Great Yarmouth Third River Crossing

Application for Development Consent Order

Document 6.2: Environmental Statement Volume II: Technical Appendix 11D: HAWRAT Assessment

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) (“APFP”)

APFP regulation Number: 5(2)(a)

Planning Inspectorate Reference Number: TR010043

Author: Norfolk County Council

Document Reference: 6.2 – Technical Appendix 11D

Version Number: 0 – Revision for Submission

Date: 30 April 2019

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1.1 Introduction

1.1.1 The assessment informs Chapter 11: Road Drainage and the Water Environment of the Environment Statement (ES) in relation to potential impacts of the Great Yarmouth Third River Crossing (“the Scheme”), specifically highway runoff, on water quality.

1.1.2 The Scheme will increase impermeable road surface and alter the current traffic flow regime. This has the potential to affect the volume and quality of surface water runoff from the road surface that in turn may affect the quality of the receiving water environment. The purpose of this assessment is to assess the potential impact of the Scheme on the chemical quality of the water environment.

1.1.3 The approach that has been adopted follows the approach promoted in Method A and Method D of the Design Manual for Roads and Bridges (DMRB) Volume 11, Part 10, Section 3 (Ref 11D.1):

- Method A is used to assess pollution impacts from routine runoff to surface waters; and
- Method D is used to assess pollution impacts from accidental spillage.

1.1.4 The methods are implemented using the DMRB HAWRAT assessment tool.

1.1.5 Method C is used to assess pollution impacts from routine runoff to groundwater. However, the disposal of road runoff via infiltration is not proposed in the Drainage Strategy (Appendix 12C (document reference 6.2)) due to high groundwater levels in the Principal Application Site and any drainage features will be lined to limit any infiltration of polluted runoff to the underlying groundwater. As such the effects of routine runoff on groundwater are considered negligible, therefore Method C has not been undertaken as part of the HAWRAT assessment.

1.1.6 The HAWRAT assessment focusses on permanent risks during the operational phase of the Scheme and does not consider risks during the construction phase as the methodology is not appropriate for assessing impacts associated with construction traffic. Potential impacts to chemical water quality during construction are qualitatively assessed within Section 11.8 of Chapter 11: Road Drainage and the Water Environment.

1.2 Assessment Parameters

1.2.1 The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. The Scheme consists of a new dual carriageway road, including a road bridge across the river, linking the A47 at Harfrey's Roundabout on the western side of the river to the A1243 South Denes Road on the eastern side.

1.2.2 The Scheme aims to relieve traffic that at present must travel through the town centre and will increase traffic flows in the immediate vicinity of the Principal Application Site. The forecast with-Scheme 24-hour two-way Annual Average Daily Traffic (AADT) flow for the 2038 scenario is estimated as 18,195 for the existing William Adams Way adjacent to Harfrey's Roundabout, compared with 15,608 under the baseline condition. The forecast AADT traffic flows for the new bridge crossing and highway (including the new roundabout) are estimated as 23,041. Both the baseline and forecast with-Scheme traffic flows are in the lowest range assessed using the HAWRAT tool, ≥ 10,000 to < 50,000. Approximately 4% of this will comprise Heavy Goods Vehicles (HGVs).

1.2.3 New highway drainage is proposed for the Scheme and the key principles of the Drainage Strategy (Appendix 12C (document reference 6.2)) are stated as follows:

The western side of the Scheme - the section of the Scheme due west of the bridge mid-point (Total area = 3.3ha)

- Runoff from the western side of the Scheme will be attenuated and discharged either via gravity into the existing Internal Drainage Board (IDB) ordinary watercourse network adjacent to the Scheme or via a pumped system into the River Yare. This assessment investigates the potential effects of both discharge options.
- Runoff to be attenuated to as close as practical to greenfield runoff rates for the 1 in 100-year event, including climate change. Where this is not achievable, the post development runoff rates and volumes should not exceed existing scenario values. The required attenuation storage will, as a minimum, consist of an underground storage tank and a pond/wetland feature.
- Runoff will be treated before discharge. Pollution control measures will include proprietary treatment devices (vortex separator) and natural treatment in the form of wet pond/wetland feature. Penstocks are also proposed as control of spillages.

The eastern side of the Scheme - the section of the Scheme due east of the bridge mid-point (Total area=0.9ha)

- Runoff from the eastern side of the Scheme will be discharged into existing Anglian Water combined sewer.
- Runoff to be attenuated, via oversized pipes and/or underground storage tanks, to achieve the restricted discharge rate of 10l/s as agreed with Anglian Water.
- Runoff to be treated, via proprietary devices, before discharge into the Anglian Water combined sewer.

1.2.4 The proposed drainage areas for the western and eastern side of the Scheme were estimated based on the General Arrangement Plans (document reference 2.2), which include a combination of permeable and impermeable area that contribute to the respective outfalls. In order to account for the limits of deviation that will allow for minor changes to the highway design and subsequently the drainage areas for the Scheme, the HAWRAT assessment has investigated the potential effects of increasing the impermeable surface area by 15%. Given the limited space within the Principal Application Site, it is not expected that the drainage areas would deviate by more than 15%.

1.3 Assessment Approach: Method A

Scope of the Assessment

1.3.1 Method A assesses the risks of water pollution within the receiving watercourse associated with the proposed routine discharges from the Scheme. The assessment has only been completed for the western side of the Scheme, which is currently known to discharge into the IDB watercourse network adjacent to the Scheme. The drainage catchment for this side of the Scheme has an impermeable area of 2.5ha based on the General Arrangement Plans (document reference 2.2). The assessment has also considered the potential impacts of increasing the impermeable area by 15% (i.e. up to 2.88ha) to allow for the limits of deviation provided for in the DCO.

