Norwich Western Link

Environmental Statement Chapter 12: Road Drainage and the Water Environment

Appendix 1: Drainage Network Water Quality Assessment

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Glossary of Abbreviations and Defined Terms

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

Term	Definition
Annual Average Daily Traffic flow	The average number of vehicles passing a point in the road network each day over a full year.
Attenuation Basin	Areas of storage that provide flow control through attenuation of stormwater runoff. They also facilitate some settling of particulate pollutants.
Base Flow Index	A measure of the proportion of the river flow that derives from the baseflow (contains groundwater flow and flow from other delayed sources).
Catchpits and deep-pot gullies	Inlets to the surface water drainage system collecting surface water runoff and trapping sediments.
Environmental Quality Standards	Published parameters in the Water Framework Directive for polluting substances. If these standards are exceeded, they could result in adverse effects to ecosystems.
Highways England Water Risk Assessment Tool	A Microsoft Excel application which has been developed to assess the acute and chronic pollution impacts to the receiving watercourses and groundwater.
Infiltration Basin	Vegetated depressions designed to store surface water runoff and infiltrate it gradually into the ground. They are dry except during periods of heavy rainfall.

Term	Definition
National Highway's Drainage Data Management System	Provides technical information about the location and condition of drainage infrastructure on National Highway's network.
Outfall	A point of discharge into a watercourse.
Pollution Control Valve	A device to seal off the drainage system preventing pollutants from discharging into the receiving watercourse or groundwater.
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.
Q95 flow	The flow in cubic metres per second which was equalled or exceeded for 95% of the flow record. The Q95 flow is a commonly used low flow parameter particularly relevant in the assessment of river water quality consent conditions.
Sediment Forebay	An area designed to slow surface water runoff and facilitate the gravity separation of suspended solids.
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.
Swale	Shallow, broad and vegetated channels designed to store and / or convey surface water runoff and remove pollutants.

1 Introduction

1.1 Purpose of the assessment

1.1.1 WSP UK Limited (hereafter referred to as 'WSP') has been commissioned by Norwich County Council (NCC 'the Applicant') to undertake an Environmental Impact Assessment (EIA) for the Proposed Scheme. To support **Chapter 12: Road Drainage and the Water Environment** (Document Reference: 3.12.00) of the Environmental Statement, impacts to water quality need to be assessed. This document summarises the methodology and results of the water quality assessment carried out to fulfil the simple assessment methodology defined within the Design Manual for Roads and Bridges (DMRB) (LA 113) (**Ref. 1.1**).

1.1.2 The Proposed Scheme would increase the impermeable road surface area and alter the current traffic flow regime through the creation of the new link road. These changes have the potential to impact the volume and quality of surface water runoff. The purpose of the assessment is to assess the potential impacts associated with the chemical quality of the receiving waterbodies and to assess the impact of the proposed mitigation measures within the **Drainage Strategy Report** (Document Reference: 4.04.00).

1.1.3 The assessment focusses on the potential risks associated with the operational phase of the Proposed Scheme and does not consider any potential risks during the construction phase. The potential impacts to the chemical quality of surface water features during the construction phase are assessed within **Chapter 12: Road Drainage and the Water Environment** (Document Reference: 3.12.00) of the Environmental Statement.

1.1.4 A separate detailed water quality impact assessment has been undertaken to assess the potential impacts from future salt spraying (de-icing during winters), with a specific focus on the River Wensum Viaduct and the related road drainage infiltration basins located near to the River Wensum. The assessment uses a different methodology and is presented as part of

Appendix 12.5 River Wensum Crossing – Groundwater Modelling Report (Document Reference: 3.12.05) and therefore is not discussed in this report.

1.2 Project Overview

1.2.1 The Proposed Scheme consists of the construction of an approximately 6 kilometre long dual carriageway connecting the A1067 / A1270 junction and the A47. The junctions with the two existing roads are to be roundabout junctions with the aim to reduce congestion.

1.2.2 A summary of the proposed **Drainage Strategy Report** (Document Reference: 4.04.00) is provided in **Section 3** of this report.

1.3 Study Area

1.3.1 The spatial scope of this assessment encompasses surface water features that are proposed to receive surface water runoff from the new outfalls as part of the **Drainage Strategy Report** (Document Reference: 4.04.00) and surface water features approximately 1 kilometre downstream from the proposed outfalls.

1.3.2 The spatial scope of this assessment encompasses groundwater features that are proposed to receive surface water runoff discharged through the infiltration basins to ground. The Study Area also includes groundwater features approximately 1 kilometre from the proposed infiltration basins.

1.3.3 The other areas within the Red Line Boundary have been excluded and not assessed due to the nature of the proposed works. There are no new outfalls or formal drainage infrastructure proposed as part of these works. The other areas within the Red Line Boundary are not supporting roads which are frequently trafficked by road vehicles.

1.4 Methodology

1.4.1 This simple assessment of impacts to water quality is defined by the methodology set out in the DMRB LA 113 (**Ref. 1.1**). Impacts to surface water receptors and groundwater receptors have been considered in this

assessment, with consideration given to effects of routine runoff and risk of a potentially polluting spillage event.

