A417 Missing Link
TR010056

6.4 Environmental Statement Appendix 13.4 Water Quality Assessment

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6.4 Environmental Statement
Appendix 13.4 Water Quality Assessment

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1 Introduction

1.1 Purpose of this Document

1.1.1 This document summarises the assessment of potential impacts to surface water and groundwater quality as a result of the scheme. These assessments have been undertaken in accordance with Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment.

2 Assessment of pollution impacts from routine runoff on surface waters

2.1 Introduction

2.1.1 The assessment of potential effects from routine runoff on surface water quality has been undertaken using the Highways England Water Risk Assessment Tool (HEWRAT), as prescribed in DMRB LA 113.

2.1.2 The Environment Agency (EA) has approved the method of assessment used by HEWRAT and has agreed that the outputs from the tool can be used to undertake an assessment of the potential impacts on surface water quality.

2.2 Methodology

2.2.1 HEWRAT adopts the following tiered approach:

- Step 1: Runoff quality. This predicts concentrations of pollutants in untreated and undiluted highway runoff prior to any treatment and dilution in a water body.
- Step 2: In-river impacts. This predicts concentrations of pollutants after mixing within the receiving water body. At this stage, the ability of the receiving watercourse to disperse sediments is considered and, if sediment is predicted to accumulate, the potential extent of sediment coverage (i.e. the deposition index, DI) is also considered. Step 2 also incorporates two 'tiers' of assessment for sediment accumulation, based on different levels of input parameters. If one or more risks are defined as unacceptable at Tier 1, i.e. ‘fail’, then a more detailed Tier 2 assessment is undertaken, requiring values for further parameters relating to the physical dimensions of the receiving watercourse.
- Step 3: In-river impacts with mitigation. Steps 1 and 2 assume that the road drainage system incorporates no mitigation measures to reduce the risk. Step 3 includes mitigation in the form of Sustainable Drainage Systems (SuDS), taking into account the risk reduction associated with any existing measures or any proposed new measures.

Cumulative assessment within HEWRAT

2.2.2 The cumulative impacts of the scheme were calculated following DMRB LA 113. The combined effect of two outfalls into the same watercourse within the same reach (distance between two outfalls into the same watercourse) are assessed by combining the contributing impermeable areas to the affected drainage basins.

2.2.3 For solutes, cumulative effects have been considered where proposed outfalls are within 1km of each other (stream length) and discharge into the same watercourse. For sediment, cumulative impacts have been considered where proposed outfalls are less than 100m apart.

2.2.4 Outfalls from basins 6, 7, 8 and 9 are within 1km of stream length and are therefore combined for cumulative assessment of solutes.

Environmental quality assessments within HEWRAT

2.2.5 A long-term impact assessment of surface water runoff from the highway has been undertaken by comparing the annual average concentrations of copper and zinc predicted in the HEWRAT results with the Environmental Quality Standards (EQSs) stated in the WFD (Standards and Classifications) Directions 2015.

2.2.6 The study area for the HEWRAT assessment encompasses all the watercourses that would receive road runoff from the proposed development, as outlined in ES Chapter 13 Road drainage and water environment (Document Reference 6.2) and displayed on ES Figure 13.1 Surface water features (Document Reference 6.3).

Input parameters

2.2.7 The parameters, methods of derivation and sources of information used in the assessment are listed in Table 2-1.

Table 2-1 Inputs used for the surface water quality assessment

Parameter	Information Source(s)
Two-way annual average daily traffic flow (AADT)	Figures provided from the traffic model. The two-way Annual Average Daily Traffic flow (AADT) for the A417 mainline ranges from 50,000-60,000 at the design year (2039). This falls within the 50,000-100,000 AADT range of the HEWRAT assessment.
Climatic conditions	Selected within HEWRAT. The scheme is within the 'warm and wet' region and with a standard average annual rainfall of 850mm (Bristol).
Q_{95} (the water flow exceeded 95% of the time) of the receiving watercourse.	Catchment descriptors obtained from the FEH Web Service and Q_{95} subsequently derived using the FEH LowFlows tool, the standard method for estimating Q_{95} in the absence of monitoring data. The estimated values have been ground-truthed via site walkover. All receiving watercourses are headwater streams with low estimated Q95 values, ranging from <0.001 to 0.002 m^3/s.
Base flow index (BFI)	Obtained from the FEH Web Service for each catchment. This is a measure of the proportion of the flow in the watercourse that derives from groundwater.
Drainage areas	Impermeable area (e.g. highway) and permeable area (e.g. cutting/slope drainage) to each outfall has been calculated from the design models of the scheme.
Water hardness	Water hardness has been estimated using the Drinking Water Inspectorate Map for England and Wales. All watercourses have been deemed to have a medium water hardness, i.e. 50-200 $CaCO_3$/l.
Physical attributes of the receiving watercourse	Watercourse dimensions and Manning's n have been estimated based on the ES Appendix 13.10 Water Features Survey (Document Reference 6.4) and site walkover. Watercourse long slope has been estimated based on available topographic survey.