1.3.2 Highway runoff from the eastern part of the Scheme will undergo two stages of treatment; first via proprietary devices installed as part of the Scheme Drainage Strategy (Appendix 12C (document reference 6.2)), prior to discharge into Anglian Water combined sewer, and second where discharged runoff will be treated alongside existing flows as part of Anglian Water's treatment processes. Given discharges from the eastern side of the Scheme will be incorporated into Anglian Water's treatment system, and Anglian Water has confirmed this will not affect the performance of their sewage treatment works, the effects have not been considered further in this assessment.

1.3.3 Two separate HAWRAT assessments have been completed:

- Scenario 1: Discharge to the existing IDB watercourse network adjacent to the Scheme. This IDB network, which forms part of the surface water drainage for the urban areas of Great Yarmouth, is connected to the wider network of dykes and drains within the Waveney, Lower Yare & Lothingland IDB district. Water level within the IDB district is managed by pumping, which removes excessive runoff from the marshes, urban area and the upland catchment to the River Yare.
- Scenario 2: Discharge to the River Yare. The River Yare is a transitional tidal waterbody through Great Yarmouth. The HAWRAT tool, used in this assessment, was designed to assess the impacts to freshwater bodies and is therefore not directly applicable to the assessment of impacts to transitional waters. Furthermore, given the size of the River Yare catchment at the Principal Application Site (estimated to be around 3,130km^2), its current use for commercial and recreational navigation, and the regular dredging activities to remove accumulated sediment, it is considered highly unlikely that the Scheme would pose a notable risk to water quality. However, in order to quantify and therefore better understand the scale of potential impact, the HAWRAT assessment process has been applied to a freshwater scenario to enable consideration of likely pollutant concentrations and dilution requirements.

1.3.4 Two types of assessment are undertaken within the HAWRAT tool:

- Short-term impacts on aquatic ecology related to the intermittent nature of road runoff. For an individual outfall to pass the HAWRAT assessment it must pass both the soluble pollutant and sediment pollutant impacts.
- Long-term impacts based on annual average concentration of certain hazardous pollutants, as defined under the Water Framework Directive (WFD). The long-term risks over the period of one year are assessed through comparison of the annual average concentration of pollutants discharged with the published Environmental Quality Standards (EQS) for those pollutants.

1.3.5 HAWRAT is a tiered consequential system which involves up to three assessment stages, outlined as ‘steps’ within the assessment spreadsheet. These are detailed as follows:

- Step 1 uses statistical models to determine pollutant concentrations in raw road runoff prior to any treatment or dilution in the receiving watercourse;

- Step 2 assess pollutant concentrations after dilution and dispersion in the receiving watercourse, but without active mitigation; and
- Step 3 considers the pollutant concentrations with active mitigation. Pollution control measures proposed as part of the Drainage Strategy (Appendix 12C (document reference 6.2)) will include a vortex separator to treat runoff that discharges into the underground storage tank and natural treatment in the form of wet pond/wetland feature. However, the proportion of the Scheme (western side) contributing to the underground storage via the vortex separator and the proportion contributing to the pond/wetland feature are currently unknown. Hence, it is assumed that the entire western side of the Scheme will contribute to the underground storage via the vortex separator to provide the worst-case scenario. A vortex separator is effective in the removal of fine sediment, sediment-bound pollutants and hydrocarbons. However, its ability to remove soluble metals is considered limited.

Assessment Parameters

1.3.6 Information used to complete the HAWRAT assessments for both discharge scenarios are summarised in Table 1.1

Table 1.1: Summary of Input Data for HAWRAT Assessments

Input Data	Discharge Locations	
	IDB Watercourse	River Yare
Impermeable area drained to outfall (ha)	2.5 (and 2.88 to allow for limits of deviation)	2.5 (and 2.88 to allow for limits of deviation)
Permeable area drained to outfall (ha)	0.8	0.8
Standard Average Annual Rainfall (SAAR)	550mm based on rain gauges from nearby stations	550mm based on rain gauges from nearby stations
Base Flow Index (BFI)[1]	0.73	0.64
Water hardness	A low value of < 50mg $CaCO_3$/L was selected as a reasonable worst case as this information is uncertain	A low value of < 50mg $CaCO_3$/L was selected as a reasonable worst case as this information is uncertain
Estimated river width (m)	2	100

[1] Derived using the LowFlows 2 software based on characteristics of the catchment.

Input Data	Discharge Locations	
	IDB Watercourse	River Yare
Is the discharge in or within 1km upstream of a protected site for conservation?	No international / national designated conservation sites have been identified within 1km downstream from the point of discharge (the Breydon Water SSSI is located approximately 2km from the point of discharge)	Yes, the River Yare is included in the Outer Thames Estuary Special Protection Area (SPA)
Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?	The IDB watercourse network is culverted in many places and a culvert structure is found within 100m of the point of discharge.	No - although on flood tides reverse flow occurs in the Yare at the point of discharge, the assessment has been undertaken assuming minimal flow (i.e. periods of slack tide when fluvial flow dominates).

Determining the Annual 95% River Flow

1.3.7 The HAWRAT tool requires an estimation of the 95 percentile (%) river flow to represent likely low flow conditions (and therefore potential for greatest impact). Consultation with the Environment Agency and the IDB has confirmed that they do not carry out or hold any flow measurements for the IDB watercourse network adjacent to the Scheme. It is expected that flows would be intermittent due to tidal influences and the largely urbanised nature of the catchment. Hence it is difficult to produce representative annual 95 percentile (%) river flows (Q95s) that feed into the assessment to determine the pollutant concentrations after dilution and dispersion in the receiving watercourse. Furthermore, given the potential ephemeral nature of the watercourse, the dilution capacity is likely to be limited with Q95s close to zero at times, in particular for the drier summer months.