1.4.2 The Highways England Water Risk Assessment Tool (HEWRAT) (the tool predates Highways England's change of name to National Highways but remains up to date) has been used to determine the potential effect of routine runoff on receiving watercourses. This is the simple assessment method provided in the DMRB which considers several factors including impermeable road area, and low flows and dimensions of the receiving watercourse. The HEWRAT has been used to assess all new outfalls as part of the Proposed Scheme. The HEWRAT assesses the likely quality of scheme-generated surface water runoff against the Environmental Quality Standards (EQS) given in the Water Framework Directive (WFD) and stated in the Environment Agency's guidance for surface water pollution risk assessments (**Ref. 1.2**) as well as determining chronic impacts from sedimentation and acute impacts from copper and zinc solubles. The results of this assessment are summarised in **Section 3**.

1.4.3 Impacts of routine road runoff on the quality of the underlying groundwater receptors has been assessed in accordance with the assessment method set out in Appendix C of LA113 (DMRB) (**Ref. 1.1**). This method uses a risk assessment matrix and is based on the 'source-pathway-receptor' pollutant linkage principle. Parameters are assessed as low, medium or high risk and assigned a risk factor. These risk factors are then weighted according to the guidance and totalled to provide the total risk score which indicates if further assessment or mitigation is required. The results of this assessment are summarised in **Section 4**.

1.4.4 The risk of a potentially polluting spillage event is calculated using equations and factors provided in Appendix D of LA113 (DMRB) (**Ref. 1.1**). This method calculates the probability of a spillage event with an associated risk of a serious pollution incident occurring. This firstly calculates the probability of a spillage occurring with the potential to pollute, and secondly calculates the probability of the pollutant reaching and impacting a receiving watercourse or

groundwater body. The results of this assessment are summarised in **Section 5**.

2 Proposed drainage strategy

2.1.1 It is proposed to install a new surface water drainage system to ensure that the Proposed Scheme does not increase flood risk to the scheme and to people and places elsewhere and provides appropriate treatment. For a detailed description of the proposed surface water drainage strategy refer to the standalone report in the **Drainage Strategy Report** (Document Reference: 4.04.00).

2.1.2 As part of the Proposed Scheme the following drainage structures are proposed:

- Outfall discharging to the Foxburrow Stream from an attenuation basin;
- Outfall discharging into the National Highways A47 DCO surface water drainage system; and
- Scheme-wide infiltration basins conveying surface water discharge from the Proposed Scheme to ground.

2.1.3 **Table 2.1** below provides an overview of the proposed attenuation, infiltration and treatment measures for each proposed outfall and infiltration basin.

Table 2.1 – Overview of proposed surface water drainage system

Ref	Proposed attenuation and treatment	Discharge location
Basin 1 (attenuation)	25% of runoff passes through grassed swales (lined) upstream of basin and all runoff passes through catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Pollution control value for spillage control.	Outlet discharges into the existing Broadland Northway (formerly known as Northern Distributor Road (NDR)) basin 1A which then discharges to ground.
Basin 2	Grassed swales (lined) and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. There is no drainage along the viaduct apart from the south abutment end which includes catchpits instead of grassed swales due to spatial constraints. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.
Basin A1067	Catchpits and deep-pot gullies to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable top soil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.
Basin 3	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.
Basin 4	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.

Ref	Proposed attenuation and treatment	Discharge location
Basin 5 (attenuation)	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	Outfall to Foxburrow Stream.
Basin 6 (attenuation)	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	Outfall to National Highways A47 DCO surface water drainage system. Subsequent outfall to River Tud

2.1.4 Basin 1 discharges to the existing Northland Broadway (formerly known as Northern Distributor Road (referred to as the NDR in this report)) basin 1A which then discharges to ground. The NDR scheme was completed in 2018. Information regarding the surface water drainage system has been taken from Document 2.11 Drainage and Surface Water Management Plans and Document 6.2 Environmental Statement: Volume II: Chapter 14. Road Drainage and the Water Environment available on Norfolk County Council's website (**Ref 1.5**).

2.1.5 Basin 6 discharges into the National Highways A47 DCO surface water drainage system that in turn discharges to the River Tud. Information regarding the proposed surface water drainage system for the National Highways A47 DCO has been taken from Appendix 13.3 - Water Quality Assessment in Volume 6 6.3 Environmental Statement Appendices available on the Planning Inspectorate website (**Ref 1.6**).

2.1.6 Consultation has been undertaken with the National Highways A47 DCO design team regarding the surface water drainage design and the parameters used within the Water Quality Assessment undertaken for the National Highways A47 DCO.

3 Impact of routine runoff on surface water quality

3.1 Methodology and Data

3.1.1 This assessment reviews the effect of pollution from routine runoff on receiving watercourses. This assessment uses the Highways England Water Risk Assessment Tool (HEWRAT) which is described in more detail in Appendix A of LA113 (DMRB) (**Ref. 1.1**). The inputs to this tool are:

- Details about the receiving watercourse
  - Annual Q95 river flow;
  - Base Flow Index (BFI);

- River width;
- Bed width;
- Manning's n;
- Channel side slope;
- Channel bed slope;
- Presence of downstream structures or sensitive areas;
- Ambient background copper concentration;
- Water hardness;
- Details about the Proposed Scheme / current arrangement;
- Annual Average Daily Traffic flow (AADT);
- Impermeable area;
- Permeable area;
- Existing mitigation; and
- Proposed mitigation.

3.1.2 Annual Q95 flow is derived from HR Wallingford's LowFlows2 software (**Ref. 1.5**). The software uses a catchment boundary to determine the low flow data. Catchment boundaries have been derived from the Centre for Ecology & Hydrology's FEH Web Service UK (**Ref. 1.6**), with some adjustments based on available LiDAR data. The FEH Web Service also provides a value for BFI for each downloaded catchment.

