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NORTH HYKEHAM RELIEF ROAD
WATER QUALITY ASSESSMENT

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WATER QUALITY ASSESSMENT

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1. INTRODUCTION

This report details the water quality risk assessment for the operational phase of the proposed North Hykeham Relief Road (NHRR). The report considers the risk of impacts to water quality which may arise from the scheme to determine whether these are acceptable or not and, where it is unacceptable, what mitigation is required to address the risk. The indicative drainage layout for the scheme is shown in Appendix 2.

The water quality assessment considers risks from routine runoff to both surface watercourses and groundwater. The risk of a spillage resulting in a pollution incident are also assessed. The assessment methods used are as described in National Highways' DMRB document 'Road Drainage and the Water Environment' (LA 113). The assessments utilise the Highways England Water Risk Assessment Tool (HEWRAT) as required by LA 113.

An overview of the methodologies is provided in the relevant sections below. Detailed information on methodology and calculations is available in DMRB LA 113 and, for treatment efficiencies, DMRB CG 501.

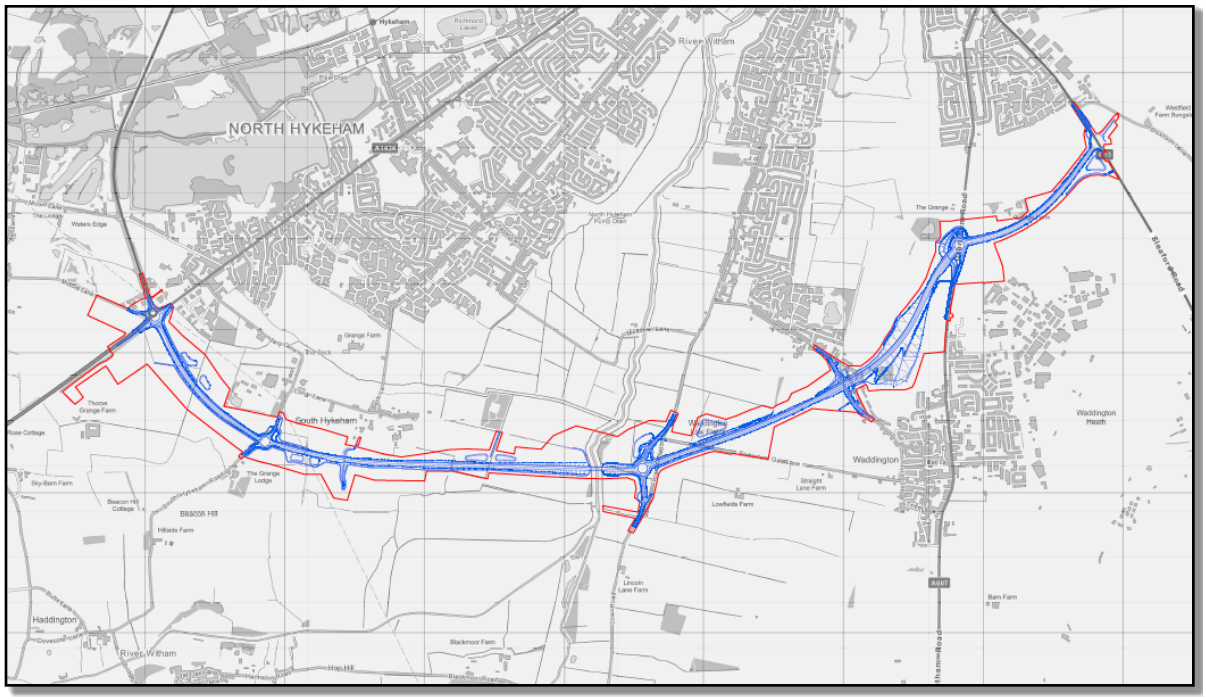
2. SITE INFORMATION

2.1 Site Location

The NHRR consists of the construction of approximately 8km of Dual All-Purpose 2lane Carriageway between the A46-Newark Road Roundabout and the Lincoln Eastern Bypass-Sleaford Road Roundabout.

The new road will pass to the south of South Hykeham and through Station Road near Waddington, before passing north around the north side of RAF Waddington. A site location plan can be found in Figure 2-1 below.

Figure 2-1 Site Location Plan



2.2 Site Description and Existing Drainage

The North Hykeham Relief Road (NHRR) crosses low-lying and largely flat farmland which is drained by man-made ditches or straightened drains. These drains are, in part, managed by an Internal Drainage Board (IDB). The ditches and drains discharge to either a watercourse named 'The Beck' (Figure 2-2) or the River Witham (Figure 2-3). The Witham flows south to north through the study area and will be crossed by the NHRR.

The Witham has levees on either bank to control flooding. The river level can often be higher than the surrounding land so many of the ditches and drains flow to an IDB pumping station which lifts the water into the Witham. The Beck is carried over the levees on embankment and flows into the Witham by gravity.

To the east of the Witham is an escarpment through which the proposed road will cut. The road rises to a proposed junction with the LEB. Grantham Road roundabout on the east is the highest point of the scheme at approximately 73 mAOD. The lowest point is at the River Witham at approximately 4.5 mAOD.

Figure 2-2 The Beck. Photo taken on 12/01/2023 at Beck lane.

Figure 2-3 River Witham. Photo taken on 12/01/2023 at Meadow Lane.

2.3 Drainage Strategy and Discharge Points

The proposed drainage for the new road is divided into ten numbered catchments with the A46 Junction forming a first catchment. The catchments are split based on the alignment and the positions of the existing watercourses. The easternmost catchment (catchment 10) is proposed to discharge to an infiltration basin, while the other catchments discharge to surface watercourses. Proposed highway catchments and water quality assessment points are shown in appendix 2. Table 2-1 gives details of the catchment areas. Traffic flows for those catchments are also shown and are reported as Annual Average Daily Traffic (AADT).

Table 2-1 Drainage Catchments

Outfall Reference	Impermeable Catchment Area (ha)	Permeable Catchment Area (ha)	Description	AADT (Annual Average Daily Traffic)
Highway catchment1	1.839	0.414	Discharges to tributary of the Beck	32923, 3.43% HGV
Highway Catchment 2	1.210	0.653	Discharges to tributary of the Beck	32923, 3.43% HGV
Highway Catchment 3	1.754	0.688	Discharges to tributary of the Beck	32923, 3.43% HGV
Highway Catchment 4	1.052	0.586	Discharges to the Witham via ditches	36798, 2.32% HGV
Highway Catchment 5	0.90	0.286	Discharges to the Witham via ditches	36798, 2.32% HGV
Highway Catchment 6	3.049	1.436	Discharges to the Witham via ditches	49121, 2.68% HGV
Highway Catchment 7	2.155	0.892	Discharges to the Witham via ditches	49121, 2.68% HGV
Highway Catchment 8	2.882	1.459	Discharges to the Witham via ditches	49121, 2.68% HGV
Highway Catchment 9	6.92	1.812	Discharges to the Witham via ditches	49121, 2.68% HGV
Highway Catchment 10	4.35	2.116	Discharges to infiltration basin	32120, 3.23% HGV

3. SURFACE WATER QUALITY ASSESSMENT

3.1 Assessment Methodology for Routine Runoff

Highways England Water Risk Assessment Tool (HEWRAT) estimates the magnitude of potential short term and longer-term impacts to water quality associated with discharge of operational road drainage. Calculated concentrations of specific elements are compared against freshwater pollutant thresholds and Environmental Quality Standards (EQS) to assess compliance with the Water Framework Directive (WFD). HEWRAT considers the following:

- Short-term impacts in the form of runoff-specific thresholds (RST), which relate to the intermittent nature of road runoff (i.e. contaminants washed off the road surface in a rainfall event), over a typical exposure period of six hours (RST 6 hour) and for a worst-case scenario of 24 hours (RST 24 hour). Dissolved copper and dissolved zinc are used as indicators of the level of impact as they can result in acute toxic effects to aquatic life in certain concentrations.

- Chronic impacts (i.e. impacts which can persist for weeks or months) associated with sediment-bound pollutants on aquatic ecology. Two standards are used for metal and polycyclic aromatic hydrocarbon (PAH) concentrations within sediment; Threshold Effects Levels (TELs) (i.e. the concentration below which toxic effects are very rare) and Probable Effects Levels (PELs) (i.e. the concentration above which toxic effects are observed on most occasions).

- Longer-term in-river annual average concentrations for soluble pollutants (dissolved copper and dissolved zinc) which includes the contribution from road runoff. These concentrations are compared against published EQS for freshwaters to assess whether there is likely to be a long-term impact on ecology.

HEWRAT uses a three-step tiered approach to assess the impacts of both soluble and sediment-bound pollutants. A 'Pass' or 'Fail' result is recorded depending on whether the risk is within or exceeds the thresholds indicated above. Where a Fail result is recorded for one or more of the pollutant types, the next step is required based on increasing levels of inputs and assessment.

As well as assessing the risk of routine runoff from each drainage outfall in isolation, an in-combination assessment is undertaken where more than one outfall discharges into the same reach of watercourse. This is the 'worst-case' scenario as the combined effects could be more significant. To aggregate the assessments, the total impermeable and permeable carriageway areas to be drained are added together, and the low flow of the watercourse is taken at the location furthest downstream (this is the assessment point of the combined outfall assessment). For drainage outfalls positioned between 100m and 1km apart, the cumulative assessment is for soluble pollutants only, whilst for outfalls positioned closer together (within 100m), the combined assessment includes soluble and sediment pollutants.

3.2 Discharge Points for Road Runoff

The discharge points to surface watercourses and HEWRAT assessment locations are shown in Figure 3-1 and Figure 3-2:

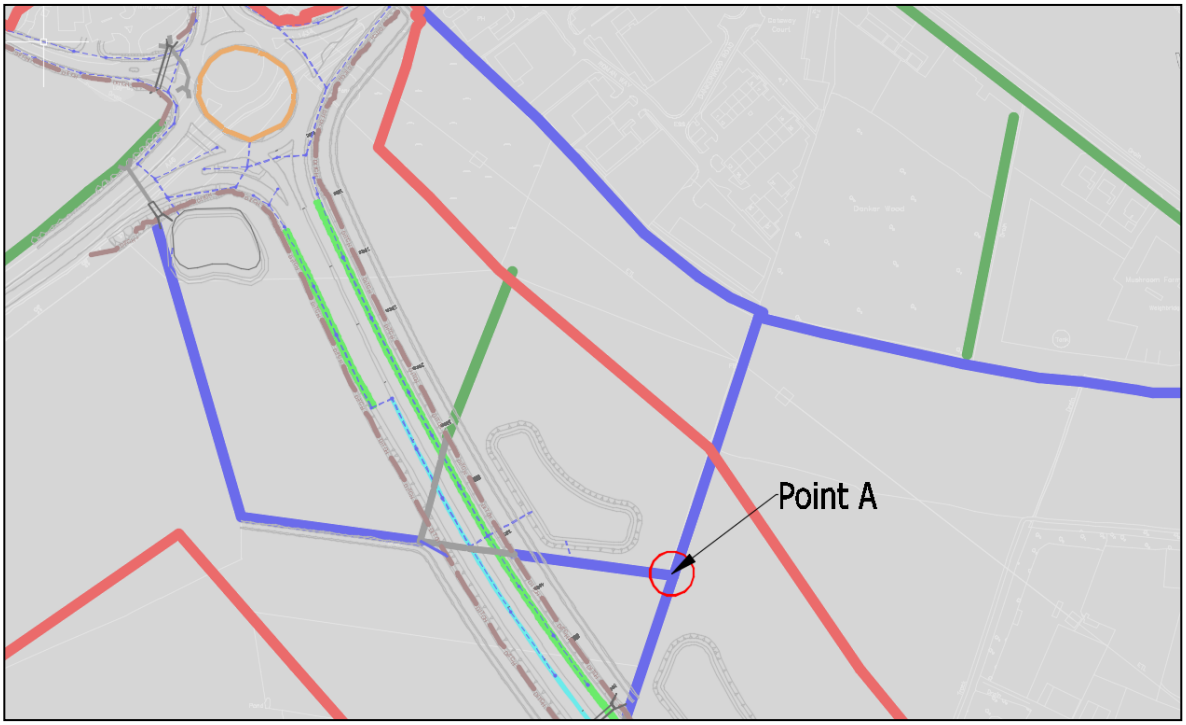


Figure 3-1 Discharge point A

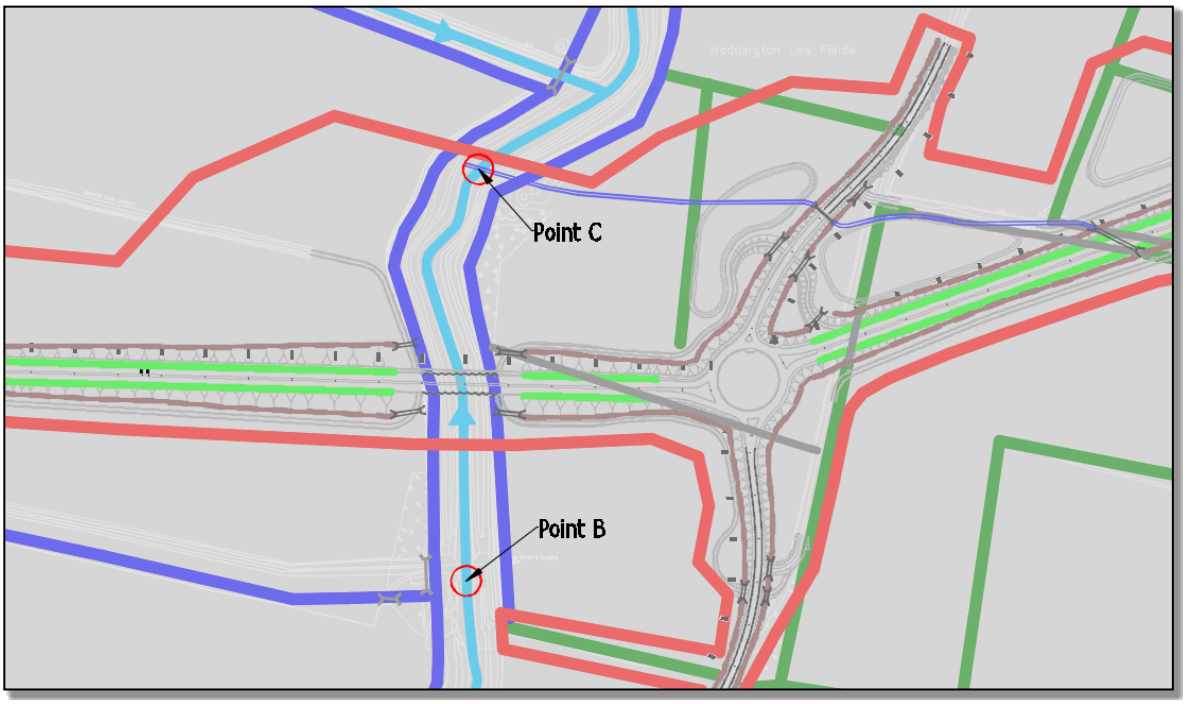


Figure 3-2 Discharge point B and C

Point A: The catchment area from highway catchment area 1 and part of catchment area 2 discharge to an existing ditch. The existing ditch has a small catchment area (the ditch originates at the A46 roundabout) such that the ditch is often dry. The location for the HEWRAT assessment of potential impacts on freshwater ecology has therefore been taken as the point downstream where the existing ditch joins another ditch with a larger catchment. The downstream location where the two ditches meet is marked 'Point A' on Figure 3-1 above.
The combined catchments of highway catchment area 1, catchment area 2 and the catchment area 3 meet at this confluence of ditches. As the discharge locations are within 100m for highway catchment 1 and 2 therefore a cumulative assessment is required at point A.

Point B: Discharge from highway catchment areas 4, 5, 6 and7 combine via local farm ditches and IDB drains at Point B. The water in these watercourses is discharged into the river Witham via a pumping station. The ditches and drains have a small contributing catchment area of less than 50 hectares such that they are often dry. The location for the HEWRAT assessment of potential impacts on freshwater ecology has therefore been taken as the point where the ditch network discharges to the river Witham (which always has water in).

Point C: Discharge from highway catchment areas 8 and 9 combine via local farm ditches and IDB drains at Point C. The water in these watercourses is discharged into the river Witham. The ditches and drains have a small contributing catchment area of less than 50 hectares such that they are often dry. The location for the HEWRAT assessment of potential impacts on freshwater ecology has therefore been taken as the point where the ditch network discharges to the river Witham (which always has water in). Watercourse parameters

Table 3-1 presents watercourses parameters which are required for the water quality risk assessment using HEWRAT. The parameters have been determined from:

- topographical surveys of the watercourses;
- a detailed lidar survey; and

- LowFlows software[1].

The Defra water hardness map(reproduced in appendix 3) shows the watercourse hardness (in terms of the concentration of calcium carbonate) to be between 200 and 300 mg $CaCO_3$/l. This is 'hard' in terms of the HEWRAT hardness bands.

Table 3-1 Watercourse Parameters for use HEWRAT assessment

Point	Grid Ref.	Watercourse	Catchment Area (km²)	Q_{95} (m³/s)	BFI	Bed Width (m)	Long slope	Side Slope (h/v)	Mannings n
A	492407 364909	Ditch/ tributary leading to the Beck	3.38	0.002	0.26	1	0.0001	1:1.4	0.03
B	495450 364700	River Witham	562	0.31	0.5	18	0.007	1:7	0.03
C	495249 364413	River Witham	562	0.31	0.5	18	0.007	1:7	0.03

3.3 Individual & Cumulative Assessments

In accordance with LA113 and depending on the proximity of outfalls, water quality assessments may need to be carried out for potential cumulative effects as well as for individual discharges. The assessments carried out are shown in Table 3-2.

Table 3-2 Individual and Cumulative Assessments

Catchment Reference	Assessment	Individual / Cumulative	Assessment Point
Highway Catchment 1	Soluble and sediment	Individual outfall	Point A
Highway Catchment 2	Soluble and sediment	Individual outfall	Point A
Highway Catchment 3	Soluble and sediment	Individual outfall	Point A
Highway Catchment 2 Highway Catchment 3	Sediment	Cumulative discharges	Point A
Highway Catchment 1 Highway Catchment 2 Highway Catchment 3	Soluble	Cumulative discharges	Point A
Highway Catchment 4	Soluble and sediment	Individual outfall	Point B
Highway Catchment 5	Soluble and sediment	Individual outfall	Point B
Highway Catchment 6	Soluble and sediment	Individual outfall	Point B

[1] Wallingford Hydrosolutions, Low Flows 2 software. Available at https://www.hydrosolutions.co.uk/software/lowflows2/ [Accessed 31-03-2023]

Highway Catchment 7	Soluble and sediment	Individual outfall	Point B
Highway Catchment 8	Soluble and sediment	Cumulative discharges	Point C
Highway Catchment 9	Soluble and sediment	Cumulative discharges	Point C
Highway Catchment 4 Highway Catchment 5 Highway Catchment 6 Highway Catchment 7 Highway Catchment 8 Highway Catchment 9	Sediment	Cumulative discharges	Point B & C
Highway Catchment 4 Highway Catchment 5 Highway Catchment 6 Highway Catchment 7 Highway Catchment 8 Highway Catchment 9	Soluble	Cumulative discharges	Point C
Highway Catchment 10	Groundwater Assessment	Infiltration Basin - see section 5	

3.4 HEWRAT Assessments Outputs

HEWRAT outputs are provided in Appendix 1 and summarised in Table 3-3.

Table 3-3 HEWRAT Assessment Summary

	Soluble Pollution				Sediment	Comment
	Acute Impact (Runoff Specific Thresholds)		Chronic Impact (Annual Ave. Concentration)			
	Copper	Zinc	Copper	Zinc	Chronic Impact	
Highway Catchment 1, Point A						
Without mitigation	Pass	Pass	Pass	Pass	Fail	64% settlement of sediments required to pass
With mitigation	Pass	Pass	Pass	Pass	Pass	proposed sedimentation pond with a forebay and ditch to the outfall.
Highway Catchment 2, Point A						
Step 2 (Tier 2)	Pass	Pass	Pass	Pass	Fail	38% settlement of sediments required to pass

	Soluble Pollution				Sediment	Comment
	Acute Impact (Runoff Specific Thresholds)		Chronic Impact (Annual Ave. Concentration)			
	Copper	Zinc	Copper	Zinc	Chronic Impact	
Step 3	Pass	Pass	Pass	Pass	Pass	Proposed swale, carrier ditches, and grit separator
Highway Catchment 3, Point A						
Step 2 (Tier 2)	Pass	Pass	Pass	Pass	Fail	58% settlement of sediments required to pass
Step 3	Pass	Pass	Pass	Pass	Pass	Proposed swale, sedimentation pond, carrier ditches, and grit separator
Cumulative assessment (sediment): Catchment 1 Catchment 2, Catchment 3, Point A						
Step 2 (Tier 2)	Pass	Pass	Pass	Pass	Fail	75% settlement of sediments required to pass
Step 3	Pass	Pass	Pass	Pass	Pass	Proposed swale, carrier ditches, and grit separator for Catchment 2 and 3
Cumulative assessment(soluble): Catchment 1 Catchment 2, Catchment 3, Point A						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 4, Point B						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 5, Point B						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 6, Point B						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 7, Point B						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 8, Point B						

	Soluble Pollution				Sediment	Comment
	Acute Impact (Runoff Specific Thresholds)		Chronic Impact (Annual Ave. Concentration)			
	Copper	Zinc	Copper	Zinc	Chronic Impact	
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Highway Catchment 9, Point B						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Cumulative assessment (sediment): Highway Catchments 4, 5, 6, 7, 8 and 9, Point B and C						
Step 2 (Tier 1)	Pass	Pass	Pass	Pass	Pass	-
Step 2 (Tier 2)	Pass	Pass	Pass	Pass	Pass	-

Table 3-3 shows failure of sediment-bound pollutants at discharge point A. However, once the proposed mitigation measures are included, the assessments pass. The mitigation measures included in the drainage design are swales, ponds, and vortex separators.

