# M60/M62/M66 Simister Island Interchange

## TR010064

# ENVIRONMENTAL STATEMENT APPENDICES

# APPENDIX 13.2 WATER QUALITY ASSESSMENT REPORT

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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**The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**

# M60/M62/M66 Simister Island Interchange

Development Consent Order 202[ ]

## ENVIRONMENTAL STATEMENT APPENDICES
## APPENDIX 13.2 WATER QUALITY ASSESSMENT REPORT

| | |
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# Appendix 13.2 Water quality assessment report

# 1 Introduction

## 1.1 Overview

1.1.1 This document presents the assessment of water quality impacts to surface water due to discharges of road runoff from the M60/M62/M66 Simister Island Interchange (the 'Scheme') during its operation as well as impacts from accidental spillage. These assessments have been undertaken in accordance with the Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment (DMRB LA 113) (Highways England, 2020a).

1.1.2 This document forms an appendix to Chapter 13: Road Drainage and the Water Environment of the Environmental Statement (TR010064/APP/6.1). This document is supported by Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR010064/APP/6.3).

## 1.2 Purpose of the assessment

1.2.1 There are two main sources of pollution from roads during the operational phase: routine runoff and accidental spillage risk.

1.2.2 Routine runoff consists of road deposits which can contain a range of contaminants such as suspended solids, heavy metals and hydrocarbons. When combined with rainfall, these contaminants can runoff into the highway drainage system that discharges to a watercourse, potentially polluting the surface water environment.

1.2.3 On all roads there is a risk that an accidental spillage or fire may lead to an acute pollution incident. Where spillages do reach a surface watercourse the pollution impact can be severe, but is usually of short duration, typical of an acute pollution impact.

## 1.3 Drainage strategy

### Existing drainage network

1.3.1 The existing drainage network is comprised of six drainage catchments. Full details on the individual drainage catchments are provided in Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR001064/APP/6.3).

1.3.2 Details of the existing drainage networks has been defined using the Drainage Data Management System (DDMS) (National Highways, 2023), as-built drawings and drainage surveys. It has been found that, currently there is no existing treatment for water quality provided. Again, full details on the individual drainage catchments are provided in Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR001064/APP/6.3).

## Drainage network

1.3.3 The drainage networks for the Scheme are comprised of seven catchments. The Scheme will include modifications to existing catchments, with the exception of Catchment 3, which is not affected by the Scheme. An additional drainage catchment (Catchment 7) would be created as part of the Scheme. The details of the drainage catchments and water quality treatment measures for the Scheme are shown in Table 1.1.

### Table 1.1 Existing and Scheme drainage network details

| Existing Drainage Catchment | Existing Network Outfall Point (Easting/Northing) | Scheme Drainage Catchment | Network Outfall Point (Easting/Northing) | New or Existing Outfall | Receiving Watercourse | Identified Water Quality Treatment Measure |
|---|---|---|---|---|---|---|
| Catchment 1 | 382836, 406494 | Catchment 1 (1A+1B) | 382879, 406583 | New | Castle Brook | 1x Retention Pond + 1x Swale |
| Catchment 2 | 382605, 407406 | Catchment 2 | 382605, 407406 | Existing | Castle Brook | 1x Retention Pond |
| Catchment 4 | 381549, 406348 | Catchment 4 | 381549, 406348 | Existing | Parr Brook | 2x Swale + 1x Retention Pond |
| Catchment 5 | 384748, 404838 | Catchment 5 | 384748, 404838 | Existing | River Irk | 1x Retention Pond |
| Catchment 6 | 378499, 403535 | Catchment 6 | 378499, 403535 | Existing | River Irwell | None (Oversized pipes for attenuation) |
| N/A – New outfall | N/A | Catchment 7 | 381549, 406348 | New | Parr Brook | 1x Retention Pond |

# 2 Assessment methodology and approach

## 2.1 Introduction

2.1.1 The assessment of potential impacts on water quality during the operational phase has been undertaken for routine runoff and spillage risk using the Highways England Water Risk Assessment Tool (HEWRAT), as detailed in DMRB LA 113.

## 2.2 Routine runoff – simple level assessment

2.2.1 The HEWRAT routine runoff assessment uses a three-step approach to assess the impacts of both soluble and sediment-bound pollutants. The three-step approach is as follows:

- Step 1: estimates pollutant concentrations in the undiluted road runoff.
- Step 2: estimates pollutant concentrations after dilution within the receiving water body.
- Step 3: estimates pollutant concentrations after mitigation (i.e. the treatment provided by the sustainable urban drainage systems (SuDS)) and dilution within the receiving water body.

2.2.2 Under Step 1, undiluted pollutant concentrations in the drainage discharges are determined. These values are then used in Step 2 to estimate the pollutant concentrations after dilution in the receiving watercourse. For Step 2, the HEWRAT model results are compared to a set of compliance thresholds for sediments, acute impacts from soluble copper and zinc (compared with Runoff Specific Thresholds (RSTs)) and the annual average concentrations of (soluble) copper and zinc which are compared with Environmental Quality Standards (EQS). Results are recorded and compliance is indicated in the model outputs by a ‘pass’ or ‘fail’.

2.2.3 Chronic impacts associated with sediment-bound pollutants are assessed on whether polluted sediment will accumulate on the riverbed or disperse in the river downstream (based on the stream velocity under low flow conditions).

2.2.4 Step 2 is carried out in two ‘tiers’ of assessment for sediment accumulation, based on different levels of input parameters: Tier 1 requires input of the estimated river width at $Q_{95}$ (the flow in the receiving watercourse that is exceeded 95% of the time) only, whilst Tier 2 requires information regarding the physical properties of the receiving watercourse, for example the bank side slopes and longitudinal gradient. Step 2 Tier 2 assessments are generally undertaken following a sediment failure of Step 2 Tier 1.

2.2.5 Step 3 allows the HEWRAT tool to apply levels of treatment (as “percentages”) to provide an indication of the type of mitigation required for both sediment-bound and soluble pollutants. Treatment values (efficiencies) are in accordance with DMRB CG 501 (Highways England, 2020b).

2.2.6 In accordance with DMRB LA 113, outfalls discharging to the same watercourse within 100m of each other have been assessed cumulatively for soluble and sediment-bound pollutants and within 1km of each other for soluble pollutants.

## 2.3 Spillage risk

2.3.1 For all roads, there is a risk that a spillage may lead to an acute pollution incident. Where spillages do reach a surface watercourse the pollution impact can be severe, but is usually of short duration, typical of an acute pollution impact.

2.3.2 The spillage risk assessment within DMRB LA 113 has been designed to calculate spillage risk during the operation of the Scheme and the associated probability of a serious pollution incident. The risk is calculated assuming an incident involving the spillage of a potentially polluting substance onto the carriageway would occur at an assumed frequency based on calculated road traffic volumes, the percentage of that road traffic volume considered as Heavy Good Vehicles (HGV), and the type of road/junction. The annual probability of an accidental spillage leading to a serious pollution incident is also dependent on the response time of the emergency services. A risk factor is applied depending on the location and road/junction type and the sensitivity of the receiving watercourse.