3.1.3 Water quality data was received from the Environment Agency but only one of the monitoring sites contained data on ambient copper concentrations, with only one sample of 2.5ug/l from 2003. As there is only one sample from 2003 this is considered to not provide a robust understanding of the ambient copper concentrations. Ambient background copper concentration has therefore been set to the default value of zero for the HEWRAT assessments. The HEWRAT

assessment therefore assesses the added risk to receiving waterbodies as a result of the Proposed Scheme.

3.1.4 The Study Area comprises chalk streams and therefore the highest water hardness has been applied for the assessment. This is considered a conservative but appropriate approach to the assessment in terms of water hardness.

3.1.5 The channel width was taken from the channel survey undertaken to support the hydraulic modelling of the River Wensum and Foxburrow Stream that informed the **Flood Risk Assessment** in **Appendix 2** (Document Reference: 3.12.02) of the Proposed Scheme.

3.1.6 AADT was extracted from the traffic model for both the baseline arrangement and the Proposed Scheme. This data was based on the design year traffic flows expected in 2044.

3.1.7 Impermeable and permeable area, discharge rates and mitigation measures, were taken from the surface water drainage strategy and associated drawings in the **Drainage Strategy Report** (Document Reference: 4.04.00).

3.1.8 Information regarding the outfall into the National Highways A47 DCO surface water drainage system and the HEWRAT assessment undertaken as part of the DCO application has been taken from Appendix 13.3 - Water Quality Assessment in Volume 6 6.3 Environmental Statement Appendices and has been used to inform this assessment. The design information for the Proposed Scheme has been combined with these parameters to take into account both of the areas draining to the outfall from the National Highways A47 DCO surface water drainage system and mitigation measures serving both schemes.

3.1.9 All input parameters used in this assessment are presented in **Sub Appendix A: Routine Runoff on Surface Water Quality Data** (Document reference: 3.12.01a).

3.1.10 A check for existing outfalls to be included within a cumulative assessment was also undertaken on National Highway's Drainage Data Management System (HA DDMS) (**Ref. 1.7**). There are no existing outfalls recorded within this database that are located within 1 kilometre of the outfalls assessed as part of the Proposed Scheme.

Outfalls

3.1.11 The outfalls in **Table 3.1** have been assessed quantitatively using HEWRAT. A cumulative assessment of outfalls is not deemed to be required as the outfalls are not located within 100m for the assessment of impacts associated with sediment related pollutants and not within 1 kilometre for the assessment of impacts associated with soluble pollutants.

Table 3.1 – Outfalls assessed with the HEWRAT

Receiving watercourse	Individual outfall assessment	Cumulative assessment
Foxburrow Stream	Yes	No
River Tud via the National Highways A47 DCO surface water drainage system	Yes	No

3.2 Mitigation Measures

3.2.1 The following mitigation measures are proposed for the drainage design and are included in the surface water drainage strategy and associated drawings in the **Drainage Strategy Report** (Document Reference: 4.04.00):

- Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway;
- Sediment forebays with wetted areas for planting; and
- Pollution control value for spillage control.

3.2.2 Each of these features have treatment efficiencies as stated in Table 8.3.2N1 of CG501 (DMRB) (**Ref. 1.8**) which have been applied in the HEWRAT. For any treatment features located downstream of another, a 50% reduction in efficiency has been applied as per guidance in CIRIA C609 (**Ref. 1.10**).

3.3 Results

3.3.1 The HEWRAT has two stages of assessment: Tier 1 and Tier 2. Tier 1 is a high level assessment based on river width. If the Tier 1 assessment fails, then Tier 2 is carried out using more channel dimensions. Two assessments are also undertaken for each Tier: Step 2 considers 'in-river' impacts without mitigation, and Step 3 considers 'in-river' impacts with mitigation. The mitigation discussed above is incorporated into the assessment to represent expected reductions in potential impact to water quality from copper, zinc and suspended solids. If the assessment passes Tier 1, the subsequent Tier 2 assessment has not been completed.

3.3.2 **Table 3.2** summarises the results for each individual outfall assessed. In accordance with DMRB, this considers acute impacts from soluble copper and zinc; chronic impacts from sedimentation; and comparison against the Environmental Quality Standards (EQS) limits for copper and zinc. A full summary of the results and input parameters are presented in **Sub Appendix A: Routine Runoff on Surface Water Quality Data** (Document reference: 3.12.01a).

Table 3.2 – Results from the HEWRAT assessing effects of routine runoff to receiving watercourses

Outfall and receiving watercourse	Step	Soluble Pollutants Acute impact assessment of copper	Soluble Pollutants Acute impact assessment of zinc	Sediments Chronic impact assessment of sediment	EQS Assessment Annual average concertation of copper (µg/l) due to road runoff	EQS Assessment Annual average concertation of zinc (µg/l) due to road runoff
Basin 5 Foxburrow Stream	Tier 1 Step 2	Pass	Pass	Fail - 81% settlement needed	0.52 µg/l Pass	1.18 µg/l Pass
Basin 5 Foxburrow Stream	Tier 1 Step 3	Pass	Pass	Pass	0.16 µg/l Pass	0.36 µg/l Pass
Basin 6 A47 surface water drainage system	Tier 1 Step 2	Pass	Pass	Pass	0.08 µg/l Pass	0.23 µg/l Pass
Basin 6 A47 surface water drainage system	Tier 1 Step 3	Pass	Pass	Pass	0.05 µg/l Pass	0.15 µg/l Pass

3.3.3 The outfall from basin 5 failed the chronic impact assessment of sediment-bound pollutants for Step 2 prior to the inclusion of proposed mitigation (treatment) measures. Re-assessing this outfall with the inclusion of proposed mitigation has demonstrated the outfall to pass the HEWRAT assessment.