1.3.8 According to the guidance provided in the DMRB (Ref 11D.1), if the Q95 value is less than $0.001m^3/s$, a figure of $0.001m^3/s$ should be used in the assessment. Due to the uncertainties associated with the flow rates and duration of the receiving watercourse, the assessment has been carried out based on a Q95 value of $0.001m^3/s$, i.e. the lowest value that should be used in the assessment, to reflect the limited dilution capacity of the watercourse and therefore the worst case.

1.3.9 Estimating an appropriate Q95 for the River Yare is equally problematic due to the transitional nature of the waterbody as it is influenced by both fluvial flows from the upper catchment and tidal inflows from the North Sea. The fluvial Q95 value has been used for this assessment, with no consideration of tidal inflows. This is considered a reasonable worst-case scenario as it represents the lowest flow rate in the River Yare, during periods of slack tide, when the dilution capacity is at its lowest. The river has a catchment area of around 3,130km^2 at the Principal Application Site and the Q95 flow was estimated to be approximately 4.5m^3/s.

Summary of Assessment

Scenario 1: Discharge to existing IDB watercourse network

1.3.10 The Scheme failed Step 1 of the HAWRAT assessment, which is the assessment of pollutant concentrations in raw road runoff prior to any treatment or dilution in the receiving watercourse. The findings of Step 2 and Step 3 of the HAWRAT assessment, which assess pollutant concentrations after dilution and dispersion in the receiving watercourse without and with active mitigation, respectively, are summarised in Table 1.2 (details provided in Annex A), with a review of this assessment provided below.

Table 1.2: Summary of HAWRAT Assessment of Pollution Risks to IDB Watercourse

Assessment stage	**Impermeable area (ha)**	**Short Term Pollutant Impacts**			**Long Term Pollutant Impacts**	
		Acute impact assess ment of Copper	Acute impact assessment of Zinc	Sediment (chronic impact)	Annual average concentration of Copper (µg/l) due to road runoff	Annual average concentration of Zinc (µg/l) due to road runoff
Step 2 (no mitigation)	2.5	FAIL	FAIL	FAIL	0.79	1.79
Step 3 (with mitigation)	2.5	FAIL	FAIL	PASS* (but alert due to presence of downstream structure)	0.79	1.79
Step 2 (no mitigation)	2.88	FAIL	FAIL	FAIL	0.86	1.95
Step 3 (with mitigation)	2.88	FAIL	FAIL	PASS* (but alert due to presence of downstream structure)	0.86	1.95
***** The vortex separator is assumed to have 80% removal capability for fine sediment.[2]						

[2] Percentage removal is based on industry design standard for a hydrodynamic vortex separator - information provided by Hydro International for their product, Downstream Defender, which is an advanced hydrodynamic vortex separator (Ref 11D.2).

1.3.11 The HAWRAT tool indicates the acute concentration of pollutants generated by the Scheme would exceed the acceptable threshold values for both Copper and Zinc set by the DMRB methodology (Ref 11D.1), thus failing the assessment of short-term pollutant impacts. Due to the presence of culvert structures along the IDB watercourse, which could potentially lower the flow velocity, the HAWRAT tool also indicates there would be extensive settlement of sediments, causing the watercourse to fail the assessment of sediment-bound pollutants. Given the ephemeral nature of the IDB watercourse, there is insufficient dilution to pass the HAWRAT assessment without active mitigation.

1.3.12 With the incorporation of the vortex separator as pollution control, the Scheme would pass the assessment of sediment-bound pollutants, but there remains a risk of impact due to the presence of a culvert structure downstream from the point of discharge, which could potentially reduce flow velocity and encourage the deposition of sediment. However, the volume of sediment entering the receiving watercourse following mitigation would be small, hence the effect of the downstream structure is considered to be insignificant.

1.3.13 The Scheme still fails the assessment of short-term pollutant impacts due to the limited capability of the vortex separator to remove soluble metals. However, it is important to note that the current assessment assumed the worst case whereby the entire western part of the Scheme was assessed to contribute to the underground storage via the vortex separator. It is understood that a proportion of the Scheme would discharge into a wet pond, which has the potential to remove up to 50 - 80% of soluble heavy metals, according to Table 3.7 of CIRIA C609, Sustainable drainage systems – Hydraulic, structural and water quality advice (Ref 11D.3). Furthermore, the CCTV survey conducted as part of the Drainage Strategy (Appendix 12C (document reference 6.2)) and consultation with the IDB has confirmed that the majority of the existing highway in the vicinity of the Scheme drains into the same IDB watercourse with no known treatment measures incorporated. Given the risk of pollution already exists in this waterbody due to existing highway discharges, runoff from the Scheme is not expected to cause significant deterioration in water quality in the IDB watercourse, even if runoff is discharged untreated.

1.3.14 As shown in Table 11D.2, the outcomes and subsequently the conclusion of the assessment of short-term pollutants in the IDB watercourse would remain unchanged with the increase in impermeable road area to account for deviation in highway design for the western side of the Scheme.

1.3.15 HAWRAT also provides an assessment of long-term pollution impacts to the receiving water environment, which considers the annual average pollutant concentrations associated with the Scheme against the EQS that inform the WFD. The threshold values in the DMRB (Ref 11D.1) are 1 µg/l in the water hardness band of < 50mg/l $CaCO_3$ for Copper and 7.8 µg/l in all water hardness bands for Zinc. The results of the HAWRAT assessment indicate annual average concentrations of Copper and Zinc are below these threshold values. With the increase in impermeable area, the concentrations would increase but only marginally and the values are still below the threshold. Therefore, in themselves, discharges from the Scheme would not result in the EQS values being exceeded at the point of discharge. The EQS values may be exceeded when taking into account existing discharges to the local IDB drains, however the estimated topographical catchment to the point of discharge is approximately 2 km^2, comprising large areas of urban development and highway. The drained area from the Scheme (~ 3.3 ha based on current highway design and ~3.7 ha that allows for deviation) represents less than 2% of this catchment, therefore discharges from the Scheme will not significantly affect the water quality in these drains.