2.3.3 DMRB LA 113 states that the risk of a serious pollution incident is deemed to be within acceptable limits if the Annual Exceedance Probability (AEP) is less than a 1% (i.e. a 1 in 100-year return period or greater). Where the spillage is within 1km of a sensitive area the risk of a serious pollutant incident is deemed within acceptable limits if the AEP is less than 0.5% (i.e. a 1 in 200-year return period or greater).

## 2.4 Summary of limitations and assumptions

2.4.1 The following assumptions and limitations have been identified:

- The assessments are based upon the latest and most up-to-date designs for the drainage design. See full details in Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR010064/APP/6.3). The Scheme will be subject to further refinement and change during future stages of the Scheme. Therefore, the design details included in this assessment are subject to change based on any design changes.
- Some data associated with this assessment has been established through a desktop study or from existing information sources.
- Some estimates of channel dimensions and characteristics used in the assessments have been informed from online aerial imagery. Where assumptions or uncertainties in the input data used in the assessments have been identified, these have been highlighted in the relevant sections of this report.
- The identification and assessment of potential mitigation solutions has not considered constraints or the presence of utilities or any other considerations which may affect feasibility.

- The ambient background concentration (ABC) for copper have not been included within the HEWRAT assessments. The reliability of the copper data available utilising site collected data or data freely available online from the Environment Agency was not considered robust to be included within the assessments. A programme of water quality sampling will be undertaken during the detailed design phase in advance of construction. This will allow refinement of the HEWRAT assessments to be undertaken. A sensitivity test has been undertaken using the existing available data and is available in Annex B.

# 3 Assessment results

## 3.1 Introduction

3.1.1 This section presents the results of the water quality assessments undertaken for the Scheme. Annex A provides a summary of the input data used within the assessments.

## 3.2 Routine runoff assessment results

### Existing situation assessment results

3.2.1 Table 3.1 shows the results of the existing situation for outfalls with available site data at Step 2 (Tier 1). Within the table, a traffic light system has been used to aid interpretation: green shading indicates a HEWRAT 'pass', and red shading indicates HEWRAT 'fail'.

**Table 3.1 HEWRAT Step 2 Tier 1 assessment results for the existing situation**

| Outfall (assessment location) | Annual Average Concentration related to EQS Compliance: EQS Copper = 1.0µg/l and Zinc = 10.9µg/l | | Sediment Bound Pollutants (Pass /Fail) | Acute Soluble Copper & Zinc number of exceedances/year (RST exceedance limits in brackets) | | | |
|---|---|---|---|---|---|---|---|
| | Cu (µg/l) | Zn (µg/l) | | RST 24 hours (2) | | RST 6 hours (1) | |
| | | | | Cu | Zn | Cu | Zn |
| 1 | 1.31 | 7.02 | Pass | 4.80 | 5.90 | 1.10 | 2.00 |
| 2 | 0.83 | 4.46 | Pass | 2.40 | 3.20 | 0.30 | 1.20 |
| 4 | 0.24 | 1.33 | Pass | 0.20 | 0.50 | 0.20 | 0.10 |
| 5 | 0.10 | 0.5 | Pass | 0.00 | 0.10 | 0.00 | 0.00 |
| 6 | 0.01 | 0.08 | Pass | 0.00 | 0.00 | 0.00 | 0.00 |

### Scheme assessment results

#### Results – without mitigation

3.2.2 All outfalls failed the Step 1 assessment, which screens against Annual Average Daily Traffic (AADT), climatic region, and standardised annual average rainfall only. This represents the undiluted pollutant concentrations in the drainage discharges prior to reaching the watercourse. These are carried forward and used in Step 2 assessments to estimate the pollutant concentrations after dilution in the receiving watercourse.

3.2.3 A Step 2 Tier 1 assessment (i.e. no mitigation) has been undertaken based upon the Scheme. The results of the assessments are summarised in Table 3.2. Locations of the outfalls are provided in Figure 13.2: Outfall Locations of the Environmental Statement Figures (TR010064/APP/6.2).

**Table 3.2 HEWRAT results from Step 2 Tier 1 (no mitigation).**

| Outfall | Receiving Watercourse (assessment location) | Annual Average Concentration related to EQS Compliance: EQS Copper = 1.0µg/l and Zinc = 10.9µg/l | | Sediment Bound Pollutants (Pass /Fail) | Acute Soluble Copper & Zinc number of exceedances/year (RST exceedance limits in brackets) | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cu (µg/l) | Zn (µg/l) | | RST 24 hours (2) | | RST 6 hours (1) | |
| | | | | | Cu | Zn | Cu | Zn |
| 1 (1A +1B) | Castle Brook downstream of confluence | 1.50 | 7.95 | Pass | 6.10 | 6.70 | 1.00 | 2.60 |
| 2 | Castle Brook | 0.82 | 4.42 | Pass | 2.30 | 3.10 | 0.30 | 1.20 |
| 4 | Parr Brook | 0.79 | 4.24 | Pass | 1.90 | 3.00 | 0.30 | 0.70 |
| 5 | River Irk | 0.10 | 0.56 | Pass | 0.00 | 0.10 | 0.00 | 0.00 |
| 6 | River Irwell | 0.01 | 0.08 | Pass | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | Parr Brook | 0.15 | 0.55 | Pass | 0.10 | 0.10 | 0.00 | 0.00 |
| **Cumulative Assessment** | | | | | | | | |
| 4 + 7 | Parr Brook | 0.98 | 5.27 | Pass | 2.90 | 3.80 | 0.30 | 1.00 |

**Step 3 (post-mitigation) HEWRAT assessment results**

3.2.4 Table 3.3 presents the results from the Step 3 HEWRAT assessments for the design including embedded mitigation.

## Table 3.3 Step 3 routine runoff results for the Scheme (including embedded mitigation)

| Outfall | Receiving Watercourse (assessment location) | Annual Average Concentration related to EQS Compliance: EQS Copper = 1.0µg/l and Zinc = 10.9µg/l | | Sediment Bound Pollutants (Pass /Fail) | Acute Soluble Copper & Zinc number of exceedances/year (RST exceedance limits in brackets) | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cu (µg/l) | Zn (µg/l) | | RST 24 hours (2) | | RST 6 hours (1) | |
| | | | | | Cu | Zn | Cu | Zn |
| 1 (1A+1B) | Castle Brook | 0.45 | 2.78 | Pass | 0.20 | 0.80 | 0.00 | 0.10 |
| 2 | Castle Brook | 0.49 | 3.09 | Pass | 0.60 | 1.70 | 0.10 | 0.20 |
| 4 | Parr Brook | 0.27 | 1.70 | Pass | 0.10 | 0.30 | 0.00 | 0.00 |
| 5 | River Irk | 0.08 | 0.48 | Pass | 0.00 | 0.10 | 0.00 | 0.00 |
| 6 | River Irwell | 0.01 | 0.08 | Pass | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | Parr Brook | 0.09 | 0.39 | Pass | 0.00 | 0.00 | 0.00 | 0.00 |
| **Cumulative Assessment** | | | | | | | | |
| 4 + 7 | Parr Brook | 0.44 | 2.74 | Pass | 0.20 | 1.30 | 0.30 | 0.20 |

# 4 Spillage risk

## 4.1 Assessment results

4.1.1 Table 4.1 presents the results from the accidental spillage risk assessment for the Scheme. With reference to the results, an annual probability of a serious pollutant incident occurring over a return period of >200 years is deemed to have a negligible magnitude of impact.