3.3.4 Prior to the inclusion of mitigation measures, both outfalls 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 Method A assessment for these parameters.

3.3.5 As Tier 1 has been passed for all assessed parameters, Tier 2 has not been undertaken.

3.4 Further Mitigation

3.4.1 No further mitigation is required to manage the risk of routine runoff on surface water quality based on the findings of the assessment presented above.

4 Impact of routine runoff on groundwater quality

4.1 Methodology and data

4.1.1 Appendix C of LA 113 (DMRB) (**Ref. 1.1**) sets out a matrix that has been designed to assess the potential overall risk to groundwater and highlight any sites at high risk, where additional measures may be required. The risk assessment matrix uses the Source-Pathway-Receptor (S-P-R) protocol developed for use in risk assessment procedures for contaminated land evaluation.

4.1.2 In the context of road drainage, the source is the road runoff with any pollutants it contains. The pathways are the processes which may modify the pollutants during transmission through the discharge system and unsaturated

zone. The receptor is groundwater. The parameters used in the risk assessment matrix are shown in **Table 4.1**.

Table 4.1 – Pathway and source descriptions

S-P-R	Parameter	Weighting Factor	Low Risk (Score 1)	Medium Risk (Score 2)	High Risk (Score 3)
Source	Traffic Flow	10	≤50,000 AADT	<50,000 AADT to <100,000 AADT	≥100,000 AADT
Source	Annual Average Rainfall	10	≤740 mm	>740 mm to <1060 mm	≥1060 mm
Source	Drainage Area Ratio (Note 1)	10	≤50	>50 to <150	≥150
Pathway	Infiltration Method	15	'Continuous' shallow linear (e.g. unlined ditch, swale, grassed channel)	'Region' shallow infiltration systems (e.g. infiltration basin)	'Point' systems (e.g. chamber soakaways, deep shafts
Pathway	Unsaturated Zone	20	Depth to water table ≥15m or unproductive strata	Depth to water table <15m and >5m	Depth to water table ≤5m

S-P-R	Parameter	Weighting Factor	Low Risk (Score 1)	Medium Risk (Score 2)	High Risk (Score 3)
Pathway	Flow Type (Note 2)	20	Dominantly intergranular flow	Mixed fracture and intergranular flow	Flow dominated by fractures / fissures
Pathway	Unsaturated Zone Clay Content	5	≥15% clay minerals	<15% to > 1% clay minerals	≤1% clay minerals
Pathway	Organic Carbon	5	≥15% soil organic matter	<15% to >1% soil organic matter	≤1% soil organic matter
Pathway	Unsaturated Zone Soil pH	5	pH ≥8	pH<8 to >5	pH≤5

Note 1 - Determined as drainage area of road / active surface area of infiltration device, where the active surface area is that part of the device through which the majority of downward discharge will occur.

Note 2 - The flow type incorporates flow type and effective grain size

4.1.3 Traffic flow data was extracted from the traffic model for both the baseline arrangement and the Proposed Scheme. This data was based on the design year traffic flows expected in 2041.

4.1.4 Annual average rainfall was taken from the nearest Met Office station at Coltishall (**Ref. 1.8**) located to the north-east of Norwich.

4.1.5 Drainage areas were taken from the surface water drainage strategy and associated drawings in the **Drainage Strategy Report** (Document Reference: 4.04.00).

4.1.6 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). Ground investigation works are typically within 100 metres or within the footprint of the of a proposed drainage feature.

4.1.7 Information regarding the existing infiltration basin NDR basin 1A that is part of the NDR scheme has been taken from Document 2.11 Drainage and Surface Water Management Plans and Document 6.2 Environmental Statement: Volume II: Chapter 14. Road Drainage and the Water Environment. The design parameters used in the planning application for the NDR scheme have been taken from Section P of the Road Drainage and the Water Environment Chapter. The design information for the Proposed Scheme has been combined with these parameters to take into account both of the areas draining to the infiltration basin and the mitigation measures serving both schemes.

4.1.8 Each parameter used in the assessment of potential overall risk to groundwater is considered and assigned a risk category. The corresponding category risk score (Low Risk – 1, Medium Risk – 2, High Risk – 3) is multiplied by the weighting factor for each parameter and then summed. The overall risk of impact to groundwater receptors is determined as:

- Overall risk score <150 – Low Risk of impact;
- Overall risk score 150 – 250 – Medium Risk of impact; and
- Overall risk score of >250 – High Risk of impact.

4.1.9 The risk score does not take mitigation into account (i.e. upstream treatment provided by the drainage system). Instead, the risk score identifies which parameters are associated with the greatest risk to best determine what actions can be taken, how to best mitigate the risk and the need for further assessment.

4.2 Results

4.2.1 A summary of the overall risk from routine runoff associated with each network is summarised in **Table 4.2** below based on the criteria and weightings detailed above. The risk score associated with each parameter is included in brackets. A more detailed summary of the results is presented in **Sub Appendix B: Routine Runoff on Groundwater Quality Data** (Document reference: 3.12.01b).