1.3.16 Contaminants released into the IDB watercourse network adjacent to the Scheme could be transported downstream to impact on the water quality of the wider network of dykes and drains within the IDB district, in particular the more sensitive marshland south of Breydon Water. However, a comparison of the catchment areas at the point of discharge (approximately 2km^2) and at the marshland (approximately 12km^2), suggests the contaminants would have been sufficiently diluted and dispersed before reaching the main dyke system within the marshes (Plate 1.1). It is therefore highly unlikely that highway discharges from the Scheme would have any significant effect on the water quality of the wider IDB catchment.

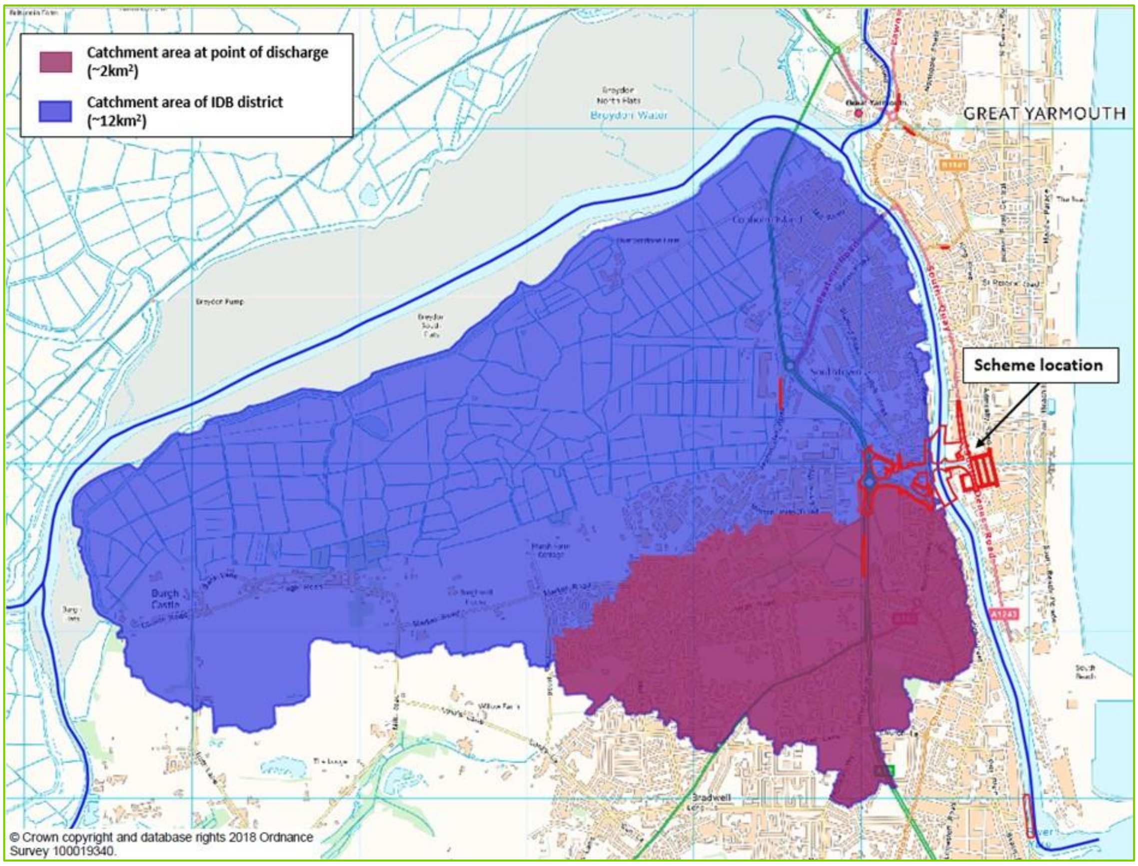


Plate 1.1: A Comparison of the Wider IDB Catchment and the Catchment at the Point of Discharge

Scenario 2: Discharge to the River Yare

1.3.17 With the option of discharging into the River Yare, the Scheme would pass Step 2 of the HAWRAT assessment, which takes into account dilution and dispersion in the river, without active mitigation being necessary. Table 1.3 summarises the findings of the Step 2 assessment (details provided in Annex A), with a review of this assessment provided below.

Table 1.3: Summary of HAWRAT Assessment of Pollution Risks to the River Yare

Assessment stage	Impermeable area (ha)	Short Term Pollutant Impacts			Long Term Pollutant Impacts	
		Acute impact assessment of Copper	Acute impact assessment of Zinc	Sediment (chronic impact)	Annual average concentration of Copper (µg/l) due to road runoff	Annual average concentration of Zinc (µg/l) due to road runoff
Step 2 (no mitigation)	2.5	PASS	PASS	PASS (but alert as runoff is discharged into a protected area)	0.00	0.00
Step 2 (no mitigation)	2.88	PASS	PASS	PASS (but alert as runoff is discharged into a protected area)	0.00	0.00

1.3.18 The HAWRAT tool indicates the acute concentration of pollutants generated by the Scheme would be below the acceptable threshold values set by the DMRB methodology (Ref 11D.1), with consideration of the dilution potential within the River Yare. It is anticipated that the dilution capacity of the river would be significantly greater than that assessed in the HAWRAT, due to tidal flows which were not considered in the assessment. Hence, the Scheme is not expected to pose a short term pollution risk to this waterbody. The results for the assessment of sediment deposition indicate there would be limited settlement of sediment and associated sediment-bound pollutants in the River Yare. However, the assessment still alerted a potential risk of impact because the River Yare is included in the Outer Thames Estuary SPA. Given the river is already regularly dredged for navigation, the potential increase in sediment and sediment-bound pollutants associated with highway discharges from the Scheme is not considered to pose a notable impact.