4. SPILLAGE ASSESSMENT

4.1 Spillage Risk Assessment

Along a road there is always some risk of a vehicular collision that could result in the spillage of fuels, chemicals or other hazardous liquids, particularly if tankers and heavy goods vehicles (HGVs) are involved. A risk assessment of a serious spillage causing a pollution incident was undertaken using the methodology outlined in LA113.

The risk is calculated assuming that an accident involving spillage of pollutants onto the carriageway would occur at an assumed frequency (expressed as an annual probability), based on calculated traffic volumes and the type of road/junction. The annual probability of a serious accidental spillage also depends upon the emergency services response time, based on the location (i.e., urban, rural, or remote location).

Where spillage risk is calculated as less than 1% Annual Exceedance Probability (AEP) (less frequent than 1 in 100 years), the risk is regarded as acceptably low, and no mitigation is required. Where the risk is greater than 1% AEP, mitigation is required. Such mitigation would allow the drainage system to be shut off before the liquid reaches the discharge point.

Similar to the routine runoff assessment, a cumulative spillage risk assessment is undertaken where more than one outfall discharges into the same reach of watercourse (or groundwater body). To aggregate the assessments, the total length of road drained (split into each road/junction type) is combined for all outfalls and the highest AADT and %HGV values are taken for each road/junction type.

The spillage risk assessment results are detailed in Appendix 1 and summarised in Table 4-1.

Table 4-1 Spillage Risk Assessment Results

Asset Reference	Length of Side Road (m)	Length of Roundabout (m)	Length of 'A' Road (m)	Risk of Incident	Pass/ Fail
Point A (catchments 1,2 & 3)	315	485	1155	0.03%	Pass
Point B (catchments 4,5,6 & 7)	530	360	2336	0.03%	Pass
Point C (catchments 8 & 9)	824	196	3339	0.04%	Pass
Catchment 10	573	225	1145	0.02%	Pass

The spillage risk assessment considers the length and type of road. Different risk factors apply depending on the type of road, for example a roundabout has a higher risk factor than a straight road. The summarise table above shows the outcome of the assessment at the discharge points. All the assessments pass as the risk is below 1%, no mitigation measures are required.

5. GROUNDWATER ASSESSMENT

5.1 Catchment 10

5.1.1 Ground Investigation

The ground investigation describes the geology in the area of the proposed infiltration basin. No borehole logs were available within the extent of the proposed basin footprint; however, logs were available adjacent to it and nearby(<100m) The three closest borehole logs were selected, each within the limestone bedrock. These logs comprise rotary core boreholes RC125, RC126, and RC215. The borehole depths extended to a maximum of 10metres below ground level (mbgl) and are situated in a similar area of elevation at approximately 67.0 mAOD to 67.5 mAOD according to OS LiDAR data.

The available logs are summarised in Table 5-1.

Table 5-1: Borehole log summary

Strata Description	Range of depth to base (m)
Grass over TOPSOIL	0.05
SAND. Clayey fine to coarse sand, some angular gravel (limestone)	0.4-1.2
Weak sandy LIMESTONE and GRAVEL. Sand is course to fine.	1.6-2.1
Moderately weak weathered LIMESTONE with horizontal discontinuities, limestone COBBLES	2.2-2.5
Medium strong LIMESTONE with sub horizontal discontinuities. Some clay and gravel infill.	5.9-7.4
Extremely weak MUDSTONE with horizontal and sub horizontal discontinuities	Unproven (>10)

From boreholes: RC125, RC126, RC215

The borehole logs confirm the presence of limestone that ranged between 1.2 to 7.4 mbgl. Fractures and fissures were not indicated in the limestone and discontinuities were mainly horizontal and subhorizontal. Groundwater was not encountered in any of the boreholes (which extended to depths of 10.0 mbgl). However, groundwater monitoring conducted for the Lincolnshire Eastern Bypass scheme, east of Catchment, identified groundwater strikes of 59.08 mAOD (5m bgl) at borehole BH652 and 60.67 mAOD (4m bgl) rising to 61.67 (3 mbgl) at borehole A48, less than 150m from the proposed infiltration basin.

No soil organic carbon data was available at the time of writing, but the GI Results have indicated loamy topsoil in the upper stratum. Additionally, no pH data was available. BGS soil data indicates lime-rich soils, which are typically alkaline, therefore a pH greater than 8 is assumed for the assessment below.

5.1.2 Groundwater Risk Assessment

At the eastern end of the scheme, Catchment 10 will discharge to an infiltration basin. A simple assessment has been made of the risk to groundwater based on the methodology described in

Appendix C of LA 113. A level of risk is assigned to each parameter (1,2,3) which his multiplied by the weighting factor of the parameter, providing a risk score. The process is carried out for each parameter and the scores are summed to provide an overall risk score. The lowest possible score is 100 and the highest is 300. The score bands for determining risk are as follows:

1. <150 low risk
2. 150-250 medium risk
3. >250 high risk

The assessment is detailed in Table 5-2. Total scores above 150 necessitate further assessment per Section 3 of DMRB LA 113.

Table 5-2 Groundwater Risk Assessment

Parameter	Weighting Factor	Score for Catchment 6 Infiltration basin	Reason for selected score	Weighting factor × score
Traffic Flow	10	1	<50,000 AADT band. Expected max AADT value approximately 32,120 AADT	10
Rainfall Depth (annual average)	10	1	<740mm band. Actual value 600mm from the SAAR (standard average annual rainfall) value for Lincoln in the catchment descriptors.	10
Drainage area ratio	10	1	<50 band. Infiltration area of basin approximately 0.5 ha (5000m^2). Catchment area 48,776m^2. Actual drainage area ratio 1:9.35. The size of the basin is subject to confirmation following the GI, but any change to the basin size is unlikely to result in a change of the <50 ratio band.	10
Infiltration method	15	2	Region method. Infiltration basin to be used.	30
Unsaturated zone	20	2	Depth to water table <15m to >5m approximated average. Based on the borehole data from the NHRR scheme, 500m west, no water was struck <10m However, borehole records from the adjacent Lincolnshire Eastern Bypass Scheme show groundwater at <5mbl.	40
Flow type	20	2	Sandy/gravelly clay overlaying limestone bedrock, however with no fractures or fissures observed. Assumed mixed fracture and intergranular flow.	40
Unsaturated zone clay content	5	1	>=15% clay minerals band selected. GI results indicate clay strata overlaying limestone with clay layers.	5
Organic carbon	5	2	Band selected is <15% to >1% soil organic matter. GI Results suggest loamy topsoil.	10
Unsaturated zone soil pH	5	1	BGS soil data indicates lime-rich soils[2], therefore pH >=8 is assumed.	5
			Total Score	**160**

[2] UK Soil Observatory, online https://mapapps2.bgs.ac.uk/ukso/home.html?layer=mySoil [Accessed March 2023]

The score of 160 indicates a 'medium' risk which, in line with LA113, warrants further assessment of the parameter(s) contributing most to the risk in terms of the source-pathway-receptor linkage. In this case the greatest contributing factor to the risk is groundwater flow being through mixed fracture and intergranular flow through weak limestone which could provide a potential pathway for soluble contaminants in the road runoff to reach the groundwater and groundwater abstraction points. In addition, an estimated unsaturated zone between 5 mbgl and 15 mbgl, which is estimated based on conflicting groundwater levels observed in the area of the proposed infiltration basin and east of the proposed infiltration basin, reduces the likelihood of contaminants being adsorbed and attenuated due to a more limited time and distance passing through the unsaturated zone.

The infiltration basin is also located within the outer extent of an outer groundwater source protection zone (SPZ2). This zone is defined by the Environment Agency as having a 400-day travel time from a point below the water table. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants. The associated SPZ1 is located 5.3km north-east of the proposed infiltration basin. Additionally, there are no active licenced groundwater abstractions or historical licenced groundwater abstractions used for drinking water identified within at least 1km according to the Insight report supplied by Groundsure.

Importantly, mitigation is embedded into the drainage design based on the results set out by water quality assessment document. Highway runoff is to be intercepted by grass surface water channels at the edge of the carriageway and conveyed by carrier drain to a lined sediment forebay equating to approximately 10% of the volume of the infiltration basin, which is based on minimum sizing provided in the SuDS Manual (CIRIA C753). Additionally, a pollution control valve (isolation penstock) is proposed for infiltration basins, at the outlet from the sediment forebay, upstream of the infiltration basin. As detailed in section 4, the risk of a spillage in catchment 10 is acceptably low. Nonetheless, the penstock will allow isolation of the drainage system in the event of a spillage should there be one.

The groundwater assessment total score of 160 represents the low end of medium risk, where low risk is less than 150. Therefore, considering the embedded mitigation in the design the risk to the groundwater environment is considered acceptably low.

6. CONCLUSION

Water quality risk assessments have been undertaken for the operational phase of the proposed North Hykeham Relief Road. The assessment includes surface water quality, spillage risk and groundwater risk.

Based on the alignment design and the locations of the natural watercourses, three assessment points were identified. Ten catchment areas have been determined and these catchments discharge to their associated assessment points.

The routine runoff assessments for impacts on water quality were undertaken using the HEWRAT assessment tool. The highway catchment 1, and catchment 2 and catchment 3 discharge to a tributary of the Beck watercourse. Without mitigation, the assessments fail due to excessive sediment. Cumulative mitigation measures of 75% is required to pass the assessment. This will be achieved by treatment measures including swales within the road verge, ditches and vortex chambers adjacent to the carriageway. Applying the treatment efficiencies given in DMRB CG501, these mitigation measures are sufficient to sufficiently reduce the amount of highway-derived sediment reaching the receiving watercourse.

Assessment point B is the discharge point to River Witham, which has contributing highway catchments from areas 4, 5, 6, 7, 8 and 9. The water quality assessment (using HEWRAT) and it passed individually and cumulatively.

A risk assessment of a serious spillage causing a pollution incident was undertaken using the methodology outlined in LA113. All assessment points passed, with the spillage risk calculated as less than 1%.

Catchment 10 is proposed to discharge to the ground via an infiltration basin. The location of the infiltration is based within a SPZ2. A risk assessment was undertaken using estimated values and scored 160 which indicated a medium risk. In accordance with LA113, further consideration of the risk was undertaken. The mitigation incorporated into the design includes grass-lined surface water channels, a sediment forebay for the infiltration basin and inclusion of a penstock to enable isolation of the drainage system in the event of a spillage. With this mitigation incorporated into the design the risk to groundwater quality is considered to be acceptably low.

APPENDIX 1
HEWRAT ASSESSMENT EXTRACTS

Highway Catchment 1

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.23	1.00	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Fail. 64 % settlement needed.

Settlement needed = 64 %, proposed = 0 %

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.03	Low flow Vel m/s
Extensive?	Yes	271	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary Leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	20-05-2024		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002
Impermeable road area drained (ha)	1.839
Permeable area draining to outfall (ha)	0.414
Base Flow Index (BFI)	0.26

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 1
- Tier 2 — Bed width (m): 1; Manning's n: 0.07; Side slope (m/m): 0.71; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		0	No restriction	0

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Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.23	1.00	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.03	Low flow Vel m/s
Extensive?	No	98	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2 &3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary Leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	20-05-2024		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002
Impermeable road area drained (ha)	1.839
Permeable area draining to outfall (ha)	0.414
Base Flow Index (BFI)	0.26

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 1
- Tier 2 — Bed width (m): 1; Manning's n: 0.07; Side slope (m/m): 0.71; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures	64% Treatment required (Pond+ ditch) is 82% mitigation	0	No restriction	64

Highway Catchment 2

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Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.17	0.71	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Fail. 38 % settlement needed.