**Table 4.1 Spillage risk assessment results**

| Catchment | Total Road Length (km) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) % | Return Period (years) of Spillage | Unacceptable Risk? |
|---|---|---|---|---|---|
| 1A + 1B | 4.478 | 0.0019 | 0.0856 | 1,169 | No |
| 2 | 0.865 | 0.0002 | 0.0105 | 9,505 | No |
| 4 | 2.621 | 0.0020 | 0.897 | 1,114 | No |
| 5 | 1.188 | 0.0007 | 0.0298 | 3,357 | No |
| 6 | 2.839 | 0.0051 | 0.2317 | 432 | No |
| 7 | 1.550 | 0.0012 | 0.0538 | 1,860 | No |

# 5 Significance of effects

## 5.1 Assessment criteria

5.1.1 The criteria for identifying the magnitude of impacts, related to water quality impacts, are documented in DMRB LA 113. Table 5.1 outlines the criteria which is dependent upon the HEWRAT results for routine runoff and accidental spillage risk. The magnitude of an impact (selected from Table 5.1) and the value of a receptor are combined to produce the significance of effect (Table 5.2). The significance of effect is based upon the criteria outlined in DMRB LA 104 (Highways England, 2020c).

**Table 5.1 Routine runoff and accidental spillage risk criteria for establishing the magnitude of impact (taken from Table 3.70 in DMRB LA 113).**

| Magnitude of impact | Criteria |
|---|---|
| Major adverse | Failure of both acute-soluble **and** chronic-sediment related pollutants in HEWRAT and compliance failure with EQS values.<br>Calculated risk of pollution from a spillage ≥2% annually (spillage assessment) |
| Moderate adverse | Failure of **both** acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values.<br>Calculated risk of pollution from spillages ≥1% annually and <2% annually. |
| Minor adverse | Failure of **either** acute soluble or chronic sediment related pollutants in HEWRAT.<br>Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. |
| Negligible | No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants).<br>Risk of pollution from spillages <0.5% |
| Minor Beneficial | HEWRAT assessment of either soluble or sediment-bound pollutants becomes a ‘pass’ from an existing baseline of a ‘fail’ condition.<br>Calculated reduction in existing spillage risk by 50% or more (when existing spillage is <1% annually). |
| Moderate Beneficial | HEWRAT assessment of both soluble and sediment-bound pollutants becomes a ‘pass’ from an existing baseline of a ‘fail’ condition.<br>Calculated reduction in existing spillage risk by 50% or more when existing spillage is >1% annually).<br>Contribution to improvement in water body WFD Regulations classification. |
| Major Beneficial | Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a water body. Improvement in water body WFD Regulations classification. |

**Table 5.2 Value of receptors for receiving watercourses**

| Outfall Number (assessment location) | Receiving watercourse | DMRB LA 113 criteria/typical examples used to determine value | Value |
|---|---|---|---|
| 1 (1A + 1B) | Castle Brook | Watercourse not having a WFD classification shown in RBMP and a $Q_{95}$>0.001m$^3$/s. | Medium |
| 2 | Castle Brook | Watercourse not having a WFD classification shown in RBMP and a $Q_{95}$>0.001m$^3$/s. | Medium |
| 4 | Parr Brook | Watercourse not having a WFD classification shown in RBMP and a $Q_{95}$>0.001m$^3$/s. | Medium |
| 5 | River Irk | Watercourse having a WFD classification shown in RBMP and a $Q_{95}$<1.0m$^3$/s. | High |
| 6 | River Irwell | Watercourse having a WFD classification shown in RBMP.<br>$Q_{95}$ >1.0m$^3$/s, however, watercourse not achieving 'High' physico-chemical and biological elements and no 'Pass' for specific pollutants/priority substances. Also not within a protected/designated site. | High |
| 7 | Parr Brook | Watercourse not having a WFD classification shown in RBMP and a $Q_{95}$>0.001m$^3$/s. | Medium |

## 5.2 Significance with embedded mitigation

5.2.1 The significance of effect has been determined with the embedded mitigation for the Scheme and based upon the HEWRAT results presented above. All outfalls pass the routine runoff and spillage risk assessments (presented in Section 4), in Table 5.3.

**Table 5.3 Residual significance of effect of single and cumulative outfall assessments**

| Outfall Number | Receiving watercourse (and value) | Magnitude of impact | Significance of effect with embedded mitigation |
|---|---|---|---|
| 1 (downstream location on Castle Brook) | Castle Brook (Medium) | Minor (Beneficial) | Slight (Beneficial) |
| 2 | Castle Brook (Medium) | Minor (Beneficial) | Slight (Beneficial) |
| 4 (at outfall location) | Parr Brook (Low) | Negligible | Neutral |
| 5 | River Irk (High) | Negligible | Neutral |
| 6 | River Irwell (High) | Negligible | Neutral |

| Outfall Number | Receiving watercourse (and value) | Magnitude of impact | Significance of effect with embedded mitigation |
|---|---|---|---|
| 7 (at outfall location) | Parr Brook (Low) | Negligible | Neutral |
| 4 + 7 (at downstream location) | Parr Brook (Medium) | Negligible | Neutral |

5.2.2 After embedded mitigation measures are applied, the significance of effects are no greater than slight (beneficial) and therefore are not deemed to be environmentally significant.

5.2.3 DMRB LA 113 also includes criteria for establishing beneficial impacts, which can be identified when comparing the existing situation results to the Scheme results including embedded mitigation. HEWRAT results demonstrate that two of the outfalls (Outfall 1 and Outfall 2) both pass all parameters where the existing situation fail for soluble copper and/or zinc.

# 6 Conclusions

6.1.1 The water quality assessments have considered the impact of the Scheme in relation to pollution from routine runoff and accidental spillage risk. Simple level assessments using HEWRAT have been undertaken and results show no significant effects including embedded mitigation. Beneficial effects (where the Scheme demonstrates an improvement upon the existing situation) have been recorded for two outfalls.

6.1.2 All outfalls pass the EQS and RSTs for Copper and Zinc and for sediment bound pollutants at Step 3 (including embedded mitigation). The spillage risk assessment results for the Scheme show that all outfalls meet the acceptable limits. As such, potential impacts from the Scheme are deemed not to be environmentally significant.