1.3.19 With respect to long-term pollution impacts, the results of the HAWRAT assessment indicate annual average concentrations of Copper and Zinc associated with the Scheme would be zero. This is to be expected given the significant dilution capacity of the River Yare. Highway runoff discharges from the Scheme represent a very small proportion of the flow in the Yare and will therefore not have any notable effect on existing pollutant concentrations.

1.3.20 It can be seen from Table 11D.3 that the increase in impermeable road area within the limits of deviation has not altered the results of the HAWRAT assessment for the River Yare.

1.3.21 Consultation has been carried out with the Environment Agency to request relevant water quality sampling data for the River Yare waterbody. The data showed that both the maximum and annual mean concentrations of the sampled elements, including Arsenic, Ammonia, Mercury, heavy metals such as Cadmium, Lead, Copper, Zinc, and Nonylphenol, are all below the transitional waters EQS used to inform the WFD. This suggests the waterbody is not at pressure relating to these elements, which are contaminants that could be found in road runoff. The HAWRAT assessment shows the Scheme discharges will not lead to a change in existing pollutant concentrations and therefore discharges from the Scheme will not affect the water quality in the River Yare.

1.3.22 Step 3 of the HAWRAT assessment was not completed for this scenario as the Scheme passes the HAWRAT assessment at Step 2.

1.4 Assessment Approach: Method D

Scope of the Assessment

1.4.1 Method D of the DMRB assesses the risk of pollution from spillages occurring during operation of the Scheme – i.e. if an accident were to occur. The assessment considers likely spillage rates based on the nature of the road (i.e. presence of slip roads, roundabouts, junctions, etc. that can increase risk) and the percentage of the AADT that comprises HGVs.

1.4.2 The assessment is designed to consider spillage risks to motorways and A-roads and, as such, is not directly applicable to this Scheme given the slower speeds of vehicles using these roads. The assessment will, however, give an indication of potential risks should an accident occur. Similar to the Method A assessment, this assessment has only been completed for the western side of the Scheme. The length of road considered in this assessment measures approximately 645m.

Assessment Parameters

1.4.3 The following information has been used to complete the HAWRAT Method D assessment:

- Outfall will drain to a surface watercourse;
- The road type was selected as an A-road in an urban area;
- Response time taken as <20 minutes as the site is urban;
- Two-way AADT of 23,041 vehicles for the new bridge crossing and highway;
- 4% HGV traffic.

1.4.4 The DMRB (Ref 11D.1) provides spillage rates for different types of junctions and for lengths of road within 100m of these junctions.

Summary of Assessment

1.4.5 A summary of this information is provided in Table 1.4, noting that only new junctions have been considered and that the assessment (details provided in Annex B) has been completed without and with the consideration of mitigation.

Table 1.4: Summary of HAWRAT Assessment of Pollution Impacts from Spillages

Assessment type	Type of junction	Length of carriageway within 100m of junction	Spillage rates (Table D1.1 (Ref 11D.1),)	Annual probability of a serious pollution incident
No mitigation	New five-arm roundabout	420	5.35	0.00034 (0.034%)
	Carriageway not within 100m of junction	225	0.31	0.00001 (0.001%)
With mitigation (spillage control penstocks with a pollution reduction factor of 0.4 (60%))	New five-arm roundabout	420	5.35	0.00014 (0.014%)
	Carriageway not within 100m of junction	225	0.31	0.00000 (0.0%)

1.4.6 The DMRB (Ref 11D.1) recommends that an annual probability of a serious pollution incident occurring of less than 1% would be acceptable. The results of the HAWRAT assessment without the consideration of mitigation indicate a total annual probability of 0.035%, which is well below this threshold.

1.4.7 Although the estimated spillage risk is below the DMRB threshold, it is considered good practice to incorporate mitigation measures of spillage containment. The use of penstocks has been proposed as part of the Drainage Strategy (Appendix 12C (document reference 6.2)) to control spillage. According to Table 8.1 of DMRB Volume 11, Part 10, Section 3 (Ref 11D.1), this has the potential to reduce the risk by 60%, which subsequently reduces the annual probability of a serious pollution incident to 0.014%.

2 References

Ref 11D.1: Design Manual for Roads and Bridges Volume 11, Section 3, Part 10 (HD 45/09) Road Drainage and the Water Environment, former Highways Agency, November 2009.