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	Yes	161	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002		Freshwater EQS limits:	
Impermeable road area drained (ha)	1.21		Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	0.653		Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only Water hardness	High = >200mg CaCO3/l		**For dissolved copper only** Ambient background concentration (µg/l)	0 D
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?				No D
Tier 1 Estimated river width (m)	5			
Tier 2 Bed width (m)	1	Manning's n 0.03	Side slope (m/m) 0.71	Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

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Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.17	0.71	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	No	64	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002		Freshwater EQS limits:	
Impermeable road area drained (ha)	1.21		Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	0.653		Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only Water hardness	High = >200mg CaCO3/l		**For dissolved copper only** Ambient background concentration (µg/l)	0 D
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?				No D
Tier 1 Estimated river width (m)	5			
Tier 2 Bed width (m)	1	Manning's n 0.03	Side slope (m/m) 0.71	Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures	38% Treatment Required (Pond+Ditch) is 60 mitigation	0 D	No restriction D	60

Highway Catchment 3

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Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.22	0.96	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Fail. 58 % settlement needed.

Settlement needed = 58 %, proposed = 0 %

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	Yes	234	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002
Impermeable road area drained (ha)	1.754
Permeable area draining to outfall (ha)	0.688
Base Flow Index (BFI)	0.26

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

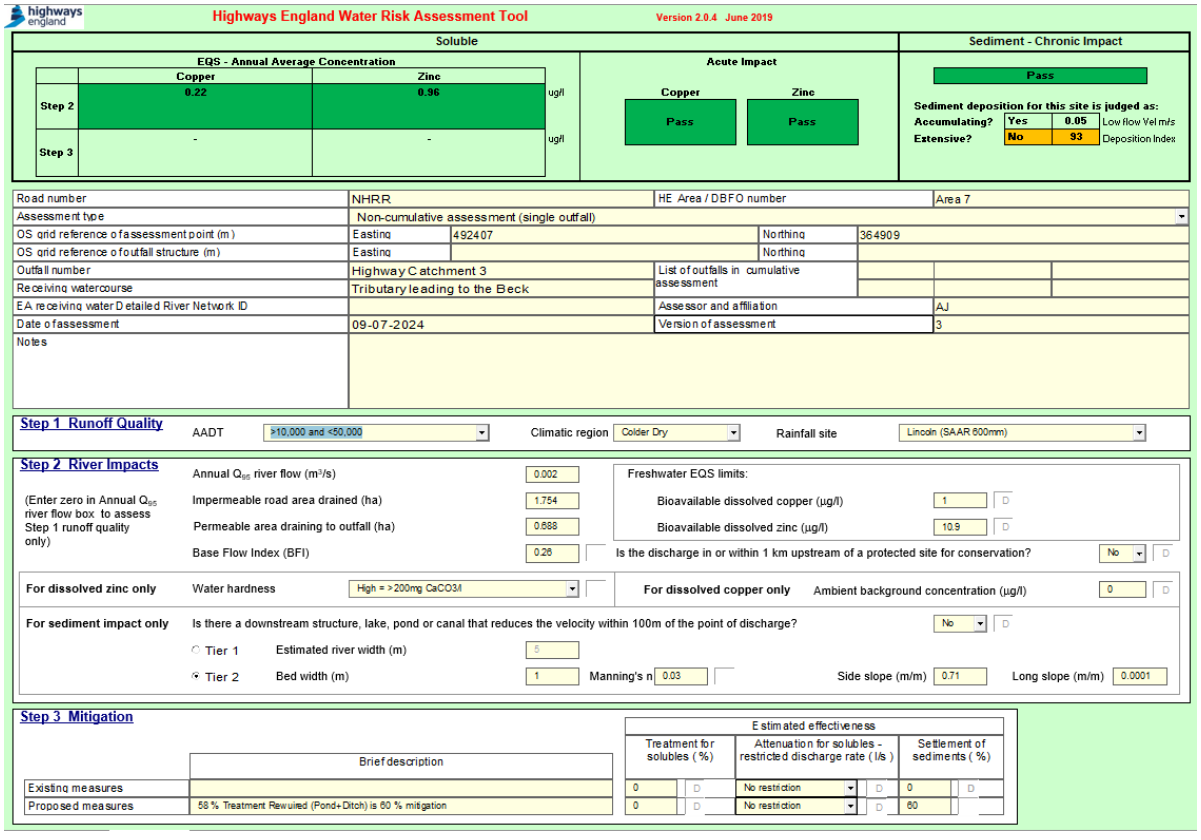
For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 5

Tier 2 — Bed width (m): 1 | Manning's n: 0.03 | Side slope (m/m): 0.71 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		0	No restriction	0



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Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.22	0.96	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	No	93	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002
Impermeable road area drained (ha)	1.754
Permeable area draining to outfall (ha)	0.688
Base Flow Index (BFI)	0.26

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

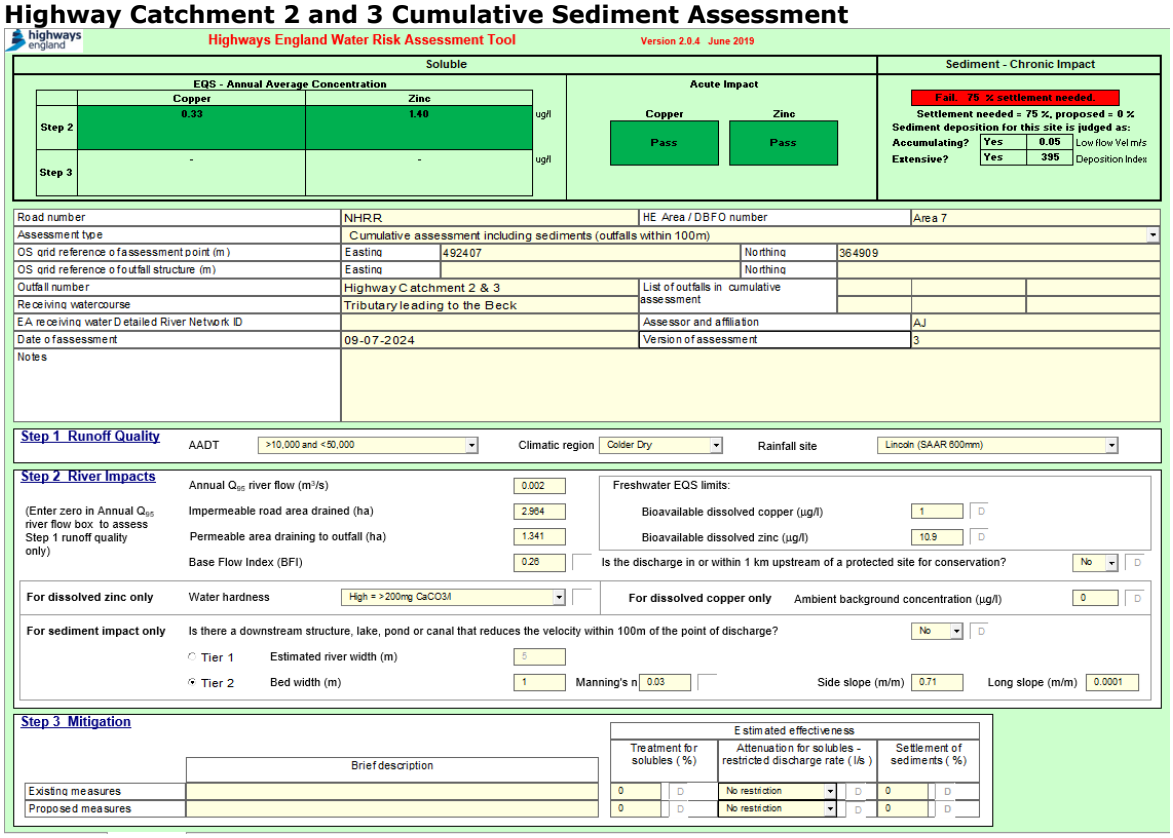
Tier 1 — Estimated river width (m): 5

Tier 2 — Bed width (m): 1 | Manning's n: 0.03 | Side slope (m/m): 0.71 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures	58 % Treatment Rewilled (Pond+Ditch) is 60 % mitigation	0	No restriction	60

Highway Catchment 2 and 3 Cumulative Sediment Assessment



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Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.33	1.40	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Fail. 75 % settlement needed.

Settlement needed = 75 %, proposed = 0 %

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	Yes	395	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2 & 3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002		
Impermeable road area drained (ha)	2.964		
Permeable area draining to outfall (ha)	1.341		
Base Flow Index (BFI)	0.26		

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1	D
Bioavailable dissolved zinc (µg/l)	10.9	D

Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (µg/l): 0 D

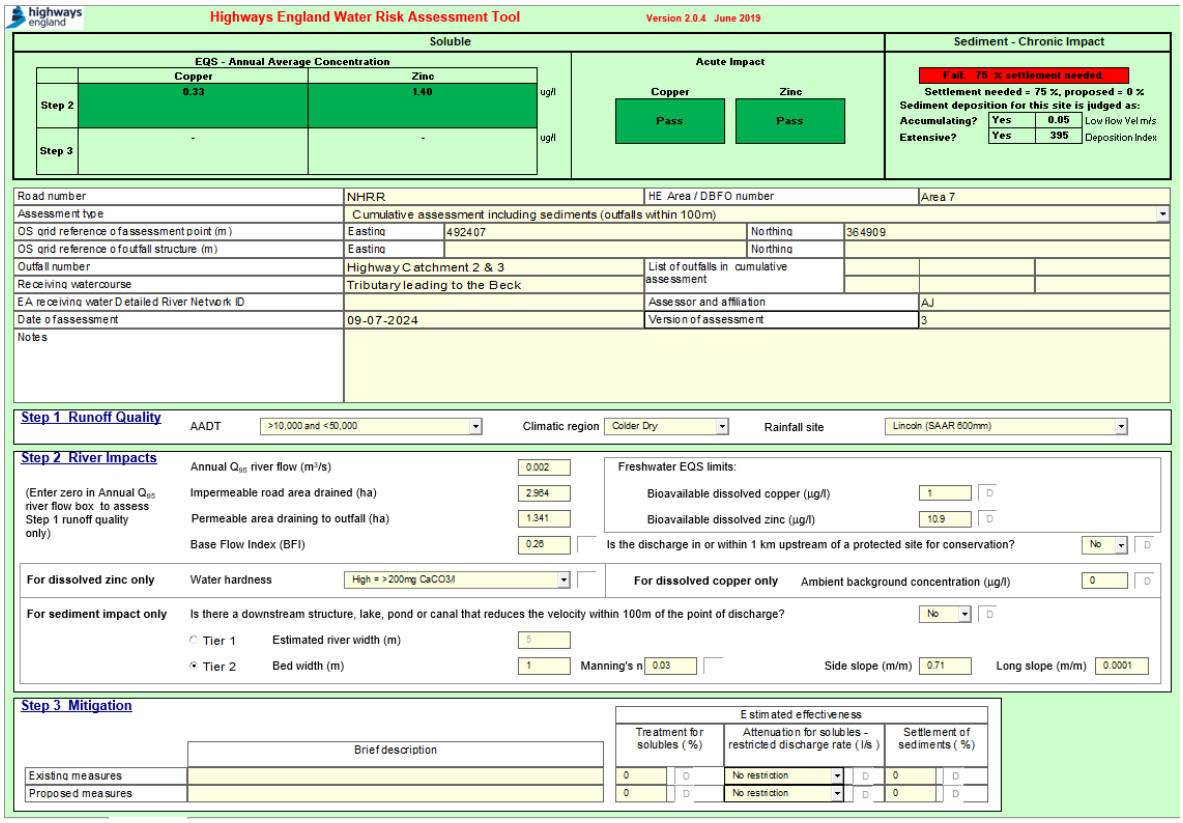
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m): 5

Tier 2 Bed width (m): 1 Manning's n: 0.03 Side slope (m/m): 0.71 Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D



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Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.33	1.40	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Fail. 75 % settlement needed.