# Acronyms and initialisms

| Acronym or initialism | Term |
|---|---|
| AADT | Annual Average Daily Traffic |
| ABC | Ambient background concentration |
| AEP | Annual Exceedance Probability |
| BFI | Baseflow Index |
| DDMS | Drainage Data Management System |
| DMRB | Design Manual for Roads and Bridges |
| EQS | Environmental Quality Standards |
| HEWRAT | Highways England Water Risk Assessment Tool |
| HGV | Heavy Goods Vehicle |
| RDWE | Road Drainage and the Water Environment |
| RST | Runoff Specific Threshold |
| SuDS | Sustainable urban drainage systems |
| SAAR | Standard Average Annual Rainfall |
| vpd | Vehicles per Day |
| WFD | Water Framework Directive |

# Glossary

| Term | Definition |
|---|---|
| Acute impact | Occurs as a result of a severe, usually transient, event. For road runoff, acute pollution is usually the result from a spillage of pollutants, but can result from routine runoff. |
| Annual Exceedance Probability (AEP) | Annual Exceedance Probability e.g. 1% AEP is equivalent to 1% (1 in 100) probability of flooding occurring in any one year (or, on average, once in every 100 years). |
| Baseflow Index | The proportion of the flow in a watercourse made up of groundwater and discharges. Base flow sustains the watercourse in dry weather. |
| Environmental Quality Standard | The maximum permissible concentration of a potentially hazardous chemical. The Environmental Quality Standard is used to assess the risk to the health of aquatic flora and fauna. |
| $Q_{95}$ | The flow rate of the watercourse that is exceeded for 95% of the time. |

| Term | Definition |
|---|---|
| Routine runoff | The normal runoff from roads including any contaminants washed off the surface in rainfall events which can result in either acute or chronic impacts. Routine runoff excludes the effect of spillages and major leaks which usually result in acute impacts. |
| Runoff Specific Threshold | Time dependent (24 hour or six hour) soluble pollutant concentration above which adverse effects may be observed in aquatic fauna. |
| Treatment Train | Where multiple SuDS measures treat runoff to a single outfall |

# References

Highways England (2020a). Design Manual for Roads and Bridges, LA 113 Road Drainage and the Water Environment. Revision 1.

Highways England (2020b). Design Manual for Roads and Bridges, CG 501 Design of highway drainage systems.

Highways England (2020c). Design Manual for Roads and Bridges, LA 104 Environmental Assessment and Monitoring. Revision 1.

National Highways (2023). Highways Agency Drainage Data Management System (DDMS). Accessed April 2023. https://www.haddms.co.uk/index.cfm?fuseaction=home.main.

Institute of Hydrology (1995). Report No. 108. Low flow estimation in the United Kingdom.

Wallingford HydroSolutions (2022). LowFlows Reports.

UK Centre for Ecology and Hydrology (2021). National River Flow Archive. Accessed May 2023.

Highways England Water Risk Assessment Tool (HEWRAT) v2.0.4 and HEWRAT Help Guide v2.0. Accessed June 2023. www.haddms.co.uk.

# Annex A Data summary

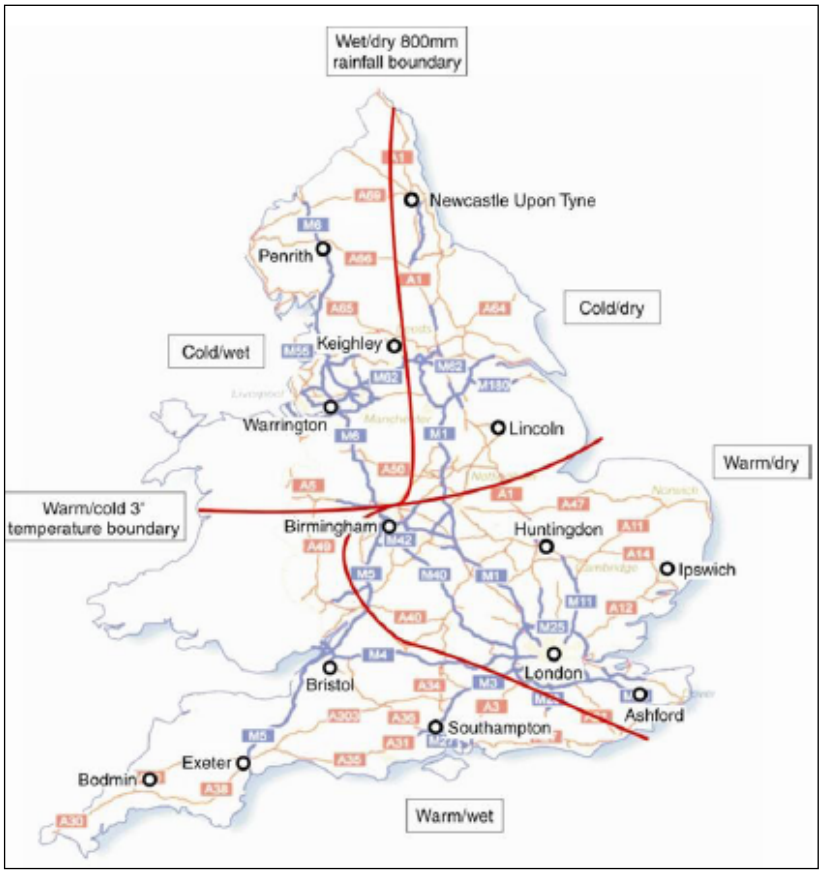
## A.1 HEWRAT – Baseline data for Step 1 (Runoff quality) assessments

A.1.1 Baseline data, site-specific data collected during site surveys, and the most recent drainage design have all been used within the routine runoff assessments.

### Climatic Region

A.1.2 The Scheme lies within the north west of England and the climatic region has been selected as Cold/Wet based upon the figure in the HEWRAT Help guide v2.0 as shown in Plate A.1.

**Plate A.1 HEWRAT Climatic Regions (HEWRAT Help Guide, 2023)**




### Rainfall Site

A.1.3 Selected as Keighley (Standard Average Annual Rainfall (SAAR) 1000mm) as the closest in proximity to the Scheme. Using the SAAR based upon the Keighley figure is therefore considered representative of the Scheme area.

A.1.4 It has been noted that the Scheme lies near to the Warrington SAAR (830mm) rainfall site. A sensitivity test has been undertaken using this rainfall site and it was recorded that this had no change on the Pass/Fail scenario of the overall results compared to using Keighley.

### Traffic data

A.1.5 The assessments have been based upon the baseline year (2017/18) for the existing situation assessments and the design year (2042) of the Scheme. The traffic flow model has been used to identify the two-way AADT for the length of road discharging to each outfall. By using the highest AADT this provides a worst-case scenario. Table A.1 details the AADT bands used in the routine runoff assessments for the Scheme based upon the design year.

**Table A.1 AADT band used in the routine runoff assessments for the Scheme (design year 2044)**

| Drainage catchment/Outfall number | AADT band used in assessment |
|---|---|
| 1 (1A+1B) | >100,000 |
| 2 | >100,000 |
| 4 | >100,000 |
| 5 | >100,000 |
| 6 | >100,000 |
| 7 | 50,000 – 100,000 |
| 4 + 7 | >100,000 |

## A.2 HEWRAT – Baseline data for Step 2 (River impacts) assessments

### Annual 95%ile river flow ($Q_{95}$) and Baseflow Index

A.2.1 $Q_{95}$ is the flow that is exceeded 95% of the time and is an indication of low flow. Within HEWRAT the minimum assessable $Q_{95}$ is 0.0011$m^3/s$. Baseflow Index is the contribution of groundwater to a watercourse.

A.2.2 Table A.2 presents the $Q_{95}$ and Baseflow Index (BFI) data used for each outfall in the assessment. $Q_{95}$ and BFI values have been obtained from various sources, these are outlined within Table A.2.