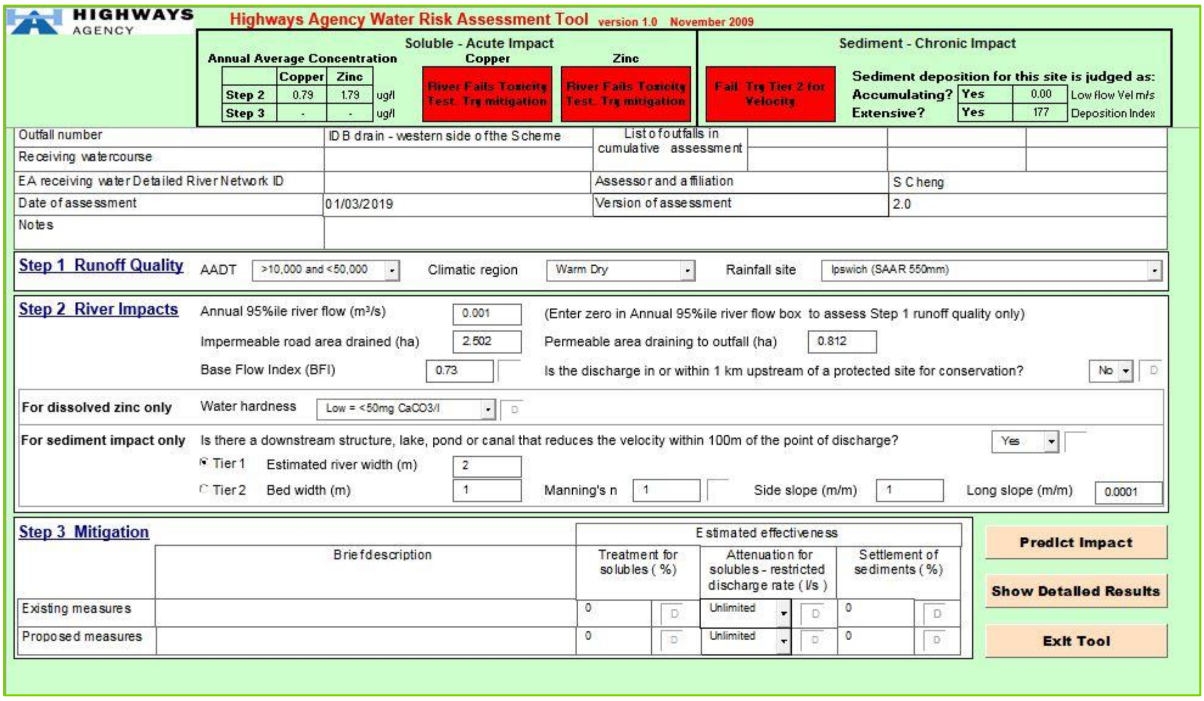
Ref 11D.2: Hydro International (2016, online). Downstream Defender Design Data Sheet.

Ref 11D.3: CIRIA (2004). CIRIA C609, Sustainable Drainage Systems – Hydraulic, structural and water quality advice.

Annex A: Details of the Method A Assessment

Scenario 1: Discharge to existing IDB watercourse (2.5ha impermeable area)

Without Active Mitigation


HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.79	1.79	ug/l
Step 3	-	-	ug/l

Copper: River Fails Toxicity Test. Try mitigation

Zinc: River Fails Toxicity Test. Try mitigation

Sediment - Chronic Impact

Fail. Try Tier 2 for Velocity

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	Yes	177	Deposition Index

Outfall number	IDB drain - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	01/03/2019	Version of assessment	2.0
Notes			

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Warm Dry Rainfall site Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s) 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 2.502 Permeable area draining to outfall (ha) 0.812

Base Flow Index (BFI) 0.73 Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only: Water hardness Low = <50mg CaCO3/l

For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

Tier 1 Estimated river width (m) 2

Tier 2 Bed width (m) 1 Manning's n 1 Side slope (m/m) 1 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	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact

Show Detailed Results

Exit Tool

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Summary of predictions

		Soluble - Acute Impact		Sediment - Chronic Impact							
		Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact	Step1										
	Step2										
	Step3										

DETAILED RESULTS

In Runoff

Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**33.60**	**21.80**
No. of exceedances/worst year	41	29
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	**10.70**	**7.50**
No. of exceedances/worst year	17	13
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	25.75	60.02
90%ile	49.14	126.87
95%ile	62.68	162.41
99%ile	86.03	300.69

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**42.60**	**53.10**	**0.30**	**8.10**	**27.50**	**8.10**	**6.60**	**15.00**
No. of exceedances/worst year	52	58	1	15	36	15	11	22
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	2	2
No. of exceedances/year	**2.8**	**2.8**
No. of exceedances/worst year	6	4
No. of exceedances/summer	1.9	1.5
No. of exceedances/worst summer	4	4
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.4**	**0.6**
No. of exceedances/worst year	3	2
No. of exceedances/summer	0.4	0.3
No. of exceedances/worst summer	3	2
Annual average concentration (ug/l)	0.79	1.79
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	6.47	15.44
90%ile	14.73	36.06
95%ile	20.08	53.48
99%ile	32.92	109.56

Step 2

Velocity 0.00 m/s — Tier 1 is used for the calculation

DI 177.25

% settlement needed 44 %

With Active Mitigation (vortex separator with assumed 80% removal of fine sediment)

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration	Copper	Zinc	
Step 2	0.79	1.79	ug/l
Step 3	-	-	ug/l

Copper: River Fails Toxicity Test. Try mitigation

Zinc: River Fails Toxicity Test. Try mitigation

Sediment - Chronic Impact

Alert. D/S Structure.

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	No	35	Deposition Index

Outfall number	IDB drain - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	04/03/2019	Version of assessment	2.0
Notes			

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Warm Dry Rainfall site Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s) 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 2.502 Permeable area draining to outfall (ha) 0.812

Base Flow Index (BFI) 0.73 Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness Low = <50mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

Tier 1 Estimated river width (m) 2

Tier 2 Bed width (m) 1 Manning's n 1 Side slope (m/m) 1 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	Unlimited	0
Proposed measures	Vortex separator	0	Unlimited	80

Predict Impact

Show Detailed Result

Exit Tool

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Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff — Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	33.60	21.80
No. of exceedances/worst year	41	29
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	10.70	7.50
No. of exceedances/worst year	17	13
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	25.75	60.02
90%ile	49.14	126.87
95%ile	62.68	162.41
99%ile	86.03	300.69

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	42.60	53.10	0.30	8.10	27.50	8.10	6.60	15.00
No. of exceedances/worst year	52	58	1	15	36	15	11	22
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

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Summary of predictions

		Soluble - Acute Impact		Sediment - Chronic Impact							
		Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact	Step1										
	Step2										
	Step3										

In River (no mitigation) — Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	2	2
No. of exceedances/year	2.8	2.8
No. of exceedances/worst year	6	4
No. of exceedances/summer	1.9	1.5
No. of exceedances/worst summer	4	4
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.4	0.6
No. of exceedances/worst year	3	2
No. of exceedances/summer	0.4	0.3
No. of exceedances/worst summer	3	2
Annual average concentration (ug/l)	0.79	1.79
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	6.47	15.44
90%ile	14.73	36.06
95%ile	20.08	53.48
99%ile	32.92	109.56