Settlement needed = 75 %, proposed = 0 %

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.05	Low flow Vel m/s
Extensive?	Yes	395	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 2 & 3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	09-07-2024		Version of assessment	3	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002		
Impermeable road area drained (ha)	2.964		
Permeable area draining to outfall (ha)	1.341		
Base Flow Index (BFI)	0.26		

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1	D
Bioavailable dissolved zinc (µg/l)	10.9	D

Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (µg/l): 0 D

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

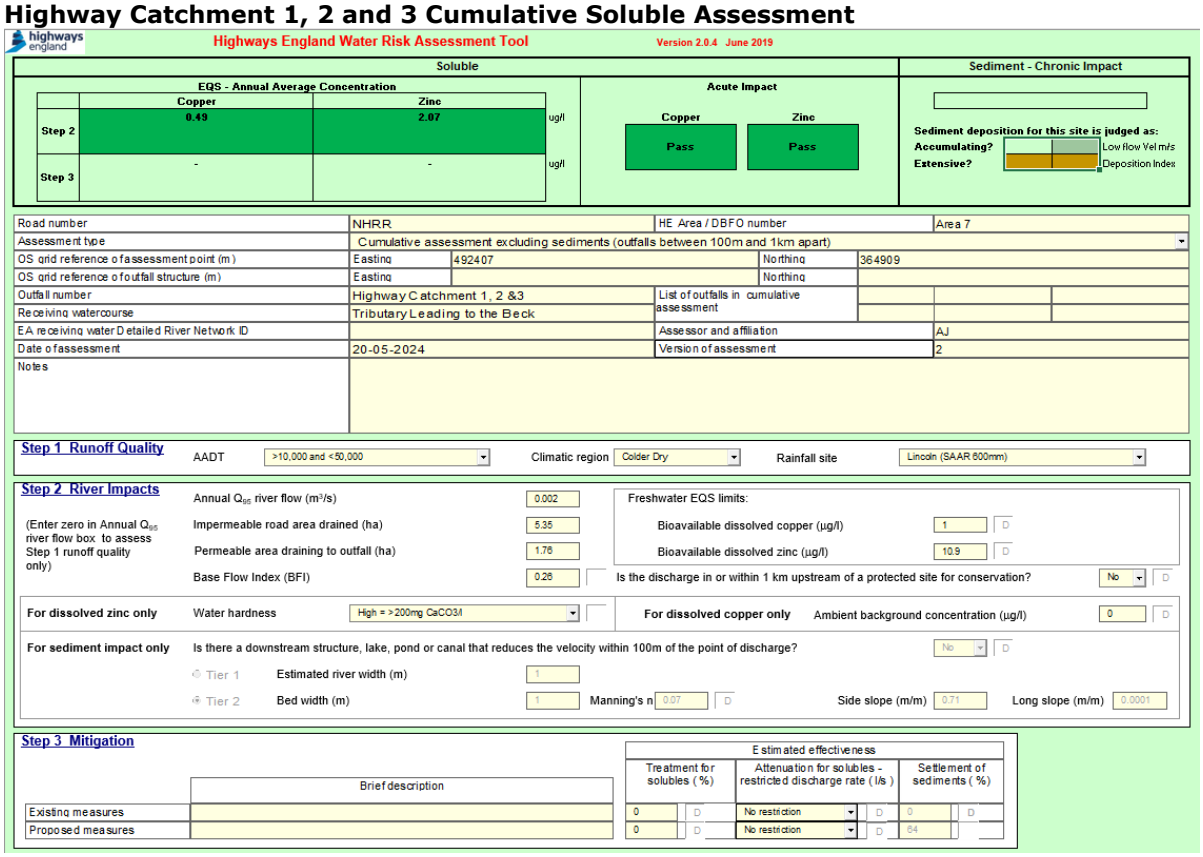
Tier 1 Estimated river width (m): 5

Tier 2 Bed width (m): 1 Manning's n: 0.03 Side slope (m/m): 0.71 Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Highway Catchment 1, 2 and 3 Cumulative Soluble Assessment



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Soluble				Sediment - Chronic Impact
EQS - Annual Average Concentration			Acute Impact	
	Copper	Zinc		
Step 2	0.49	2.07 ug/l	Copper: Pass	Sediment deposition for this site is judged as:
Step 3	-	- ug/l	Zinc: Pass	Accumulating? Low flow Vel m/s
				Extensive? Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Cumulative assessment excluding sediments (outfalls between 100m and 1km apart)				
OS grid reference of assessment point (m)	Easting	492407	Northing	364909	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 1, 2 &3		List of outfalls in cumulative assessment		
Receiving watercourse	Tributary Leading to the Beck				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	20-05-2024		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.002	Freshwater EQS limits:	
Impermeable road area drained (ha)	5.35	Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	1.76	Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26	Is the discharge in or within 1 km upstream of a protected site for conservation?	No D

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0 D

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

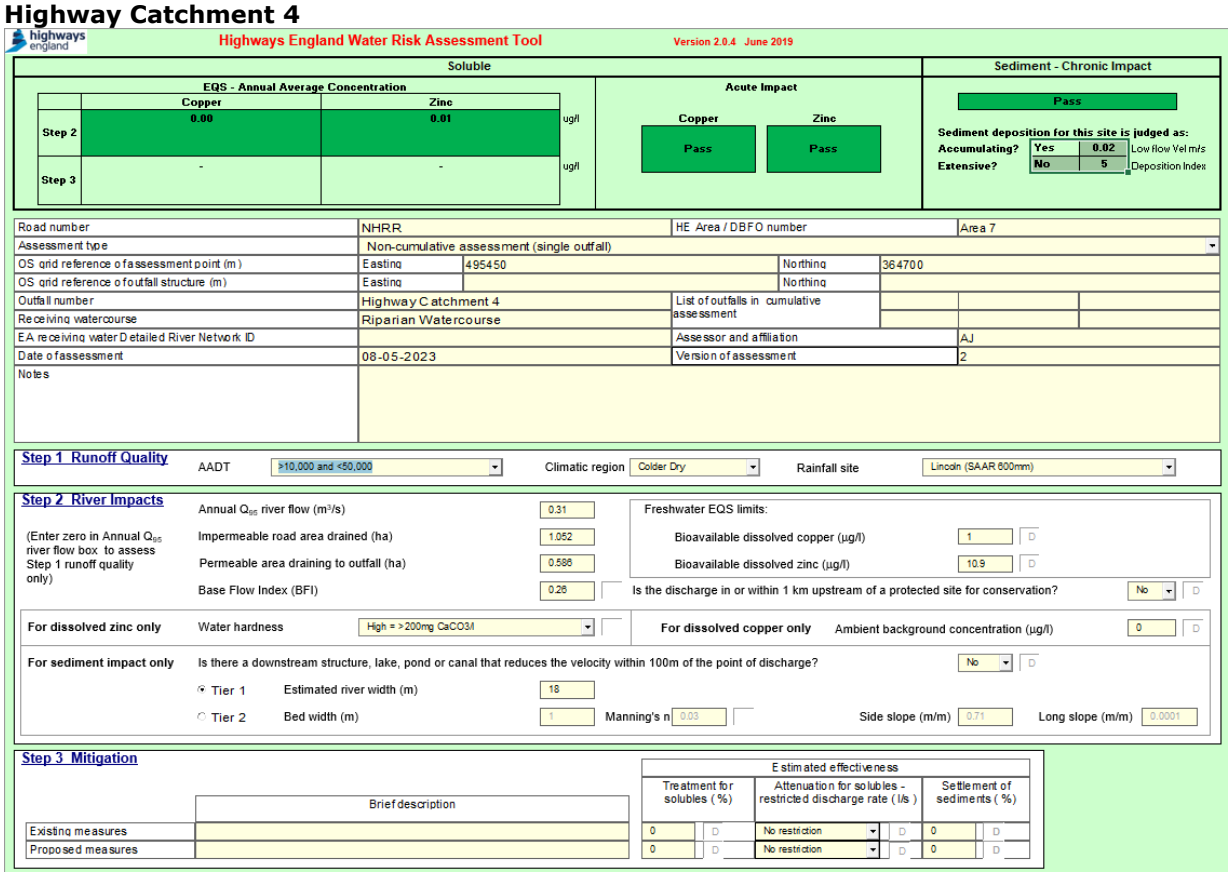
Tier 1 — Estimated river width (m): 1

Tier 2 — Bed width (m): 1 — Manning's n: 0.07 D — Side slope (m/m): 0.71 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	64

Highway Catchment 4



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Soluble				Sediment - Chronic Impact
EQS - Annual Average Concentration			Acute Impact	Pass
	Copper	Zinc		
Step 2	0.00	0.01 ug/l	Copper: Pass	Sediment deposition for this site is judged as:
Step 3	-	- ug/l	Zinc: Pass	Accumulating? Yes 0.02 Low flow Vel m/s
				Extensive? No 5 Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	495450	Northing	364700	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 4		List of outfalls in cumulative assessment		
Receiving watercourse	Riparian Watercourse				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	08-05-2023		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31	Freshwater EQS limits:	
Impermeable road area drained (ha)	1.052	Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	0.586	Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26	Is the discharge in or within 1 km upstream of a protected site for conservation?	No D

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0 D

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 — Estimated river width (m): 18

Tier 2 — Bed width (m): 1 — Manning's n: 0.03 — Side slope (m/m): 0.71 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Highway Catchment 5

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Soluble				Sediment - Chronic Impact
EQS - Annual Average Concentration			Acute Impact	
	Copper	Zinc	Copper / Zinc	Pass
Step 2	0.00	0.00 ug/l	Pass / Pass	Sediment deposition for this site is judged as:
Step 3	-	- ug/l		Accumulating? Yes 0.02 Low flow Vel m/s
				Extensive? No 4 Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	495450	Northing	364700	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 5		List of outfalls in cumulative assessment		
Receiving watercourse	Riparian Watercourse				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	08-05-2023		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31		Freshwater EQS limits:	
Impermeable road area drained (ha)	0.9		Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	0.286		Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only Water hardness	High = >200mg CaCO3/l		**For dissolved copper only** Ambient background concentration (µg/l)	0 D
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?				No D
Tier 1 Estimated river width (m)	18			
Tier 2 Bed width (m)	1	Manning's n 0.03	Side slope (m/m) 0.71	Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Highway Catchment 6