**Table A.2 $Q_{95}$ for each assessment point**

| Catchment (Receiving watercourse) Location of $Q_{95}$ | Easting/ Northing of Outfall Point to Receiving Watercourse | Outfall | $Q_{95}$ used in the assessment ($m^3/s$) | BFI | Description/Data source |
|---|---|---|---|---|---|
| Castle Brook | 382879, 406583 | 1 | 0.010 | 0.8 | From Wallingford LowFlow Service |
| Castle Brook | 382605, 407406 | 2 | 0.012 | 0.75 | From Wallingford LowFlow Service |

| Catchment (Receiving watercourse) Location of $Q_{95}$ | Easting/ Northing of Outfall Point to Receiving Watercourse | Outfall | $Q_{95}$ used in the assessment ($m^3/s$) | BFI | Description/Data source |
|---|---|---|---|---|---|
| Parr Brook | 381549, 406348 | 4 | 0.014 | 0.78 | Wallingford Hydrosolutions (2022) LowFlow Service |
| River Irk | 384748, 404838 | 5 | 0.24065 | 0.597 | Institute of Hydrology (1995) Report No. 108. Low flow estimation in the United Kingdom |
| River Irwell | 378499, 403535 | 6 | 3.645 | 0.47 | UK Centre for Ecology and Hydrology (2021) National River Flow Archive |
| Parr Brook | 381549, 406348 | 7 | 0.014 | 0.78 | Wallingford Hydrosolutions (2022) LowFlow Service |
| Parr Brook | 381549, 406348 | 4 & 7 | 0.014 | 0.78 | Wallingford Hydrosolutions (2022) LowFlow Service |

## Impermeable road area drained

A.2.3 For the Scheme the impermeable areas have been obtained from the drainage design, see Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR010064/APP/6.3) for full details. The impermeable areas for each catchment used in the routine runoff assessments is shown in Table A.3.

**Table A.3 Impermeable areas per catchment/outfall for the existing situation Scheme**

| Catchment/outfall number | Impermeable area (ha) |
|---|---|
| 1 (1A + 1B) | 8.3 |
| 2 | 4.6 |
| 4 | 5.4 |
| 5 | 10.3 |
| 6 | 21.8 |
| 7 | 1.5 |
| 4 + 7 | 6.9 |

## Permeable road area

A.2.4 Permeable road areas have been used in the assessments of the Scheme. Table A.4 outlines the permeable road areas used in the assessments of the Scheme.

**Table A.4 Permeable road areas**

| Outfall | Permeable Road Area (ha) |
|---|---|
| 1 (1A + 1B) | 6.9 |
| 2 | 1.2 |
| 4 | 6.6 |
| 5 | 3.8 |
| 6 | 1 |
| 7 | 1.5 |
| 4+7 | 8.1 |

## Protected sites

A.2.5 There are no statutory designated nature conservation sites within 1km downstream of any of the discharge points.

## For dissolved zinc only – water hardness

A.2.6 Water samples were taken where possible during the site visit. These were used to inform water hardness. The value chosen for all outfalls is 'Medium'.

## Estimated river width and presence of downstream structures

A.2.7 The estimated river width at $Q_{95}$ has been estimated from a combination of sources including photographs (in Annex C), measurements taken on site, and google aerial imagery. The data is presented in A.5.

A.2.8 It is also necessary to identify whether any in-channel structures have the potential to reduce velocity and thus increase the likelihood of sediments accumulating. This was checked for each identified outfall during the site visit. This data is also presented in the Table A.5.

**Table A.5 River width and in-channel structures for Step 2 Tier 1 sediment impacts**

| Catchment | Is there a structure, lake, pond or canal that reduces velocity within 100m of the point of discharge? | Estimated river width at $Q_{95}$ (m) |
|---|---|---|
| 1 (downstream on Castle Brook) | No | 0.5 |
| 2 | No | 0.5 |
| 4 | No | 0.5 |

| Catchment | Is there a structure, lake, pond or canal that reduces velocity within 100m of the point of discharge? | Estimated river width at $Q_{95}$ (m) |
|---|---|---|
| 5 | No (however note that there is a weir approximately 130m downstream of outfall) | 5 |
| 6 | No | 15 |
| 7 | No | 0.5 |
| 4 + 7 (based upon downstream open channel assessment location) | No | 0.5 |

## A.3 Step 3 - Design treatment

A.3.1 The calculated treatment for each drainage catchment is outlined in Table A.6.

A.3.2 The efficiency of each treatment component within a SuDS treatment train, has been multiplied together to determine the combined efficiency, using the following equation:

% Treatment = 1- ((1 - Treatment 1)*(1 - Treatment 2))

A.3.3 Where only a percentage of the total catchment impermeable area passes through a SuDS component, the treatment efficiency for the SuDS component has been factored down using the percentage of catchment passing through the SuDS. This percentage value is then used within the calculation above.

A.3.4 For cumulative assessments, the following methodology has been used to calculate a weighted averaged treatment efficiency, when treatment trains vary between two catchments that ultimately are being discharged into the same watercourse.

A.3.5 The three main steps of the methodology are as follows:

- Calculate out percentage of each catchment of the Total Area (of all catchments in the cumulative assessment), e.g., X% = X / (X+Y)
- Multiple catchment percentage (X%) to relevant Total treatment train efficiency
- Add both values from the step above together to get final weighted treatment efficiency. Totals should be rounded down to the nearest number so as not to over-estimate the final treatment efficiency.

## Table A.6 Step 3 Treatment %

| Catchment | Water Quality Treatment Measure | Identified Treatment (%) | | | Comments |
|---|---|---|---|---|---|
| | | Cu | Zn | Sediments | |
| 1 (1A+1B) | 1x Retention Pond + 1x Swale | 70 | 65 | 92 | 100% of total impermeable runoff passes through retention pond and swale. |
| 2 | 1x Retention Pond | 40 | 30 | 60 | 100% of total impermeable runoff passes through retention pond. |
| 4 | 2x Swale + 1x Retention Pond | 66 | 60 | 86 | 22.6% of total impermeable runoff passes through Swale 1.<br>73.6% of total impermeable runoff passes through Swale 2.<br>100% of total impermeable runoff passes through retention pond. |
| 5 | 1x Retention Pond | 19 | 14 | 28 | 46% of total impermeable runoff passes through retention pond. |
| 6 | None (Oversized pipes for attenuation) | 0 | 0 | 0 | n/a |
| 7 | 1x Retention Pond | 40 | 30 | 60 | 100% of total impermeable runoff passes through retention pond. |
| 4+7 | 2x Swale + 1x Retention Pond for each catchment | 55 | 48 | 75 | n/a |

# Annex B Sensitivity testing

B.1.1 As part of the routine runoff assessments, the ABC for copper value can be included within the assessment. The ABC is the upstream dissolved copper concentration in the receiving watercourse prior to receiving surface water runoff. In HEWRAT, this ABC value is simply added onto the established EQS value from the routine runoff from the Scheme.