Step 2

Velocity 0.00 m/s — Tier 1 is used for the calculation

DI 177.25

% settlement needed 44 %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	2	2
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-
Annual average concentration (ug/l)	-	-
	(ug/l)	(ug/l)
Thresholds resholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	-	-
90%ile	-	-
95%ile	-	-
99%ile	-	-

DI 35.45

Scenario 1: Discharge to existing IDB watercourse (2.88ha impermeable area)

Without Active Mitigation

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.86	1.95	ug/l
Step 3	-	-	ug/l

Copper: River Fails Toxicity Test. Try mitigation

Zinc: River Fails Toxicity Test. Try mitigation

Sediment - Chronic Impact

Fail. Try Tier 2 for Velocity

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	Yes	204	Deposition Index

Outfall number	IDB drain - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	12/03/2019	Version of assessment	2.0
Notes	Impermeable road area increased by 15% to allow for limits of deviation		

Step 1 Runoff Quality AADT: >10,000 and <50,000; Climatic region: Warm Dry; Rainfall site: Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 2.877; Permeable area draining to outfall (ha): 0.812

Base Flow Index (BFI): 0.73; Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: Low = <50mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

Tier 1 Estimated river width (m): 2

Tier 2 Bed width (m): 1; Manning's n: 1; Side slope (m/m): 1; 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	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact

Show Detailed Results

Exit Tool

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Summary of predictions

	Soluble - Acute Impact		Sediment - Chronic Impact							
	Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**33.60**	**21.80**
No. of exceedances/worst year	41	29

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**10.70**	**7.50**
No. of exceedances/worst year	17	13

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	25.75	60.02
	90%ile	49.14	126.87
	95%ile	62.68	162.41
	99%ile	86.03	300.69

Step 1

Toxicity Threshold	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**42.60**	**53.10**	**0.30**	**8.10**	**27.50**	**8.10**	**6.60**	**15.00**
No. of exceedances/worst year	52	58	1	15	36	15	11	22
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	2	2
No. of exceedances/year	**3.7**	**3.2**
No. of exceedances/worst year	8	5
No. of exceedances/summer	2.4	1.7
No. of exceedances/worst summer	4	5

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.4**	**0.7**
No. of exceedances/worst year	3	3
No. of exceedances/summer	0.4	0.3
No. of exceedances/worst summer	3	2
Annual average concentration (ug/l)	0.86	1.95

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	7.01	16.74
	90%ile	15.54	37.90
	95%ile	21.21	56.65
	99%ile	34.90	115.47

Step 2

Velocity 0.00 m/s

Tier 1 is used for the calculation

DI 203.82

% settlement needed 51 %

With Active Mitigation (vortex separator with assumed 80% removal of fine sediment)

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration	Copper	Zinc	
Step 2	0.86	1.95	ug/l
Step 3	-	-	ug/l

Copper: River Fails Toxicity Test. Try mitigation

Zinc: River Fails Toxicity Test. Try mitigation

Sediment - Chronic Impact

Alert. D/S Structure.

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	No	41	Deposition Index

Outfall number	IDB drain - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	12/03/2019	Version of assessment	2.0
Notes	Impermeable road area increased by 15% to allow for limits of deviation		

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Warm Dry Rainfall site Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s) 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 2.877 Permeable area draining to outfall (ha) 0.812

Base Flow Index (BFI) 0.73 Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness Low = <50mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

Tier 1 Estimated river width (m) 2

Tier 2 Bed width (m) 1 Manning's n 1 Side slope (m/m) 1 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	Unlimited	0
Proposed measures	vortex separator	0	Unlimited	80

Predict Impact

Show Detailed Results

Exit Tool

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Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff — Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	33.60	21.80
No. of exceedances/worst year	41	29
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	10.70	7.50
No. of exceedances/worst year	17	13
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	25.75	60.02
90%ile	49.14	126.87
95%ile	62.68	162.41
99%ile	86.03	300.69

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	42.60	53.10	0.30	8.10	27.50	8.10	6.60	15.00
No. of exceedances/worst year	52	58	1	15	36	15	11	22
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

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Summary of predictions

	Soluble - Acute Impact		Sediment - Chronic Impact							
	Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact *Step1*										
Step2										
Step3										

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	2	2
No. of exceedances/year	3.7	3.2
No. of exceedances/worst year	8	5
No. of exceedances/summer	2.4	1.7
No. of exceedances/worst summer	4	5

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0.4	0.7
No. of exceedances/worst year	3	3
No. of exceedances/summer	0.4	0.3
No. of exceedances/worst summer	3	2
Annual average concentration (ug/l)	0.86	1.95

		(ug/l)	(ug/l)
Thresholds	*RST24*	21	60
Thresholds	*RST6*	42	120
Event Statistics	Mean	7.01	16.74
	90%ile	15.54	37.90
	95%ile	21.21	56.65
	99%ile	34.90	115.47

Step 2

Velocity 0.00 m/s — Tier 1 is used for the calculation

DI 203.82

% settlement needed 51 %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	2	2
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-
Annual average concentration (ug/l)	-	-

		(ug/l)	(ug/l)
Thresholds resholds	*RST24*	21	60
Thresholds	*RST6*	42	120
Event Statistics	Mean	-	-
	90%ile	-	-
	95%ile	-	-
	99%ile	-	-

DI 40.76

Scenario 2: Discharge to the River Yare (2.5ha impermeable area)

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration	Copper	Zinc		Copper	Zinc
Step 2	0.00	0.00	ug/l	Pass	Pass
Step 3	-	-	ug/l		