Table 4.2 – Results of LA 113 assessment for routine runoff to groundwater

Parameter	Weighting Factor	Score: Basin 1	Score: Basin 2	Score: Basin A1067	Score: Basin 3	Score: Basin 4
Traffic Flow	**10**	20 (medium)	10 (low)	10 (low)	10 (low)	10 (low)
Annual Average Rainfall	**10**	10 (low)	10 (low)	10 (low)	10 (low)	10 (low)
Drainage Area Ratio	**10**	10 (low)	10 (low)	10 (low)	10 (low)	10 (low)
Infiltration Method	**15**	30 (medium)	30 (medium)	30 (medium)	30 (medium)	30 (medium)
Unsaturated Zone	**20**	60 (high)	60 (high)	60 (high)	60 (high)	60 (high)
Flow Type	**20**	40 (medium)	40 (medium)	40 (medium)	40 (medium)	40 (medium)
Unsaturated Zone Clay Content	**5**	5 (low)	5 (low)	5 (low)	5 (low)	5 (low)
Organic Carbon	**5**	15 (high)	15 (high)	15 (high)	15 (high)	15 (high)
Unsaturated Zone Soil pH	**5**	15 (high)	15 (high)	15 (high)	15 (high)	15 (high)

Parameter	Weighting Factor	Score: Basin 1	Score: Basin 2	Score: Basin A1067	Score: Basin 3	Score: Basin 4
Overall Risk Score	**N/A**	**205 (Medium Risk)**	**195 (Medium Risk)**	**195 (Medium Risk)**	**195 (Medium Risk)**	**195 (Medium Risk)**

4.2.2 All of the basins have resulted in a Medium Risk score. LA 113 (DMRB) (**Ref. 1.1**) indicates that further assessment is required in order to understand the potential impacts of the Proposed Scheme.

4.2.3 Review of the assessment results indicates that the shallow depth to groundwater in superficial deposits and the underlying soil properties has a significant effect on the overall risk score. Undertaking more detailed quantitative analysis of the Proposed Scheme was not considered likely to change the findings of this assessment and instead a qualitative review of the Proposed Scheme and sensitivity of receiving waters has been undertaken, taking the following information into account:

- Proposed treatment measures and existing drainage regime (where relevant); and
- Sensitivity of underlying groundwater resources and downstream surface waters.

Proposed treatment measures and existing drainage regime

4.2.4 As discussed above, the overall risk score does not take proposed treatment into account.

4.2.5 Surface water runoff from all new sections of highway will pass through two vegetated treatment trains (grassed swales and integrated sediment forebay upstream of the infiltration basin) which will provide robust treatment of runoff. The base of the basins is also located a minimum of 1m above highest recorded groundwater levels and, as such, provides treatment via percolation

through the soil layers as required by the DMRB and standard design practices.

4.2.6 Grassed swales are not proposed for the section of highway that is realigning the existing A1067 road network, noting that this comprises a c.200 metre length of the existing carriageway that will discharge to basin A1067. However, a review of the existing drainage regime serving this section of road indicates that surface water runoff currently infiltrates directly to ground via an unlined filter drain. The proposed drainage system for this section of road comprises an integrated sediment forebay upstream of the infiltration basin and with dedicated maintenance access. An additional 300mm depth of permeable topsoil is also proposed to be included in the base of this basin to provide additional treatment. The proposed drainage system is therefore not considered to pose greater risk to receiving waterbodies when compared to the current regime and may provide some benefit.

Sensitivity of underlying groundwater resources

4.2.7 The Proposed Scheme is located within Zone 3 (Total Catchment) of a Source Protection Zone. This is associated with the Chalk Principal Aquifer that underlies the Study Area and not the shallow superficial deposits. The sensitivity of shallow groundwater in superficial deposits is deemed to be relatively low when considered in isolation, although the importance of these resources is elevated due to their connectivity with the underlying Principal Aquifer and the River Wensum.

4.2.8 When considering the findings of the DMRB risk assessment, infiltration from basins 1 and 2 and basin A1067 is most likely to flow the short distance towards the River Wensum and not percolate to the Principal Aquifer. Potential impacts to the River Wensum is discussed in the section below.

4.2.9 The hydrogeological conditions in the area of basins 3 and 4 are characterised by a generally dry valley (only pockets of perched ground / surface water). Low to medium permeability superficial deposits restrict vertical groundwater flow into the underlying Chalk to some extent. The

proposed drainage design in principal mimics the natural conditions where this valley collects overland flow and shallow groundwater and gradually loses the water to the Chalk aquifer. The slightly increased surface water catchment is compensated by storage capacity in the basins and overall drainage network. Basins 3 and 4 are soakaway features which initially generate groundwater recharge to the shallow perched aquifer producing mainly lateral flow within the superficial deposits. The proposed basins will reduce the thickness of the superficial deposits to around 1 to 3m above the Chalk. The groundwater table within the Chalk was found to be approximately 7 to 8m below the base elevation of basin 4. The proposed drainage system may overall slightly improve groundwater recharge to the Chalk which is important to maintain or improve the quantitative status of this regional water body.

4.2.10 With regards to pollution risk this is considered low to negligible considering:

- Treatment train within the drainage system prior to soakaway;
- Slow infiltration and high retention capacity of the basins;
- Infiltration through low to medium permeability porous superficial deposits provides a filter effect and capacity for natural attenuation of pollutants;
- Several meters of unsaturated zone within the top zone of the Chalk (weathered Chalk) provides additional natural attenuation capacity; and
- Slow infiltration rates towards a thick regional chalk aquifer means high dilution effect.

