitigation measures are proposed.	Neutral residual effects (not significant) T / I / ST	Monitoring of water quality would be undertaken during and following the works as set out in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).
Construction Phase Foxburrow Stream (Medium Sensitivity)	Sedimentation Pollution risks Works within the watercourse Changes to WFD	Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01) details the need for further consultation with the LLFA during the development of the ordinary watercourse consent application. Appropriate and site-specific method statements would be submitted which would further reduce the risk of increased sedimentation and pollution risks and as a result potential effects to the Foxburrow Stream. This process is separate to the planning process.	Slight Adverse residual effect (not significant) T / D / ST	Monitoring of water quality would be undertaken during and following the works as set out in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Construction Phase IDB drains (Low Sensitivity)	Sedimentation Pollution risks Works within the watercourses Changes to WFD	Culverting of WC5 will require temporary dewatering and diversion of a section of the existing watercourse. This will require a licence from the Environment Agency. As an IDB managed drain and given its proximity to the Wensum SSSI / SAC, it will also require IDB consent and engagement with Natural England consultation during the application as detailed in Section 4.1 of **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).	Slight Adverse residual effect (not significant) T / D / ST	Monitoring of water quality would be undertaken during and following the works as set out in **Appendix 3.1: OCEMP** (Document Reference: 3.03.01).
Construction Phase Third party flood risk receptors – agricultural land, golf course and local access tracks (Low Sensitivity) Third party flood risk receptors – gas main (High Sensitivity)	River Wensum and Floodplain Flood Risk Reservoir Flood Risk Foxburrow Stream Flood Risk Groundwater Flood Risk Management of Overland Flows Surface Water Flood Risk	There is a residual risk associated with the exposure of the gas main located downstream of the viaduct location. This increase is not considered to pose increased erosional risk when compared to baseline velocities predicted during the same magnitude event. The management of this residual risk will need to be agreed with National Grid.	Moderate Adverse residual effect (significant) in relation to the River Wensum and floodplain and reservoir flood risks T / D / ST Slight Adverse residual effect (not significant) in relation to the other sources of flood risk T / D / ST	It is recommended the site of the gas main is monitored during the construction works following flood events to account for a potential increase in flow velocity that may increase scour risk at this location.
Construction Phase Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 (High Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.	Slight Adverse residual effect (not significant) T / D / ST	Appropriate monitoring will be outlined in the Dewatering Management Plan and the Piling Risk Assessment.

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Construction Phase Secondary A Aquifers (Alluvium and River Terrace Deposits) (Medium Sensitivity) and Secondary Undifferentiated Aquifers (Sheringham Cliffs Formation, Lowestoft Formation and Head Deposits) (Low Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.	Neutral to Slight Adverse residual effect (not significant) T / D / ST	Appropriate monitoring will be outlined in the Dewatering Management Plan and the Piling Risk Assessment.
Construction Phase Private Groundwater Abstractions (Medium Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from construction dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.	Neutral to Slight Adverse residual effect (not significant) T / I / ST	Appropriate monitoring will be outlined in the Dewatering Management Plan and the Piling Risk Assessment.

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Construction Phase Groundwater Dependent Terrestrial Ecosystems (GWDTEs) – River Wensum SAC and connected habitats (Very High Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	A Dewatering Management Plan will be produced by the Contractor that provides a general framework for assessing the potential risks arising from dewatering, but also to act as a vehicle for more specific and detailed assessment. Piling Risk Assessments are required to ensure the most appropriate piling technique is adopted for the scheme avoiding impacts on shallow and deep groundwater quality. All relevant consents should be sought from the Environment Agency for temporary dewatering and discharges.	Slight Adverse residual effect (not significant) T / I / ST	Appropriate monitoring will be outlined in the Dewatering Management Plan and the Piling Risk Assessment.
Operation Phase River Wensum (Very High Sensitivity)	Pollution Risks Impacts to WFD and geomorphology	There are no additional mitigation measures proposed.	Slight Adverse residual effect (not significant) P / D / LT	Not applicable
Operation Phase River Tud (High Sensitivity)	Pollution Risks Impacts on WFD	There are no additional mitigation measures proposed.	Neutral residual effects (not significant) P / I / LT	Not applicable
Operation Phase Foxburrow Stream (Medium Sensitivity)	Pollution Risks Foxburrow Culvert and impacts on WFD Changes in catchment hydrology	There are no additional mitigation measures proposed.	Slight Adverse residual effect (not significant) P / D / LT	Not applicable
Operation Phase IBD drains (Low Sensitivity)	Culvert crossing and impacts on WFD	There are no additional mitigation measures proposed.	Neutral residual effects (not significant) P / D / LT	Not applicable

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Operation Phase Third party flood risk receptors (Low to High Sensitivity) Proposed Scheme (Very High Sensitivity)	River Wensum and floodplain Flood Risk Foxburrow Stream Flood Risk Reservoir Flood Risk Groundwater Flood Risk Overland Flows Surface Water Flood Risk Changes in catchment hydrology	**Appendix 12.2: Flood Risk Assessment** (Document Reference: 3.12.02) concludes that no additional mitigation is required.	Moderate Adverse residual effect (significant) in relation to the River Wensum and reservoir flood risk T / D / ST Slight Adverse residual effect (not significant) in relation to the other sources of flood risk	Not applicable
Operation Phase Principal Aquifer (White Chalk Subgroup) and Source Protection Zone 3 (High Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting groundwater, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation, before the drainage system can be used again. Future salt spreading for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.	Slight Adverse residual effect (not significant) P / D / LT	Not applicable

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Operation Phase Secondary A Aquifers (Alluvium and River Terrace Deposits) (Medium Sensitivity) and Secondary Undifferentiated Aquifers (Sheringham Cliffs Formation, Lowestoft Formation and Head Deposits) (Low Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation may be required in such an event to close manual penstocks and implement a clean-up operation, before the drainage system can be used again. Future salt spreading for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.	Neutral to Slight Adverse residual effect (not significant) P / D / LT	Not applicable
Operation Phase Private Groundwater Abstractions (Medium Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	In the event of a spillage of pollutants on the Proposed Scheme, the spillage could migrate via the drainage system towards the infiltration basins and then into the ground. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation before the drainage system can be used again.	Slight Adverse residual effect (not significant) P / I / ST	Not applicable

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Operation Phase Groundwater Dependent Terrestrial Ecosystems (GWDTEs) – River Wensum SAC and related habitats (Very High Sensitivity)	Changes to groundwater levels and flows Changes to groundwater quality	In the event of a spillage of pollutants on the Proposed Scheme, the spillage would drain to the proposed drainage system. Although the proposed drainage system has measures to reduce the risk of a spillage event from polluting watercourses, further mitigation could be required in such an event to close manual penstocks and implement a clean-up operation before the drainage system can be used again. Future salt spreading for de-icing of the River Wensum Viaduct was assessed in **Appendix 12.5: River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05). The assessments are based on actual average salt usage data for high priority roads. Efforts should be made to reduce salt usage over the long-term, e.g. by de-icing product innovations and improved weather monitoring facilities.	Slight Adverse residual effect (not significant) P / I / LT	Not applicable

Key to table: P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short Term, Medium Term or Long Term

12.11 References

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