B.1.2 As part of site surveys, in September 2019, one water sample from each existing receiving watercourse was taken and sent for laboratory analysis. At the time of this survey, Outfall 3 was included within the Scheme and Outfall 6 was assumed to discharge to Bradley Brook. As a consequence, not all outfalls within the Scheme were sampled for laboratory analysis. A review of the Environment Agency Water Quality Archive found that data was available for some receiving watercourses. These sites are:

- Hollins (Whittle) Brook Ptc River Roch (NW-88002239) - Potentially applies to Catchments 1 & 2 which discharge to Castle Brook, a tributary of Whittle Brook.
- River Irk at Hendham Vale (NW-88002375) – Potentially applies to Catchment 5) which discharges to River Irk.
- River Irwell At Old Ringley Bridge NW-88002324 - Potentially applies to Catchment 6 which discharges to River Irwell.

B.1.3 A summary of the ABC data is presented in Table B.1.

**Table B.1 ABC Copper Data Sources**

| Relevant Catchment | Receiving Watercourse | Jacobs Sept 2019 Sampling Value (Cu µg/l) | EA Water Quality Archive (Average value from last 10 available samples) (Cu µg/l) |
|---|---|---|---|
| Catchment 1 (1A + 1B) | Castle Brook (Tributary of Whittle Brook) | 4.90 | 3.86 |
| Catchment 2 | Castle Brook (Tributary of Whittle Brook) | 4.90 | 3.86 |
| Catchment 4 | Parr Brook | 2.70 | N/A |
| Catchment 5 | River Irk | 4.00 | 2.76 |
| Catchment 6 | River Irwell | Not sampled | 4.45 |
| Catchment 7 | Parr Brook | 2.70 | N/A |
| Catchment 4+7 | Parr Brook | 2.70 | N/A |

B.1.4 As there was only one sample taken during the site survey, and the data from the Environment Agency Water Quality Archive is from 2002 and 2013, this data was not considered robust to provide a representative value for each watercourse that could be used with confidence in HEWRAT to determine the overall copper concentration from the Scheme within each receiving watercourse.

B.1.5 However, as part of a sensitivity analysis, HEWRAT assessments have been undertaken to include the ABC copper values. Where a value from each source is recorded, the higher of the two has been included. The results of these are shown in Table B.2.

B.1.6 It should be noted that adding the ABC for copper in HEWRAT means that the EQS for copper for all catchments now fails the EQS threshold of 1 µg/l. The HEWRAT assessment tool uses inputs to determine the annual average concentration for dissolved copper and compares the output value against the EQS threshold which is the threshold for bioavailable dissolved copper in a given watercourse. In general, dissolved copper outputs from HEWRAT are expected to be an order of magnitude above the bioavailable EQS. A detailed-level assessment (Metal Bioavailability Assessment Tool (M-BAT)) can be undertaken to help mitigate these failures as this generates a value that can be used as a site specific EQS value. Using measured dissolved copper within the M-BAT tool as an input value also allows a bioavailable copper concentration to be calculated and this would be expected to be an order of magnitude below the measured dissolved copper concentrations.

B.1.7 A programme of water quality monitoring will be carried out during the detailed design phase to support updated HEWRAT assessments. As part of that monitoring copper concentrations will be recorded.

**Table B.2 HEWRAT Step 3 (post-mitigation) EQS copper results with ABC included.**

| Relevant Catchment | Receiving Watercourse | Annual Average Concentration related to EQS Compliance: (µg/l) |
|---|---|---|
| Catchment 1 (1A + 1B) | Castle Brook (Tributary of Whittle Brook) | 5.14 |
| Catchment 2 | Castle Brook (Tributary of Whittle Brook) | 5.29 |
| Catchment 4 | Parr Brook | 2.91 |
| Catchment 5 | River Irk | 4.07 |
| Catchment 6 | River Irwell | 4.47 |
| Catchment 7 | Parr Brook | 2.77 |
| Catchment 4+7 | Parr Brook | 3.06 |

# Annex C Site visit photographs

### Plate C.1 Existing Outfall 1 (Approximate Outfall Easting/Northing: 382836, 406494)

## Plate C.2 Existing Outfall 2 (Approximate Outfall Easting/Northing: 382605, 407406)

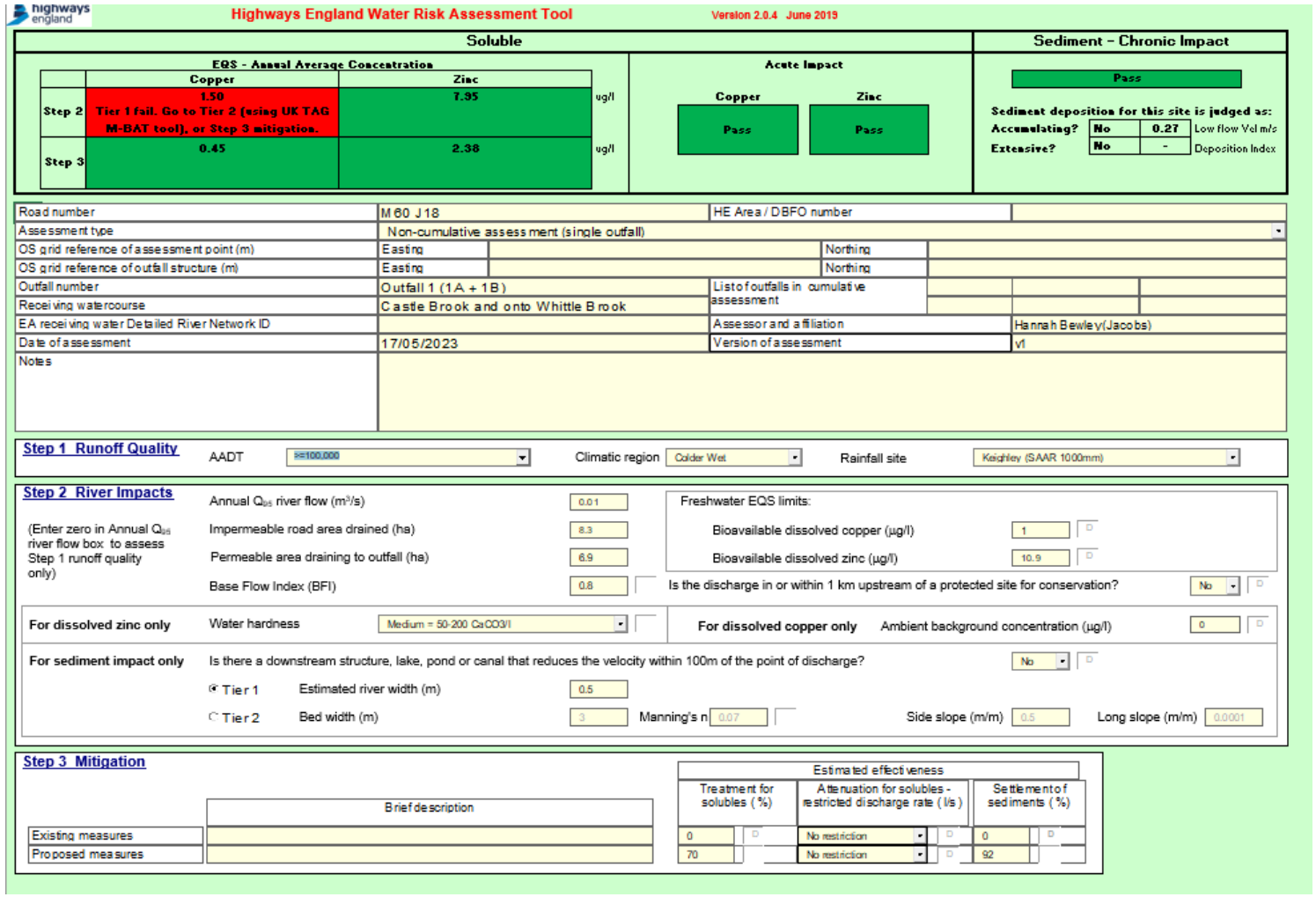
**Plate C.3 Existing Outfall 4 (Approximate Outfall Easting/Northing: 382519, 405640)**