4.2.11 Therefore the risks of pollution of the Chalk aquifer and related groundwater abstraction is considered to be Low.

Sensitivity of downstream surface waters

4.2.12 Hydrogeological assessments undertaken as part of the EIA show a high connectivity between surface water in the River Wensum, shallow groundwater in superficial deposits and the deeper Chalk aquifer in proximity

of the River Wensum. The River Wensum is the main and the most sensitive receptor of groundwater flow in this area. The potential risk of pollutants migrating towards the River Wensum via groundwater flow has therefore been assessed by applying HEWRAT and treating the discharge as a point source surface water outfall to the Wensum. The assessment has been undertaken for all basins to present a robust assessment, although connectivity between basins 3 and 4 and the River Wensum is much more remote compared to basins 1, 2 and A1067.

4.2.13 The assessment demonstrates that these outfalls (independently and cumulatively) would pass the HEWRAT with the inclusion of the proposed treatment measures, noting that this has not considered the additional treatment provided by migration through soil layers and dilution in the shallow aquifer.

4.2.14 **Table 4.3** below shows the results of the additional HEWRAT assessments for each individual outfall, incorporating proposed mitigation (treatment) measures. Consideration has also been given to the potential for cumulative impact from all outfalls, recognising that flow from the basins could enter the Wensum within 1 kilometre of each basin. **Table 4.4** below shows the results of the cumulative assessment; both the soluble and sediment impacts have been assessed within the cumulative assessment although it is recognised that impacts associated with sediment are unlikely to occur as this will be filtered by percolation through the infiltration basin and soil layers. A more detailed summary of the results and input parameters is presented in **Sub Appendix C: Additional Routine Runoff on Groundwater Quality Data** (Document reference: 3.12.01c).

4.2.15 The sources of data used to inform this assessment are the same as summarised in **Section 3.1**.

4.2.16 As Tier 1 has been passed for all assessed parameters, Tier 2 has not been undertaken.

Table 4.3 – Results from the HEWRAT assessing effects of routine runoff to the River Wensum via groundwater baseflow

Outfall	Step	Soluble Pollutants Acute impact assessment of copper	Soluble Pollutants Acute impact assessment of zinc	Sediments Chronic impact assessment of sediment	EQS Assessment Annual average concertation of copper (µg/l) due to road runoff	EQS Assessment Annual average concertation of zinc (µg/l) due to road runoff
Basin 1	Tier 1 Step 2	Pass	Pass	Pass	0.00 µg/l Pass	0.01 µg/l Pass
Basin 1	Tier 1 Step 3	Pass	Pass	Pass	0.00 µg/l Pass	0.01 µg/l Pass
Basin 2	Tier 1 Step 2	Pass	Pass	Pass	0.00 µg/l Pass	0.01 µg/l Pass
Basin 2	Tier 1 Step 3	Pass	Pass	Pass	0.00 µg/l Pass	0.01 µg/l Pass
Basin A1067	Tier 1 Step 2	Pass	Pass	Pass	0.00 µg/l Pass	0.00 µg/l Pass
Basin A1067	Tier 1 Step 3	Pass	Pass	Pass	0.00 µg/l Pass	0.00 µg/l Pass
Basin 3	Tier 1 Step 2	Pass	Pass	Pass	0.00 µg/l Pass	0.00 µg/l Pass
Basin 3	Tier 1 Step 3	Pass	Pass	Pass	0.00 µg/l Pass	0.00 µg/l Pass
Basin 4	Tier 1 Step 2	Pass	Pass	Pass	0.00 µg/l Pass	0.01 µg/l Pass
Basin 4	Tier 1 Step 3	Pass	Pass	Pass	0.00 µg/l Pass	0.00 µg/l Pass

Table 4.4 - Results from the cumulative HEWRAT assessing effects of routine runoff to the River Wensum via groundwater baseflow

Outfalls	Step	Soluble Pollutants Acute impact assessment of copper	Soluble Pollutants Acute impact assessment of zinc	Sediment Chronic impact assessment of sediment	EQS Assessment Annual average concertation of copper (µg/l) due to road runoff	EQS Assessment Annual average concertation of zinc (µg/l) due to road runoff
Basin 1 Basin 2 Basin A1067 Basin 3 Basin 4	Tier 1 Step 2	Pass	Pass	Pass	0.02 µg/l Pass	0.04 µg/l Pass
Basin 1 Basin 2 Basin A1067 Basin 3 Basin 4	Tier 1 Step 3	Pass	Pass	Pass	0.01 µg/l Pass	0.02 µg/l Pass

4.2.17 A high-level overflow is proposed in basin A1067 that would discharge surface water from the basin towards the River Wensum. This is a risk management measure that would only come into use in the unlikely scenario that the basin exceeds design capacity and overflows, noting that exclusion of the overflow could pose risk to the safety of the carriageway. The overflow would discharge to a vegetated ditch upstream of the River Wensum and not to the Wensum itself. Given the findings of the HEWRAT assessment above and noting that this is a risk management measure that would occur during high flows (i.e. diluted discharge) the potential risk to the River Wensum is considered to be low.

4.3 Further Mitigation

4.3.1 No further mitigation is deemed to be required to manage the risk of routine runoff on groundwater quality (or indirect risks to surface water quality) based on the findings of the assessment presented above.

4.3.2 A separate standalone assessment has been undertaken to assess the risks of salt runoff to the underlying groundwater body and the River Wensum. This is presented as part of **Appendix 12.5 River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05) and therefore is not discussed in this report.