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:			
Accumulating?	Yes	0.02	Low flow Vel m/s
Extensive?	No	2	Deposition Index

Outfall number	River Yare - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	01/03/2019	Version of assessment	1.0
Notes			

Step 1 Runoff Quality AADT: >10,000 and <50,000 Climatic region: Warm Dry Rainfall site: Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s): 4.549 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 2.502 Permeable area draining to outfall (ha): 0.812

Base Flow Index (BFI): 0.64 Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Low = <50mg CaCO3/l

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): 100

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

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact

Show Detailed Results

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Summary of predictions

Soluble - Acute Impact: Copper, Zinc

Sediment - Chronic Impact: Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene

Prediction of impact: Step1, Step2, Step3

DETAILED RESULTS

In Runoff

Step 1 — Soluble

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**33.60**	**21.80**
No. of exceedances/worst year	41	29
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	**10.70**	**7.50**
No. of exceedances/worst year	17	13
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	25.75	60.02
90%ile	49.14	126.87
95%ile	62.68	162.41
99%ile	86.03	300.69

Step 1 — Sediment (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**42.60**	**53.10**	**0.30**	**8.10**	**27.50**	**8.10**	**6.60**	**15.00**
No. of exceedances/worst year	52	58	1	15	36	15	11	22
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00
	(ug/l)	(ug/l)
Thresholds RST24	21	60
Thresholds RST6	42	120
Event Statistics Mean	0.00	0.01
90%ile	0.01	0.02
95%ile	0.01	0.03
99%ile	0.03	0.10

Step 2

Velocity 0.02 m/s Tier 1 is used for the calculation

DI 2.71

% settlement needed 0 %

Scenario 2: Discharge to the River Yare (2.88ha impermeable area)

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment Tool version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration	Copper	Zinc		Copper	Zinc
Step 2	0.00	0.00	ug/l	Pass	Pass
Step 3	-	-	ug/l		

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:			
Accumulating?	Yes	0.02	Low flow Vel m/s
Extensive?	No	3	Deposition Index

Outfall number	River Yare - western side of the Scheme	List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	S Cheng
Date of assessment	12/03/2019	Version of assessment	2.0
Notes	Impermeable road area increased by 15% to allow for limits of deviation		

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Warm Dry Rainfall site Ipswich (SAAR 550mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s) 4.549 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 2.877 Permeable area draining to outfall (ha) 0.812

Base Flow Index (BFI) 0.73 Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only Water hardness Low = <50mg CaCO3/l

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) 100

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

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact

Show Detailed Results

Exit Tool

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Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	33.60	21.80
No. of exceedances/worst year	41	29

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	10.70	7.50
No. of exceedances/worst year	17	13

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	25.75	60.02
	90%ile	49.14	126.87
	95%ile	62.68	162.41
	99%ile	86.03	300.69

Step 1

Toxicity Threshold	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	42.60	53.10	0.30	8.10	27.50	8.10	6.60	15.00
No. of exceedances/worst year	52	58	1	15	36	15	11	22
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	367	1308	1	10016	1733	1663	106	469
90%ile	776	3117	1	22387	3873	3716	237	1048
95%ile	1027	3835	2	56234	9729	9335	596	2632
99%ile	1453	7397	3	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	0.00	0.01
	90%ile	0.01	0.02
	95%ile	0.01	0.03
	99%ile	0.04	0.11

Step 2

Velocity 0.02 m/s Tier 1 is used for the calculation

DI 3.29

% settlement needed 0 %

Annex B: Details of the Method D Assessment

Without Active Mitigation

HIGHWAYS AGENCY

View Spillage Assessment Parameters | Reset | Go To Runoff Risk Assessment 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						
D2	Length of road draining to outfall *(m)*	225	420						
D3	Road Type *(A-road or Motorway)*	A	A						
D4	If A road, is site urban or rural?	Urban	Urban						
D5	Junction type	No junction	Roundabout						
D6	Location	< 20 minutes	< 20 minutes						
D7	Traffic flow (AADT two way)	23,041	23,041						
D8	% HGV	4	4						
D8	Spillage factor *(no/10^9HGVkm/year)*	0.31	5.35						
D9	Risk of accidental spillage	0.00002	0.00076	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45						
D11	Risk of pollution incident	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**						
D13	Return period without pollution reduction measures	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000	0.0004	2851
D14	Existing measures factor	1	1						
D15	Return period with existing pollution reduction measures	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000	0.0004	2851
D16	Proposed measures factor	1	1						
D17	Residual with proposed Pollution reduction measures	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000	0.0004	2851

With Active Mitigation (Spillage control penstocks)

HIGHWAYS AGENCY

View Spillage Assessment Parameters | Reset | Go To Runoff Risk Assessment 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						
D2	Length of road draining to outfall *(m)*	225	420						
D3	Road Type *(A-road or Motorway)*	A	A						
D4	If A road, is site urban or rural?	Urban	Urban						
D5	Junction type	No junction	Roundabout						
D6	Location	< 20 minutes	< 20 minutes						
D7	Traffic flow (AADT two way)	23,041	23,041						
D8	% HGV	4	4						
D8	Spillage factor *(no/10^9HGVkm/year)*	0.31	5.35						
D9	Risk of accidental spillage	0.00002	0.00076	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.45	0.45						
D11	Risk of pollution incident	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**	**No**						
D13	Return period without pollution reduction measures	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000	0.0004	2851
D14	Existing measures factor	1	1						
D15	Return period with existing pollution reduction measures	0.00001	0.00034	0.00000	0.00000	0.00000	0.00000	0.0004	2851
D16	Proposed measures factor	0.4	0.4						
D17	Residual with proposed Pollution reduction measures	0.00000	0.00014	0.00000	0.00000	0.00000	0.00000	0.0001	7128