## Plate C.4 Existing Outfall 5 (Approximate Outfall Easting/Northing: 384748, 404838)

**Plate C.5 River Irk looking downstream with outfall entering watercourse on right bank (right) (Approximate Outfall Easting/Northing: 384748, 404838)**

# Annex D HEWRAT screenshots

## Plate D.1 Catchment 1 (1A+1B) Step 3 (post-mitigation) HEWRAT Results (Copper)



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**Soluble**

EQS - Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 1.50 Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation. | 7.95 | ug/l |
| Step 3 | 0.45 | 2.38 | ug/l |

Acute Impact

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment - Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.27 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | |
|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | |
| Assessment type | Non-cumulative assessment (single outfall) | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | |
| OS grid reference of outfall structure (m) | Easting | | Northing | |
| Outfall number | Outfall 1 (1A + 1B) | | List of outfalls in cumulative assessment | |
| Receiving watercourse | Castle Brook and onto Whittle Brook | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 |
| Notes | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.01 |
| Impermeable road area drained (ha) | 8.3 |
| Permeable area draining to outfall (ha) | 6.9 |
| Base Flow Index (BFI) | 0.8 |

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: Medium = 50-200 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

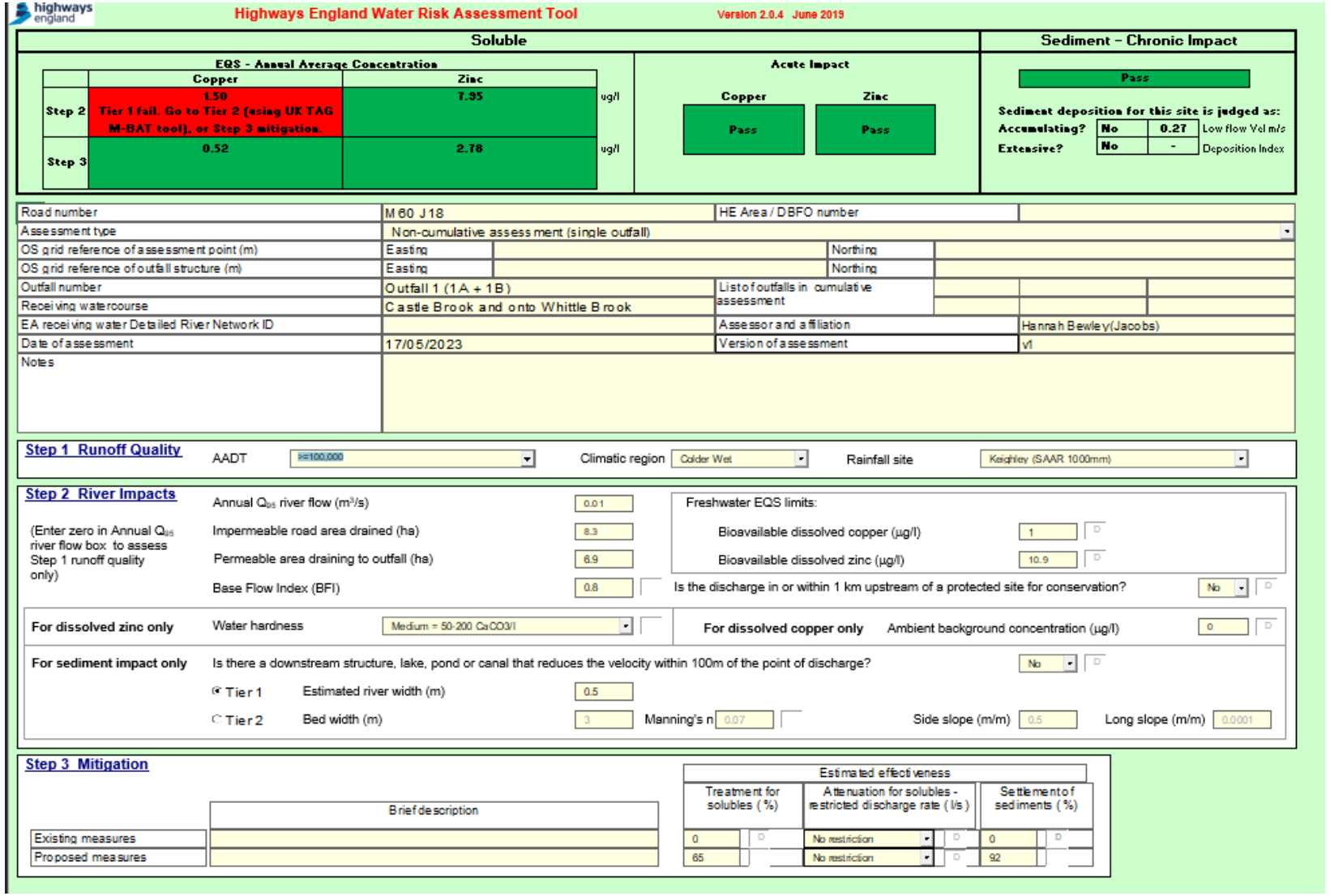
Tier 1: Estimated river width (m): 0.5

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 | No restriction | 0 |
| Proposed measures | | 70 | No restriction | 92 |

## Plate D.2 Catchment 1 (1A+1B) Step 3 (post-mitigation) HEWRAT Results (Zinc)



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| Soluble | | | | Acute Impact | | Sediment – Chronic Impact | | |
|---|---|---|---|---|---|---|---|---|
| EQS - Annual Average Concentration | | | | | | Pass | | |
| | Copper | Zinc | | Copper | Zinc | Sediment deposition for this site is judged as: | | |
| Step 2 | 1.50 Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation. | 7.95 | ug/l | Pass | Pass | Accumulating? | No | 0.27 Low flow Vel m/s |
| Step 3 | 0.52 | 2.78 | ug/l | | | Extensive? | No | - Deposition Index |

| | | | |
|---|---|---|---|
| Road number | M60 J18 | HE Area / DBFO number | |
| Assessment type | Non-cumulative assessment (single outfall) | | |
| OS grid reference of assessment point (m) | Easting | Northing | |
| OS grid reference of outfall structure (m) | Easting | Northing | |
| Outfall number | Outfall 1 (1A + 1B) | List of outfalls in cumulative assessment | |
| Receiving watercourse | Castle Brook and onto Whittle Brook | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | Hannah Bewley(Jacobs) |
| Date of assessment | 17/05/2023 | Version of assessment | v1 |
| Notes | | | |

**Step 1 Runoff Quality**

AADT >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**Step 2 River Impacts**