5 Impacts of increased spillage risk on surface water bodies and groundwater receptors

5.1 Methodology and data

5.1.1 This assessment reviews the probability of a spillage event occurring and the potential for this event to pollute receiving watercourses and groundwater resources. The calculation is based on a formula provided in Appendix D of LA113 (DMRB) (**Ref. 1.1**). The inputs to this calculation are:

- Road grade (motorway, urban trunk road, rural trunk road);

- Road type and junction type (roundabout, slip road, side road, crossroads, road with no junction);
- Road length of each junction type;
- Road location (rural or urban);
- AADT for each road type; and
- Percentage of heavy goods vehicles (%HGV) use for each road type.

5.1.2 The road location considers the proximity to urban areas that are likely to support emergency response services. The data was sourced from a review of OS mapping.

5.1.3 AADT and %HGV data was extracted from the traffic model for both the baseline arrangement and the Proposed Scheme. This data was based on the design year traffic flows expected in 2044.

5.1.4 Road grade, type and length was derived from review of Proposed Scheme design information including the Surface Water Drainage Strategy and associated drawings in the **Drainage Strategy Report** (Document Reference: 4.04.00) and consultation with the drainage designers.

5.1.5 Information regarding the proposed surface water drainage system for the A47 DCO Scheme has been taken from Appendix 13.3 - Water Quality Assessment in Volume 6 6.3 Environmental Statement Appendices. Consultation has been undertaken with the National Highways A47 DCO design team regarding the surface water drainage design and parameters used within the Water Quality Assessment undertaken for the National Highways A47 DCO scheme. The parameters set out in the Water Quality Assessment undertaken for the National Highways A47 DCO scheme were combined with the parameters for the Proposed Scheme to take into account both of the areas draining to the outfall and the mitigation measures serving both schemes.

5.1.6 Information regarding the existing infiltration basin 1a that is part of the NDR scheme has been taken from Document 2.11 Drainage and Surface Water Management Plans and Document 6.2 Environmental Statement: Volume II: Chapter 14. Road Drainage and the Water Environment. The design parameters used in the planning application for the NDR scheme have been taken from Section P of the Road Drainage and the Water Environment Chapter. The design information for the Proposed Scheme has been combined with these parameters to take into account both of the areas draining to the infiltration basin and the mitigation measures serving both schemes.

5.1.7 The calculation was carried out for each proposed outfall and infiltration basin, including those discharging to existing drainage systems. Where more than one outfall discharges into a reach or more than one soakaway drains into the same groundwater body, the annual probabilities for each section of road are added to get the combined risk. All input parameters are presented in **Sub Appendix D: Spillage Risk Assessment Data** (Document reference: 3.12.01d).

5.1.8 In accordance with LA113 (DMRB) (**Ref. 1.1**), the risk of a serious pollution incident is deemed acceptable if the annual probability is less than 1%. Where the spillage could affect sensitive areas, the risk of a serious pollutant incident is deemed acceptable if the annual probability is less than 0.5%. The River Wensum is located approximately 7 kilometres downstream of the outfall from the National Highways A47 DCO scheme. Although the risk to this feature is low given the distance from the Proposed Scheme, the Wensum holds European designation as a Special Area of Conservation (SAC) and UK designation as a Site of Special Scientific Interest (SSSI). The threshold for acceptability in this assessment is therefore set to 0.5%. Any probability determined to be greater than this will need to be reduced to its associated threshold level with additional mitigation measures.

5.2 Mitigation Measures

5.2.1 The following mitigation measures are proposed for the drainage design:

- Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway;
- Sediment forebays with wetted areas for planting; and
- Pollution control value for spillage control.

5.2.2 Each of these features have a spillage risk reducing factor as stated in Table 8.3.2N1 of CG501 (DMRB) (**Ref. 1.9**).

5.3 Results

5.3.1 A summary of the results of the spillage risk assessment for the new outfalls and infiltration basins are presented in **Table 5.1** and the results are shown in **Sub Appendix D: Spillage Risk Assessment Data** (Document reference: 3.12.01d).

5.3.2 From **Table 5.1** it can be seen that the proposed drainage and included mitigation for all outfalls and basins has an acceptable risk of spillage.

Table 5.1 – Spillage risk assessment results for proposed new outfalls

Outfall / Basin	Description	Mitigation	Proposed Scheme spillage risk
Basin 1	Infiltration basin discharges into the existing NDR Basin 1A which then discharges to ground	25% of runoff passes through grassed swales (lined) upstream of basin and all runoff passes through catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Pollution control value for spillage control.	0.04%
Basin 2	Infiltration to ground	Grassed swales (lined) and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. There is no drainage along the viaduct apart from the south abutment end which includes catchpits instead of grassed swales due to spatial constraints. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	0.02%
Basin A1067	Infiltration to ground	Catchpits and deep-pot gullies to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of top soil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	0.01%
Basin 3	Infiltration to ground	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	0.01%

Outfall / Basin	Description	Mitigation	Proposed Scheme spillage risk
Basin 4	Infiltration to ground	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	0.02%
Basin 5	Outfall to Foxburrow Stream	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	0.02%
Basin 6	Outfall to A47 surface water drainage system	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	0.01%

5.3.3 A cumulative assessment of the infiltration basins was also undertaken to assess the cumulative impacts to groundwater receptors. All of the Proposed Scheme spillage risks for the infiltration basins were added together to total 0.1%. This is below the 0.5% acceptable threshold for sensitive sites.