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble				Sediment - Chronic Impact
EQS - Annual Average Concentration			Acute Impact	
	Copper	Zinc	Copper / Zinc	Pass
Step 2	0.00	0.01 ug/l	Pass / Pass	Sediment deposition for this site is judged as:
Step 3	-	- ug/l		Accumulating? Yes 0.02 Low flow Vel m/s
				Extensive? No 15 Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	495450	Northing	364700	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 6		List of outfalls in cumulative assessment		
Receiving watercourse	Riparian Watercourse				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	08-05-2023		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31		Freshwater EQS limits:	
Impermeable road area drained (ha)	3.049		Bioavailable dissolved copper (µg/l)	1 D
Permeable area draining to outfall (ha)	1.436		Bioavailable dissolved zinc (µg/l)	10.9 D
Base Flow Index (BFI)	0.26		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only Water hardness	High = >200mg CaCO3/l		**For dissolved copper only** Ambient background concentration (µg/l)	0 D
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?				No D
Tier 1 Estimated river width (m)	18			
Tier 2 Bed width (m)	1	Manning's n 0.03	Side slope (m/m) 0.71	Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Highway Catchment 7

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble				Acute Impact		Sediment - Chronic Impact	
EQS - Annual Average Concentration	Copper	Zinc		Copper	Zinc	Pass	
Step 2	0.00	0.01	ug/l	Pass	Pass	Sediment deposition for this site is judged as:	
Step 3	-	-	ug/l			Accumulating? Yes 0.02 Low flow Vel m/s	
						Extensive? No 10 Deposition Index	

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	495450	Northing	364700	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 7		List of outfalls in cumulative assessment		
Receiving watercourse	Riparian Watercourse				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	08-05-2023		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31	Freshwater EQS limits:	
Impermeable road area drained (ha)	2.155	Bioavailable dissolved copper (µg/l)	1
Permeable area draining to outfall (ha)	0.892	Bioavailable dissolved zinc (µg/l)	10.9
Base Flow Index (BFI)	0.26	Is the discharge in or within 1 km upstream of a protected site for conservation?	No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 18
- Tier 2 — Bed width (m): 1 | Manning's n: 0.03 | Side slope (m/m): 0.71 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		0	No restriction	0

Highway catchment 8

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble				Acute Impact		Sediment - Chronic Impact	
EQS - Annual Average Concentration	Copper	Zinc		Copper	Zinc	Pass	
Step 2	0.00	0.01	ug/l	Pass	Pass	Sediment deposition for this site is judged as:	
Step 3	-	-	ug/l			Accumulating? Yes 0.02 Low flow Vel m/s	
						Extensive? No 14 Deposition Index	

Road number	NHRR		HE Area / DBFO number	Area 7	
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	495450	Northing	364700	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	Highway Catchment 8		List of outfalls in cumulative assessment		
Receiving watercourse	Riparian Watercourse				
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ	
Date of assessment	08-05-2023		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31	Freshwater EQS limits:	
Impermeable road area drained (ha)	2.882	Bioavailable dissolved copper (µg/l)	1
Permeable area draining to outfall (ha)	1.459	Bioavailable dissolved zinc (µg/l)	10.9
Base Flow Index (BFI)	0.26	Is the discharge in or within 1 km upstream of a protected site for conservation?	No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 18
- Tier 2 — Bed width (m): 1 | Manning's n: 0.03 | Side slope (m/m): 0.71 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		0	No restriction	0

Highway catchment 9

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.01	0.03	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.02	Low flow Vel m/s
Extensive?	No	34	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7
Assessment type	Non-cumulative assessment (single outfall)			
OS grid reference of assessment point (m)	Easting	495450	Northing	364700
OS grid reference of outfall structure (m)	Easting		Northing	
Outfall number	Highway Catchment 8		List of outfalls in cumulative assessment	
Receiving watercourse	Riparian Watercourse			
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ
Date of assessment	08-05-2023		Version of assessment	2
Notes				

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31		
Impermeable road area drained (ha)	6.92	Freshwater EQS limits:	
Permeable area draining to outfall (ha)	1.812	Bioavailable dissolved copper (µg/l)	1 D
Base Flow Index (BFI)	0.26	Bioavailable dissolved zinc (µg/l)	10.9 D
		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only: Water hardness	High = >200mg CaCO3/l	For dissolved copper only: Ambient background concentration (µg/l)	0 D
For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?			No D
Tier 1: Estimated river width (m)	18		
Tier 2: Bed width (m)	1	Manning's n: 0.03	Side slope (m/m): 0.71 Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Highway Catchment 4, 5, 6, 7, 8 and 9 Cumulative Sediment Assessment

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.02	0.08	ug/l
Step 3	-	-	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.02	Low flow Vel m/s
Extensive?	No	82	Deposition Index

Road number	NHRR		HE Area / DBFO number	Area 7
Assessment type	Cumulative assessment including sediments (outfalls within 100m)			
OS grid reference of assessment point (m)	Easting	495450	Northing	364700
OS grid reference of outfall structure (m)	Easting		Northing	
Outfall number	Highway catchments 4,5,6,7,8,9		List of outfalls in cumulative assessment	
Receiving watercourse	Riparian Watercourse			
EA receiving water Detailed River Network ID			Assessor and affiliation	AJ
Date of assessment	08-05-2023		Version of assessment	2
Notes				

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.31		
Impermeable road area drained (ha)	16.958	Freshwater EQS limits:	
Permeable area draining to outfall (ha)	6.471	Bioavailable dissolved copper (µg/l)	1 D
Base Flow Index (BFI)	0.26	Bioavailable dissolved zinc (µg/l)	10.9 D
		Is the discharge in or within 1 km upstream of a protected site for conservation?	No D
For dissolved zinc only: Water hardness	High = >200mg CaCO3/l	For dissolved copper only: Ambient background concentration (µg/l)	0 D
For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?			No D
Tier 1: Estimated river width (m)	18		
Tier 2: Bed width (m)	3	Manning's n: 0.07	Side slope (m/m): 0.5 Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	No restriction D	0 D
Proposed measures		0 D	No restriction D	0 D

Spillage Assessment

Spillage assessment Point A

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View Parameters | Reset Spillage Risk | Go To Interface

Assessment of Priority Outfalls

Method D - assessment of risk from accidental spillage

		A (main road)	Additional columns for use if other roads drain to the same outfall: B	C	D	E	F	Totals	Return Period (years)
D1	Water body type	Surface watercourse	Surface watercourse	Surface watercourse	Surface watercourse				
D2	Length of road draining to outfall *(m)*	1,155	355	130	315				
D3	Road Type *(A-road or Motorway)*	A	A	A	A				
D4	If A road, is site urban or rural?	Rural	Rural	Rural	Rural				
D5	Junction type	No junction	Roundabout	Roundabout	Slip road				
D6	Location (response time for emergency services)	< 20 minutes	< 20 minutes	< 20 minutes	< 20 minutes				
D7	Traffic flow (AADT two way)	32,323	32,323	32,323	3,625				
D8	% HGV	3.43	3.43	3.43	1.12				
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.29	3.09	3.09	0.93				
D9	Risk of accidental spillage	0.00014	0.00044	0.00016	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45	0.45	0.45				
D11	Risk of pollution incident	0.00006	0.00020	0.00007	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**	**No**	**No**			**Totals**	**Return Period (years)**
D13	Return period without pollution reduction measures	0.00006	0.00020	0.00007	0.00000	0.00000	0.00000	0.0003	2977
D14	Existing measures factor	1	1	1	1				
D15	Return period with existing pollution reduction measures	0.00006	0.00020	0.00007	0.00000	0.00000	0.00000	0.0003	2977
D16	Proposed measures factor	1	1	1	1				
D17	Residual with proposed Pollution reduction measures	0.00006	0.00020	0.00007	0.00000	0.00000	0.00000	0.0003	2977

Spillage assessment Point B (catchment 4, 5, 6 and 7)

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View Parameters | Reset Spillage Risk | Go To Interface

Assessment of Priority Outfalls

Method D - assessment of risk from accidental spillage

		A (main road)	Additional columns for use if other roads drain to the same outfall: B	C	D	E	F	Totals	Return Period (years)
D1	Water body type	Surface watercourse	Surface watercourse	Surface watercourse					
D2	Length of road draining to outfall *(m)*	2,336	360	530					
D3	Road Type *(A-road or Motorway)*	A	A	A					
D4	If A road, is site urban or rural?	Rural	Rural	Rural					
D5	Junction type	No junction	Roundabout	Side road					
D6	Location (response time for emergency services)	< 20 minutes	< 20 minutes	< 20 minutes					
D7	Traffic flow (AADT two way)	36,798	36,798	3,625					
D8	% HGV	2.32	2.32	1.12					
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.29	3.09	0.93					
D9	Risk of accidental spillage	0.00021	0.00035	0.00001	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45	0.45					
D11	Risk of pollution incident	0.00009	0.00016	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**	**No**				**Totals**	**Return Period (years)**
D13	Return period without pollution reduction measures	0.00009	0.00016	0.00000	0.00000	0.00000	0.00000	0.0003	3933
D14	Existing measures factor	1	1	1					
D15	Return period with existing pollution reduction measures	0.00009	0.00016	0.00000	0.00000	0.00000	0.00000	0.0003	3933
D16	Proposed measures factor	1	1	1					
D17	Residual with proposed Pollution reduction measures	0.00009	0.00016	0.00000	0.00000	0.00000	0.00000	0.0003	3933

Spillage assessment Point C (Catchment 8 and 9)

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View Parameters | Reset Spillage Risk | Go To Interface

Assessment of Priority Outfalls

Method D - assessment of risk from accidental spillage

		A (main road)	Additional columns for use if other roads drain to the same outfall: B	C	D	E	F	Totals	Return Period (years)
D1	Water body type	Surface watercourse	Surface watercourse	Surface watercourse					
D2	Length of road draining to outfall *(m)*	3,339	196	824					
D3	Road Type *(A-road or Motorway)*	A	A	A					
D4	If A road, is site urban or rural?	Urban	Rural	Rural					
D5	Junction type	No junction	Roundabout	Side road					
D6	Location (response time for emergency services)	< 20 minutes	< 20 minutes	< 20 minutes					
D7	Traffic flow (AADT two way)	49,121	49,121	6,727					
D8	% HGV	2.68	2.68	1.96					
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.29	3.09	0.93					
D9	Risk of accidental spillage	0.00047	0.00029	0.00004	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45	0.45					
D11	Risk of pollution incident	0.00021	0.00013	0.00002	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**	**No**				**Totals**	**Return Period (years)**
D13	Return period without pollution reduction measures	0.00021	0.00013	0.00002	0.00000	0.00000	0.00000	0.0004	2802
D14	Existing measures factor	1	1	1					
D15	Return period with existing pollution reduction measures	0.00021	0.00013	0.00002	0.00000	0.00000	0.00000	0.0004	2802
D16	Proposed measures factor	1	1	1					
D17	Residual with proposed Pollution reduction measures	0.00021	0.00013	0.00002	0.00000	0.00000	0.00000	0.0004	2802