2.2.8 Table 2-2 lists the receiving watercourse, Q_{95} and drainage areas for each outfall on the new section of A417 and side roads.

Table 2-2 Input data for HEWRAT assessments

Outfall	Receiving watercourse	Q95 (m^3/s)	Impermeable area (ha)	Permeable area (ha)	BFI
2	Tributary of Normans Brook	0.001	5.38	1.25	0.635
3c	Tributary of Normans Brook	0.001	1.97	0.77	0.635
3a	Tributary of River Churn 1	0.001	3.77	2.01	0.635
5a, 5b, 5c	Tributary of River Churn 1	0.001	2.22	1.48	0.635
6	Tributary of River Churn 2	0.001	2.09	1.17	0.746
7b	Tributary of River Churn 2	0.002	2.13	2.17	0.746
8	Tributary of River Churn 2	0.002	0.88	0.27	0.746
9	Tributary of River Churn 2	0.001	1.89	2.01	0.746
10	Tributary of River Frome 1	0.002	2.52	3.26	0.746
11a, 11b, 11c	Tributary of River Frome 2	0.002	5.75	7.34	0.746

2.2.9 The proposed discharge locations were screened against the location of protected areas (e.g. Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC)). Outfall locations less than 1km upstream of a protected site require more stringent pollutant thresholds to be applied. Only Outfall 10, which is approximately 300m upslope of Bushley Muzzard SSSI meets this criterion.

2.3 Results – without mitigation

2.3.1 All outfalls failed the Step 1 assessment.

2.3.2 All outfalls failed the Step 2 soluble pollutant assessment, but all pass the sediment assessment. Mitigation (treatment) is therefore required within the drainage design to reduce the soluble pollutant load. The detailed results of the Step 2 assessment are shown in Table 2-3.

Table 2-3 Summary of routine runoff assessments

Basin Outfall	Step 2 HEWRAT result				
	Copper - Acute	Copper - EQS	Zinc - Acute	Zinc - EQS	Sediment
2	Fail	Fail	Fail	Fail	Pass at Tier 2
3c	Fail	Fail	Fail	Fail	Pass at Tier 2
3a	Fail	Fail	Fail	Fail	Pass at Tier 2
5a, 5b, 5c	Combined with Basin 3a for cumulative sediment and soluble pollutant assessment.				
6	Fail	Fail	Fail	Fail	Pass at Tier 2
7b	Combined with outfall 6 in cumulative assessment for soluble pollutants.				Pass at Tier 2
8					Pass at Tier 2
9					Pass at Tier 2
10	Fail	Fail	Fail	Fail	Pass at Tier 2
11a, 11b, 11c	Fail	Fail	Fail	Fail	Pass at Tier 2

2.4 Mitigation

2.4.1 A sensitivity test was undertaken using the HEWRAT model to identify the percentage mitigation required for each outfall to pass (Table 2-5). Treatment trains have been developed for the drainage systems to each outfall to ensure that the required treatment levels met.

2.4.2 The level of pollutant removal have been determined from the values listed in CG501 Design of highway drainage systems (Table 2-4).

Table 2-4 Indicative treatment efficiencies (from CG 501, Table 8.6.4N3)

Name of measure	Indicative treatment efficiencies		
	Suspended Solids (% removal)	Dissolved Copper (% removal)	Dissolved Zinc (% removal)
Filter Drains	60	0	45
Ditch	25	15	15
Swale/grassed SWC	80	50	50
Drainage basin (wet)	60	40	30
Infiltration basin (soakaway)	100	100	100

Table 2-5 Summary of proposed pollutant treatment

Basin Outfall	Percent of treatment required (soluble)	Proposed treatment methods	Comment
2	60	Swale, Filter Drain, drainage basin	Sufficient pollution removal
3c	35	Swale, Filter Drain, drainage basin, Ditch	Sufficient pollution removal
3a	60	Swale, Filter Drain, drainage basin, Ditch	Sufficient pollution removal
5a, 5b, 5c		Filter Drain, drainage basin, Ditch	Sufficient pollution removal
6	45	Filter Drain, drainage basin, Ditch	**Additional measures required in forebay for copper removal**
7b		Filter Drain, drainage basin, Ditch	**Additional measures required in forebay for copper removal**
8		Drainage basin, Ditch	**Additional measures required in forebay for copper and zinc removal**
9		Swale, Filter Drain, drainage basin, Ditch	Sufficient pollution removal
10	50	Swale, Filter Drain, drainage basin, Ditch	Sufficient pollution removal
11a, 11b, 11c	40	Swale, Filter Drain, drainage basin, Ditch	Sufficient pollution removal

2.5 Results – with mitigation

2.5.1 All networks on the scheme include a basin along with at least one other measure as a treatment train. Catchments with high “% Treatment Required” and no swale

/ grassed SWC such as catchments 6, 7b/c and 8 require an additional pollution control measure to meet the required removal percentage. This additional treatment would be in the form of a forebay within the drainage basins to effectively remove pollutants. The forebay design would be developed at the detailed design stage.