5.4 Further Mitigation

5.4.1 No further mitigation is required to manage the risk of a polluting spillage event to an acceptable level.

5.5 Pollution Incident Control

5.5.1 Pollution control valves are integrated into the proposed drainage system of all proposed outfalls from the proposed infiltration and attenuation basins. Where possible these are located downstream of the sediment forebay or (as appropriate) attenuation basin to provide an element of residual benefit to pollution containment by storing volumes of water prior to discharge to ground or receiving watercourses. The sediment forebays will be lined to aid in preventing pollution to underlying groundwater receptors. **Table 5.2** below details the volumes of the sediment forebays (and basins as appropriate) to show what volume can be contained upstream of the pollution control valves in case of a spillage event.

Table 5.2 – Basin storage volumes upstream of pollution control valves

Basin	Penstock location	Approximate Sediment Forebay volume (m^3) upstream of pollution control valve
Basin 1	Outgoing pipe from NWL Basin 1 to NDR infiltration basin 1A.	479.3 (full volume of the lined attenuation basin (NWL Basin 1) located upstream of the NDR infiltration basin 1A)

Basin	Penstock location	Approximate Sediment Forebay volume (m^3) upstream of pollution control valve
Basin 2	Outgoing pipe from sediment forebay to infiltration basin.	1087.8
Basin A1067	Incoming pipe to sediment forebay.	As the penstock is located in the incoming pipe to the sediment forebay the storage for a spillage event is within the drainage pipe network upstream of the penstock.
Basin 3	Outgoing pipe from sediment forebay to infiltration basin.	537.8
Basin 4	Outgoing pipe from sediment forebay to infiltration basin.	1321.1
Basin 5	Outgoing pipe from basin to outfall.	1200 (full volume of the sediment forebay and lined attenuation basin)
Basin 6	Outgoing pipe from sediment forebay to basin.	257

6 Conclusion

6.1.1 The introduction of a new highway and changes to existing highway junctions can impact water quality of nearby surface water and groundwater bodies which receive highway drainage. This assessment determines if the proposed surface water drainage system serving the Proposed Scheme is likely to cause a significant adverse effect to receiving waterbodies and groundwater receptors. This assessment has considered the impact to water quality from

changes to routine runoff and from changes to the risk of a spillage event with potential to pollute waterbodies.

6.1.2 The assessment of routine runoff to surface water features was conducted using HEWRAT. This assessment determined that the proposed system is acceptable for the receiving waterbodies.

6.1.3 The assessment of routine runoff to groundwater resources was conducted using the method outlined in Appendix C of LA 113 (DMRB) (**Ref. 1.1**) and concluded Medium Risk from all outfalls. With consideration given to proposed treatment measures and the sensitivity of groundwater resources, the risk to underlying groundwater resources is not considered to be significant. Further assessment was undertaken to assess risks associated with the migration of pollutants through the ground towards the River Wensum and this concluded negligible indirect risk to the Wensum.

6.1.4 The assessment of spillage risk was conducted using the calculations provided in Appendix D of LA 113 (DMRB) (**Ref. 1.1**) and covered the entire length of the Proposed Scheme and adjoining junctions. This assessment determined that the proposed system is acceptable for all receiving surface water bodies and groundwater receptors.

6.1.5 The inclusion of the embedded mitigation would reduce potential impact to receiving water bodies to an acceptable level according to HEWRAT and LA 113 (**Ref. 1.1**).

6.1.6 A separate standalone assessment has been undertaken to assess the risks of salt runoff to the underlying groundwater body and the River Wensum. This is presented as part of **Appendix 12.5 River Wensum Crossing – Groundwater Modelling Report** (Document Reference: 3.12.05) and therefore is not discussed in this report.

7 References

Reference 1.1: Design Manual for Roads and Bridges (2020). 'LA 113 Road Drainage and the Water Environment, Revision 1'. Available at: LA 113 Road drainage and the water environment

Reference 1.2: Environment Agency (2016). 'Surface Water Pollution Risk Assessment for your Environmental Permit'. Available at: Surface water pollution risk assessment for your environmental permit

Reference 1.3: Norfolk County Council. (no date) DCO documents, DCO documents - Norfolk County Council. Available at: https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/broadland-northway/planning-and-approval-process/development-consent-order/dco-documents (Accessed: 16 February 2024).

Reference 1.4: Highways England (2021) A47 North Tuddenham to Easton Dualling A47 North Tuddenham to Easton Dualling, Volume 6, 6.3 Environmental Statement Appendices Appendix 13.3 - Water Quality Assessment A. Available at: Highways England (2021) A47 North Tuddenham to Easton Dualling A47 North Tuddenham to Easton Dualling, Volume 6, 6.3 Environmental Statement Appendices Appendix 13.3 - Water Quality Assessment A

Reference 1.5: Wallingford HydroSolutions (2023). 'LowFlows 2'. Available at: LowFlows 2

Reference 1.6: UK Centre for Ecology & Hydrology (2023). 'Flood Estimation Handbook Web Service'. Available at: Flood Estimation Handbook Web Service

Reference 1.7: National Highways (2023). 'Highways Agency Drainage Data Management System'. Available at: Highways England Drainage Data Management System

Reference 1.8: Met Office (2023). ‘UK Climate Averages'. Available at: Coltishall Climate Station

Reference 1.9: Design Manual for Roads and Bridges (2022). ‘CG 501 - Design of highway drainage systems, Revision 2.1’. Available at: Design of highway drainage systems

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