Spillage assessment Catchment 10

highways england

View Parameters | Reset Spillage Risk | Go To Interface

Assessment of Priority Outfalls

Method D - assessment of risk from accidental spillage

			Additional columns for use if other roads drain to the same outfall							
		A (main road)	B	C	D	E	F		
D1	Water body type	Groundwater	Groundwater	Groundwater					
D2	Length of road draining to outfall *(m)*	1,145	225	573					
D3	Road Type *(A-road or Motorway)*	A	A	A					
D4	If A road, is site urban or rural?	Rural	Rural	Rural					
D5	Junction type	No junction	No junction	No junction					
D6	Location (response time for emergency services)	< 20 minutes	< 20 minutes	< 20 minutes					
D7	Traffic flow (AADT two way)	32,120	32,120	9,165					
D8	% HGV	3.23	3.23	4.26					
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.29	3.09	0.93					
D9	Risk of accidental spillage	0.00013	0.00026	0.00008	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45	0.45					
D11	Risk of pollution incident	0.00006	0.00012	0.00003	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**	**No**				**Totals**	**Return Period (years)**
D13	Return period without pollution reduction measures	0.00006	0.00012	0.00003	0.00000	0.00000	0.00000	0.0002	4779
D14	Existing measures factor	1	1	1					
D15	Return period with existing pollution reduction measures	0.00006	0.00012	0.00003	0.00000	0.00000	0.00000	0.0002	4779
D16	Proposed measures factor	1	1	1					
D17	Residual with proposed Pollution reduction measures	0.00006	0.00012	0.00003	0.00000	0.00000	0.00000	0.0002	4779

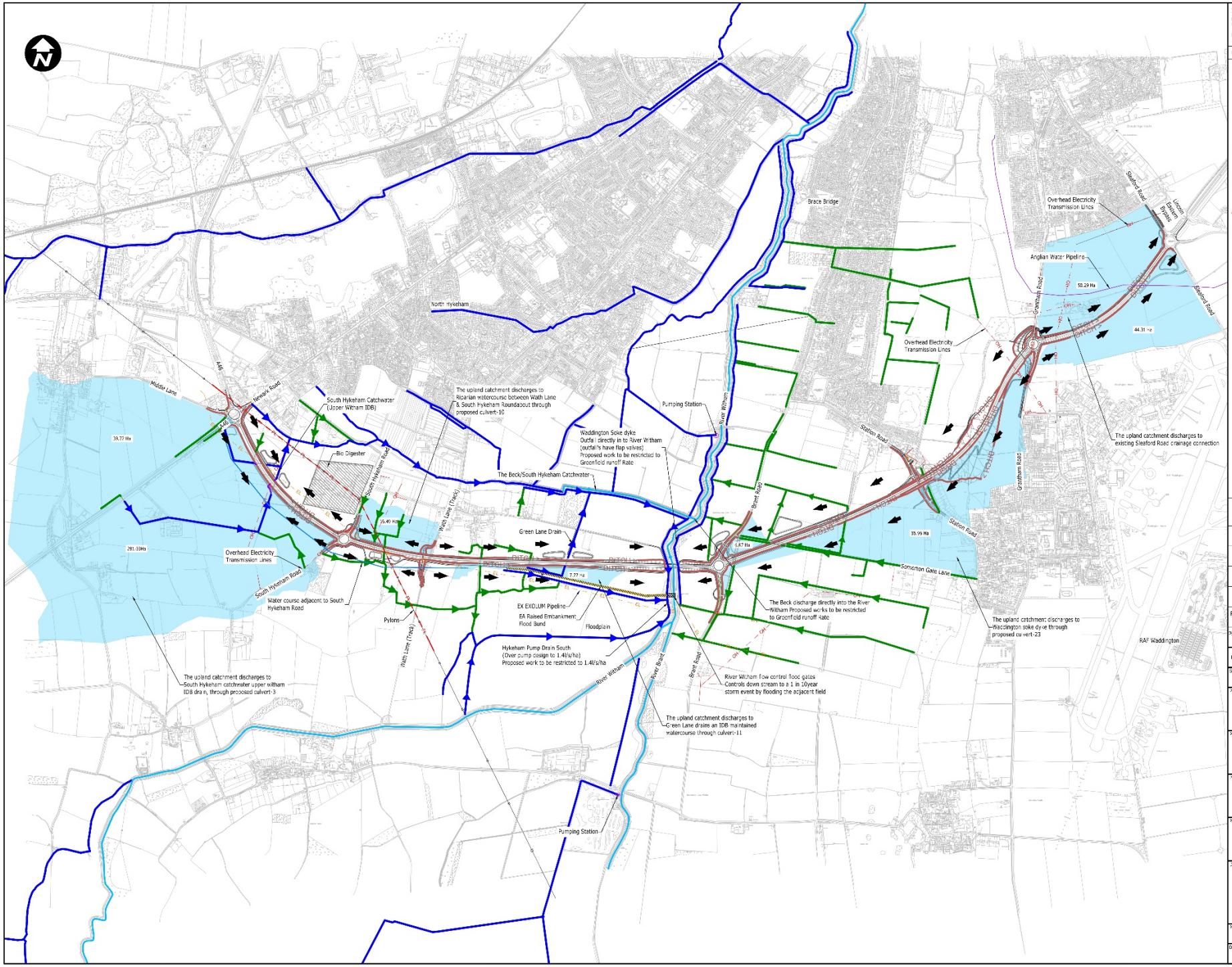
Catchment 10 Groundwater Assessment

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Mixed fracture and intergranular flow (e.g. consolidated deposits or unconsolidated deposits of medium – coarse sand)	2	40
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<15% to >1% SOM	2	10
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**160**
RISK SCREENING LEVEL	**Medium**

APPENDIX 2
DRAWINGS



Notes

Key-

- Natural Catchment with area in Ha.
- Flow Direction (Lidar)
- Watercourses - Upper Witham IDB Responsibility
- Watercourses - Riparian Responsibility
- Pre-excavation ditches
- Proposed EXOLUM Diversion

Rev	Description	Drawn	Checked	Approved	Date
P01	First Issue	AJ	AJ	AV	27/03/23
P02.1		AJ	—	—	—