2.5.2 Once this additional treatment is incorporated into the drainage design, all outfalls pass the assessment of pollution impacts from routine runoff on surface waters.

2.5.3 The exact type and configuration of the drainage basins would depend heavily on the specific ground conditions (suitability for infiltration) at each location and the preferred maintenance regime of the adopting body (HE or GCC).

2.5.4 This surface water quality assessment is based on a precautionary assumption that no infiltration would take place within the drainage systems and at the drainage basins. When the ground investigation is complete, there would be opportunities to introduce infiltration techniques and optimise the drainage basin designs. Infiltration would also significantly improve the pollutant removal performance of the highway drainage systems.

3 Assessment of pollution impacts from routine runoff on groundwater

3.1 Introduction

3.1.1 Given the relatively low flows of the watercourses receiving flow from the road drainage and the suitability of ground conditions for infiltration across much of the scheme, it is prudent to carry out an assessment of pollution impacts from routine runoff to groundwater. This assessment has also been undertaken using HEWRAT, following the guidance in DMRB LA 113.

3.1.2 This risk assessment procedure is based on the study of the source-pathway-receptor (S-P-R) pollutant linkage principal, whereby the:

- source comprises the road drainage water with any pollutants contained therein, as it enters any unlined ditch, watercourse or soakaway discharge system, that has the potential to transmit water through the ground to groundwater
- pathway represents the processes, which may modify the pollutants during transmission through the discharge system and soil and subsoil until the actual 'point of entry' to groundwater (this includes the unsaturated zone)
- receptor is groundwater

3.1.3 For there to be a risk of impact to the receiving environment, all elements of the S-P-R model must be present to for there to be a pollutant linkage.

3.2 Methodology

3.2.1 The drainage solution for the scheme includes drainage basins, all of which discharge to surface watercourses but may also infiltrate to groundwater pending completion of the ground investigation. The drainage basins are situated at various points along the scheme and for the purposes of the assessment, are assumed to act as soakaways.

3.2.2 The assessment determines an overall risk score by incorporating the key factors affecting the level of risk posed by the source of pollutants, the persistence and movement of pollutants within the pathway to groundwater and linkages between them. In this way, the matrix provides a means of ranking specific road drainage discharge sites in terms of their potential risks to groundwater.

3.3 Results

3.3.1 Table 3-6 summarises the results of the groundwater assessment. The risk scores range from 170 to 220, within the 150 – 250 suggested action class range, which indicates there is a medium risk of impact.

Table 3-6 Overall risk scores

	Weighting factor	Property or parameter	Site data	Risk score	Component score
SOURCE	10	Traffic flow	>50,000 to <100,000	Medium	20
	10	Rainfall depth (annual averages)	850mm (Bristol)	Medium	20
	10	Drainage area ratio	<50	Low	10
PATHWAY	15	Infiltration method	Region	Medium	30
	20	Unsaturated Zone	Ranges from <5m to >15m. Based on groundwater monitoring data.	Low, medium or high	20, 40, 60
	20	Flow Type	Intergranular, mixed and fracture flow present at different locations along scheme.	Low, medium or high	20, 40, 60
	5	Unsaturated zone clay content	Ranges from <1% to >15% along scheme.	Low, medium or high	5, 10, 15
	5	Organic carbon	Typically <1% but occasionally 1-15%	Medium or high	10, 15
	5	Unsaturated zone soil pH	<5 or 5-8	Medium or high	10, 15
Overall Risk Score				Medium risk	Min = 170 Max = 220

3.4 Mitigation

3.4.1 DMRB LA 113 states that where a medium risk of impact is indicated, a detailed assessment is required to be undertaken by a competent expert.

3.4.2 The detailed assessment would be undertaken at the detailed design stage. This would be supported by further site-specific tests, such as infiltration rate through the ground. Ground conditions specific to the drainage basin locations would also be ascertained through further ground investigation. Baseline groundwater level and quality monitoring would be ongoing and would also inform the assessments.

3.4.3 The specific mitigation measures required in the design of drainage systems and drainage basins would therefore be refined at detailed design. This could include measures to separate carriageway drainage systems from groundwater, the lining of drainage basins, and limitations on the disposal of surface water though infiltration.

3.4.4 Where required, the detailed assessment would incorporate mitigation measures to reduce the risk to a suitable level.

3.4.5 Details of mitigation are reported in ES Chapter 13 Road drainage and water environment (Document Reference 6.2) and Annex G Ground and surface water management plan of ES Appendix 2.1 Environmental Management Plan (EMP) (Document Reference 6.4).