Suitability: S0 — Drawing Status: Work in Progress

Project Name: North Hykeham Relief Road

Project Client: Lincolnshire County Council — Working for a better future

Project Contractor: Balfour Beatty

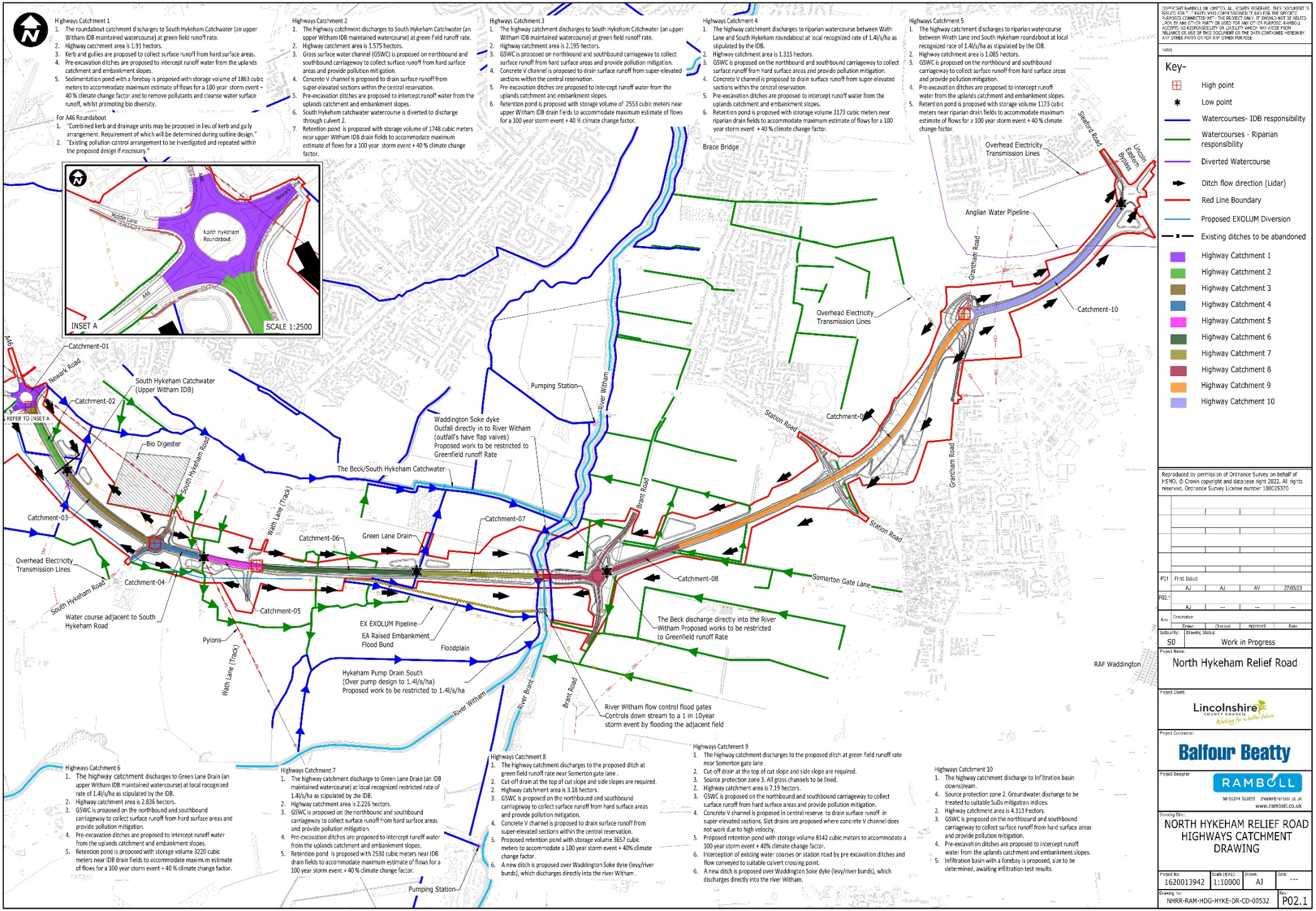
Project Designer: RAMBOLL

tel 01244 311555 · cmuller@ramboll.co.uk
www.ramboll.co.uk

Drawing title: NORTH HYKEHAM RELIEF ROAD UPLAND DRAINAGE CATCHMENT PLAN

Project No:	Scale @A1:	Drawn:	Date:
1620013942	1:12500	AJ	---

Drawing No.: NHRR-RAM-HDG-HYKE-DR-CD-00531 — Rev: P02.1


Highways Catchment 1
1. The roundabout catchment discharges to South Hykeham Catchwater (an upper Witham IDB maintained watercourse) at green field runoff rate.
2. Highway catchment area is 1.91 hectors.
3. Kerb and gullies are proposed to collect surface runoff from hard surface areas.
4. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
5. Sedimentation pond with a forebay is proposed with storage volume of 1863 cubic meters to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor and to remove pollutants and cleanse water surface runoff, whilst promoting bio diversity.
For A46 Roundabout
1. "Combined kerb and drainage units may be proposed in lieu of kerb and gully arrangement. Requirement of which will be determined during outline design."
2. "Existing pollution control arrangement to be investigated and repeated within the proposed design if necessary."
Highways Catchment 2
1. The highway catchment discharges to South Hykeham Catchwater (an upper Witham IDB maintained watercourse) at green field runoff rate.
2. Highway catchment area is 1.575 hectors.
3. Grass surface water channel (GSWC) is proposed on northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Concrete V channel is proposed to drain surface runoff from super-elevated sections within the central reservation.
5. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
6. South Hykeham catchwater watercourse is diverted to discharge through culvert 2.
7. Retention pond is proposed with storage volume of 1748 cubic meters near upper Witham IDB drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
Highways Catchment 3
1. The highway catchment discharges to South Hykeham Catchwater (an upper Witham IDB maintained watercourse) at green field runoff rate.
2. Highway catchment area is 2.195 hectors.
3. GSWC is proposed on northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Concrete V channel is proposed to drain surface runoff from super-elevated sections within the central reservation.
5. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
6. Retention pond is proposed with storage volume of 2553 cubic meters near upper Witham IDB drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
Highways Catchment 4
1. The highway catchment discharges to riparian watercourse between Wath Lane and South Hykeham roundabout at local recognized rate of 1.4l/s/ha as stipulated by the IDB.
2. Highway catchment area is 1.315 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Concrete V channel is proposed to drain surface runoff from super-elevated sections within the central reservation.
5. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
6. Retention pond is proposed with storage volume 1173 cubic meters near riparian drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
Highways Catchment 5
1. The highway catchment discharges to riparian watercourse between Wrath Lane and South Hykeham roundabout at local recognized rate of 1.4l/s/ha as stipulated by the IDB.
2. Highway catchment area is 1.085 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
5. Retention pond is proposed with storage volume 1173 cubic meters near riparian drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
INSET A
SCALE 1:2500
North Hykeham Roundabout
Middle Lane
Newark Road
A46
Brace Bridge
Overhead Electricity Transmission Lines
Anglian Water Pipeline
Sleaford Road
Lincoln Eastern Bypass
Grantham Road
Catchment-10
Catchment-01
Catchment-02
Catchment-03
Catchment-04
Catchment-05
Catchment-06
Catchment-07
Catchment-08
Catchment-09
REFER TO INSET A
South Hykeham Catchwater (Upper Witham IDB)
Bio Digester
South Hykeham Road
Wath Lane (Track)
The Beck/South Hykeham Catchwater
Waddington Soke dyke Outfall directly in to River Witham (outfall's have flap valves) Proposed work to be restricted to Greenfield runoff Rate
Pumping Station
River Witham
Brant Road
Station Road
Somerton Gate Lane
Green Lane Drain
Water course adjacent to South Hykeham Road
EX EXOLUM Pipeline
EA Raised Embankment Flood Bund
Floodplain
Pylons
Hykeham Pump Drain South (Over pump design to 1.4l/s/ha) Proposed work to be restricted to 1.4l/s/ha
The Beck discharge directly into the River Witham Proposed works to be restricted to Greenfield runoff Rate
River Witham flow control flood gates Controls down stream to a 1 in 10year storm event by flooding the adjacent field
RAF Waddington
Highways Catchment 6
1. The highway catchment discharges to Green Lane Drain (an upper Witham IDB maintained watercourse) at local recognized rate of 1.4l/s/ha as stipulated by the IDB.
2. Highway catchment area is 2.836 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
5. Retention pond is proposed with storage volume 3220 cubic meters near IDB drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
Highways Catchment 7
1. The highway catchment discharge to Green Lane Drain (an IDB maintained watercourse) at local recognized restricted rate of 1.4l/s/ha as stipulated by the IDB.
2. Highway catchment area is 2.226 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
5. Retention pond is proposed with 2530 cubic meters near IDB drain fields to accommodate maximum estimate of flows for a 100 year storm event + 40 % climate change factor.
Pumping Station
Highways Catchment 8
1. The highway catchment discharges to the proposed ditch at green field runoff rate near Somerton gate lane .
2. Cut-off drain at the top of cut slope and side slopes are required.
3. Highway catchment area is 3.18 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Concrete V channel is proposed to drain surface runoff from super-elevated sections within the central reservation.
5. Proposed retention pond with storage volume 3657 cubic meters to accommodate a 100 year storm event + 40% climate change factor.
6. A new ditch is proposed over Waddington Soke dyke (levy/river bunds), which discharges directly into the river Witham .
Highways Catchment 9
1. The highway catchment discharges to the proposed ditch at green field runoff rate near Somerton gate lane .
2. Cut-off drain at the top of cut slope and side slope are required.
3. Source protection zone 3. All grass channels to be lined.
2. Highway catchment area is 7.19 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Concrete V channel is proposed in central reserve to drain surface runoff in super-elevated sections. Slot drains are proposed where concrete V channel does not work due to high velocity.
5. Proposed retention pond with storage volume 8142 cubic meters to accommodate a 100 year storm event + 40% climate change factor.
6. Interception of existing water courses on station road by pre excavation ditches and flow conveyed to suitable culvert crossing point.
6. A new ditch is proposed over Waddington Soke dyke (levy/river bunds), which discharges directly into the river Witham.
Highways Catchment 10
1. The highway catchment discharge to Inf Tration basin downstream.
4. Source protection zone 2. Groundwater discharge to be treated to suitable SuDs mitigation indices.
2. Highway catchment area is 4.313 hectors.
3. GSWC is proposed on the northbound and southbound carriageway to collect surface runoff from hard surface areas and provide pollution mitigation.
4. Pre-excavation ditches are proposed to intercept runoff water from the uplands catchment and embankment slopes.
5. Infiltration basin with a forebay is proposed, size to be determined, awaiting infiltration test results.
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Notes
Key-
High point
Low point
Watercourses- IDB responsibility
Watercourses - Riparian responsibility
Diverted Watercourse
Ditch flow direction (Lidar)
Red Line Boundary
Proposed EXOLUM Diversion
Existing ditches to be abandoned
Highway Catchment 1
Highway Catchment 2
Highway Catchment 3
Highway Catchment 4
Highway Catchment 5
Highway Catchment 6
Highway Catchment 7
Highway Catchment 8
Highway Catchment 9
Highway Catchment 10
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P01 First Issue AJ AJ AV 27/03/23
P02.1 AJ --- --- ---
Rev. Description Drawn Checked Approved Date
Suitability: S0
Drawing Status: Work in Progress
Project Name: North Hykeham Relief Road
Project Client: Lincolnshire County Council
Project Contractor: Balfour Beatty
Project Designer: RAMBOLL
tel 01244 311855 chester@ramboll.co.uk
www.ramboll.co.uk
Drawing Title: NORTH HYKEHAM RELIEF ROAD HIGHWAYS CATCHMENT DRAWING
Project No: 1620013942
Scale (@A1): 1:10000
Drawn: AJ
Date: ---
Drawing No: NHRR-RAM-HDG-HYKE-DR-CD-00532
Rev: P02.1

APPENDIX 3
WATER HARDNESS MAP

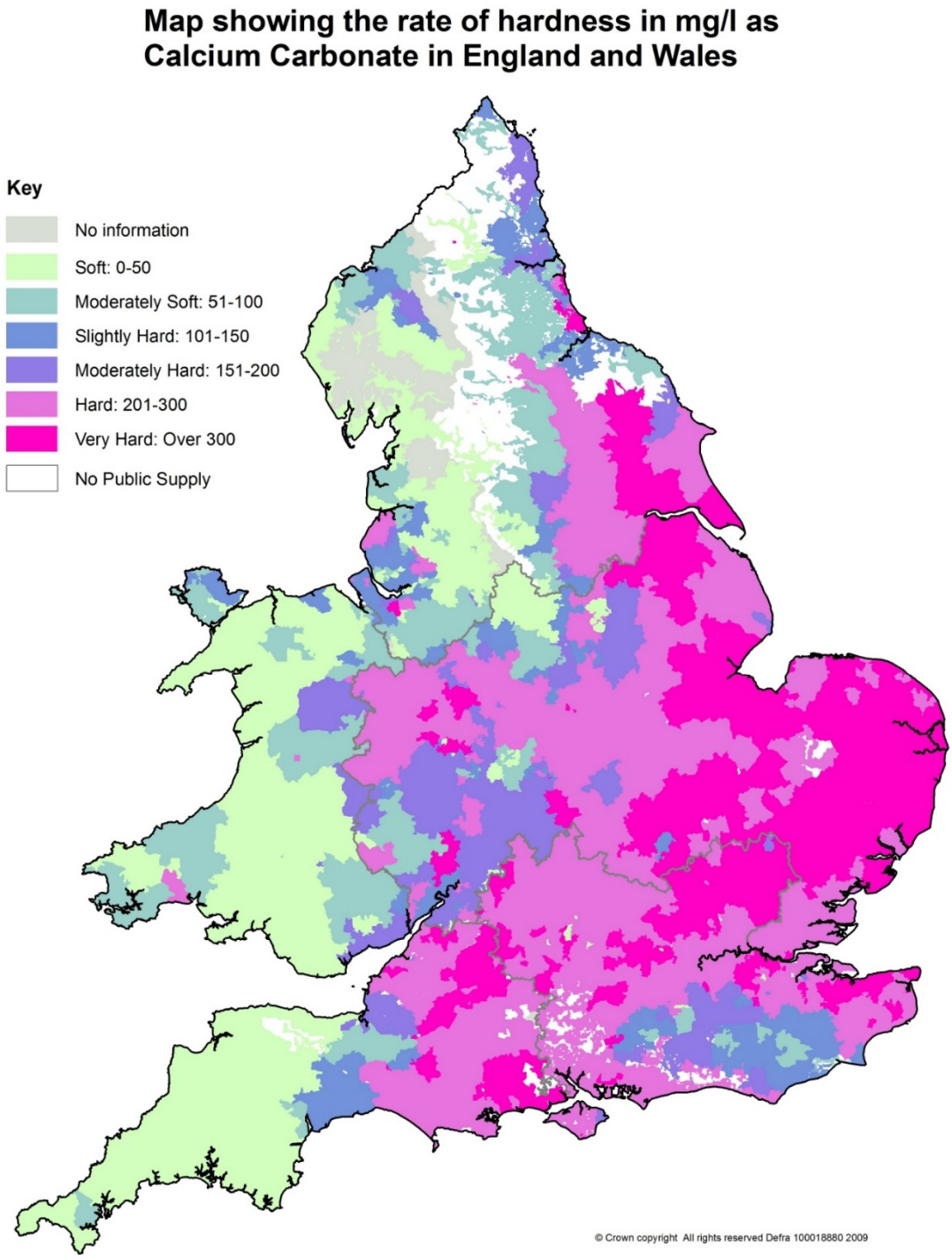

Figure 4 - Defra water hardness map