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

| | | Freshwater EQS limits: | |
|---|---|---|---|
| Annual $Q_{95}$ river flow ($m^3/s$) | 0.01 | | |
| Impermeable road area drained (ha) | 8.3 | Bioavailable dissolved copper (µg/l) | 1 |
| Permeable area draining to outfall (ha) | 6.9 | Bioavailable dissolved zinc (µg/l) | 10.9 |
| Base Flow Index (BFI) | 0.8 | Is the discharge in or within 1 km upstream of a protected site for conservation? | No |

**For dissolved zinc only** — Water hardness: Medium = 50-200 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

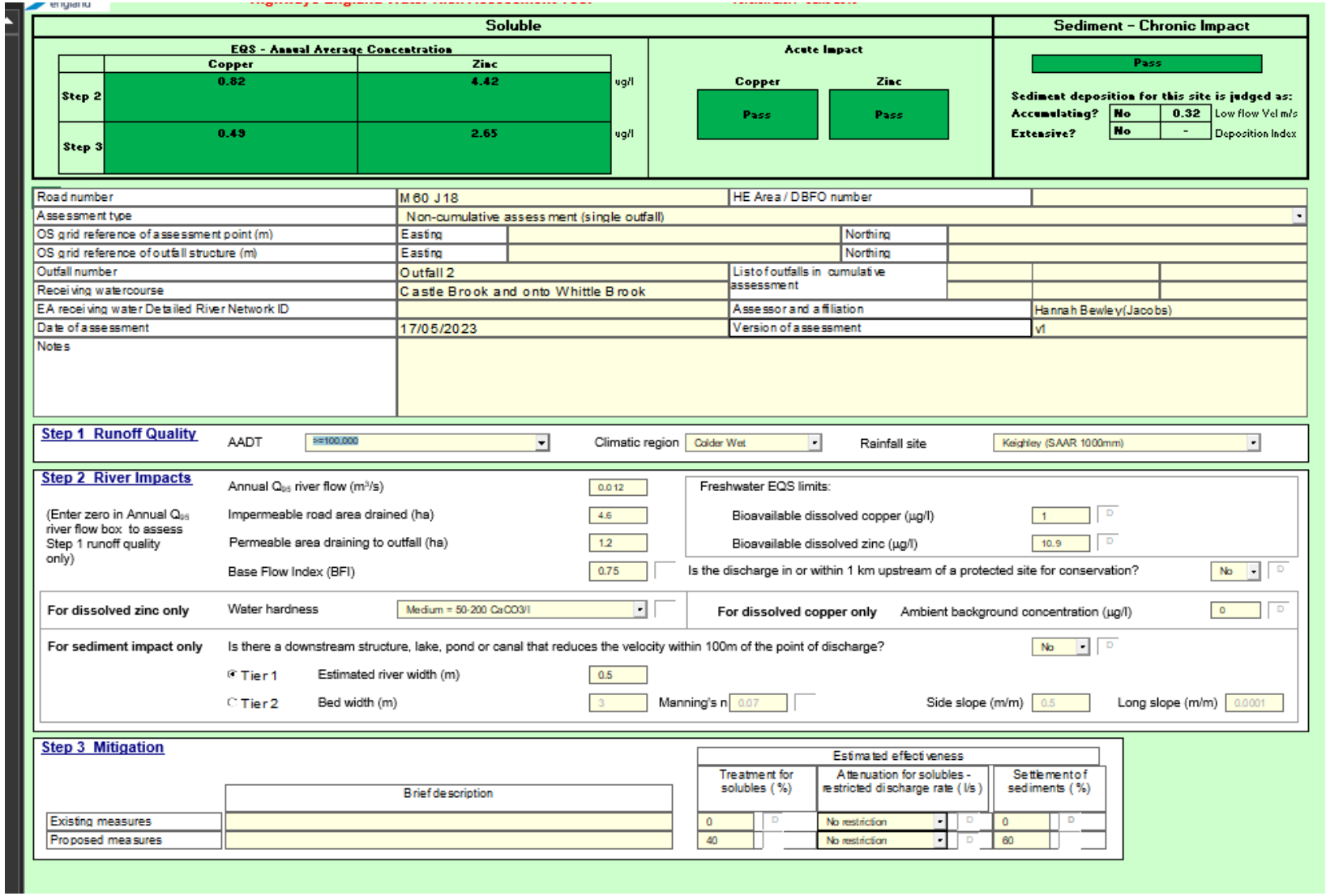
Tier 1 — Estimated river width (m): 0.5

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 | No restriction | 0 |
| Proposed measures | | 65 | No restriction | 92 |

## Plate D.3 Catchment 2 Step 3 (post-mitigation) HEWRAT Results (Copper)



**Soluble**

EQS - Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.82 | 4.42 | ug/l |
| Step 3 | 0.49 | 2.65 | ug/l |

Acute Impact

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment – Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.32 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 2 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Castle Brook and onto Whittle Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.012 |
| Impermeable road area drained (ha) | 4.6 |
| Permeable area draining to outfall (ha) | 1.2 |
| Base Flow Index (BFI) | 0.75 |

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: Medium = 50-200 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): 0.5

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 | No restriction | 0 |
| Proposed measures | | 40 | No restriction | 60 |

## Plate D.4 Catchment 2 Step 3 (post-mitigation) HEWRAT Results (Zinc)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2015

**Soluble**

**EQS - Annual Average Concentration**

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.82 | 4.42 | ug/l |
| Step 3 | 0.57 | 3.09 | ug/l |

**Acute Impact**

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment - Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.32 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 2 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Castle Brook and onto Whittle Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.012 |
| Impermeable road area drained (ha) | 4.6 |
| Permeable area draining to outfall (ha) | 1.2 |
| Base Flow Index (BFI) | 0.75 |

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: Medium = 50-200 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): 0.5

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 | No restriction | 0 |
| Proposed measures | | 30 | No restriction | 60 |

## Plate D.5 Catchment 4 Step 3 (post-mitigation) HEWRAT Results (Copper)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

**Soluble**

**EQS - Annual Average Concentration**

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.80 | 4.32 | ug/l |
| Step 3 | 0.27 | 1.47 | ug/l |

**Acute Impact**

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment - Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.38 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 4 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Parr Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley (Jacobs) | |
| Date of assessment | 22/05/2023 | | Version of assessment | v2 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 |
| Impermeable road area drained (ha) | 5.4 |
| Permeable area draining to outfall (ha) | 6.6 |
| Base Flow Index (BFI) | 0.78 |

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: Medium = 50-200 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): 0.5
- 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 | No restriction | 0 |
| Proposed measures | | 66 | No restriction | 86 |

## Plate D.6 Catchment 4 Step 3 (post-mitigation) HEWRAT Results (Zinc)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

**Soluble**

**EQS - Annual Average Concentration**

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.80 | 4.32 | ug/l |
| Step 3 | 0.32 | 1.73 | ug/l |

**Acute Impact**

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment - Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.38 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 4 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Parr Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley (Jacobs) | |
| Date of assessment | 22/05/2023 | | Version of assessment | v2 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 |
| Impermeable road area drained (ha) | 5.4 |
| Permeable area draining to outfall (ha) | 6.6 |
| Base Flow Index (BFI) | 0.78 |

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: Medium = 50-200 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

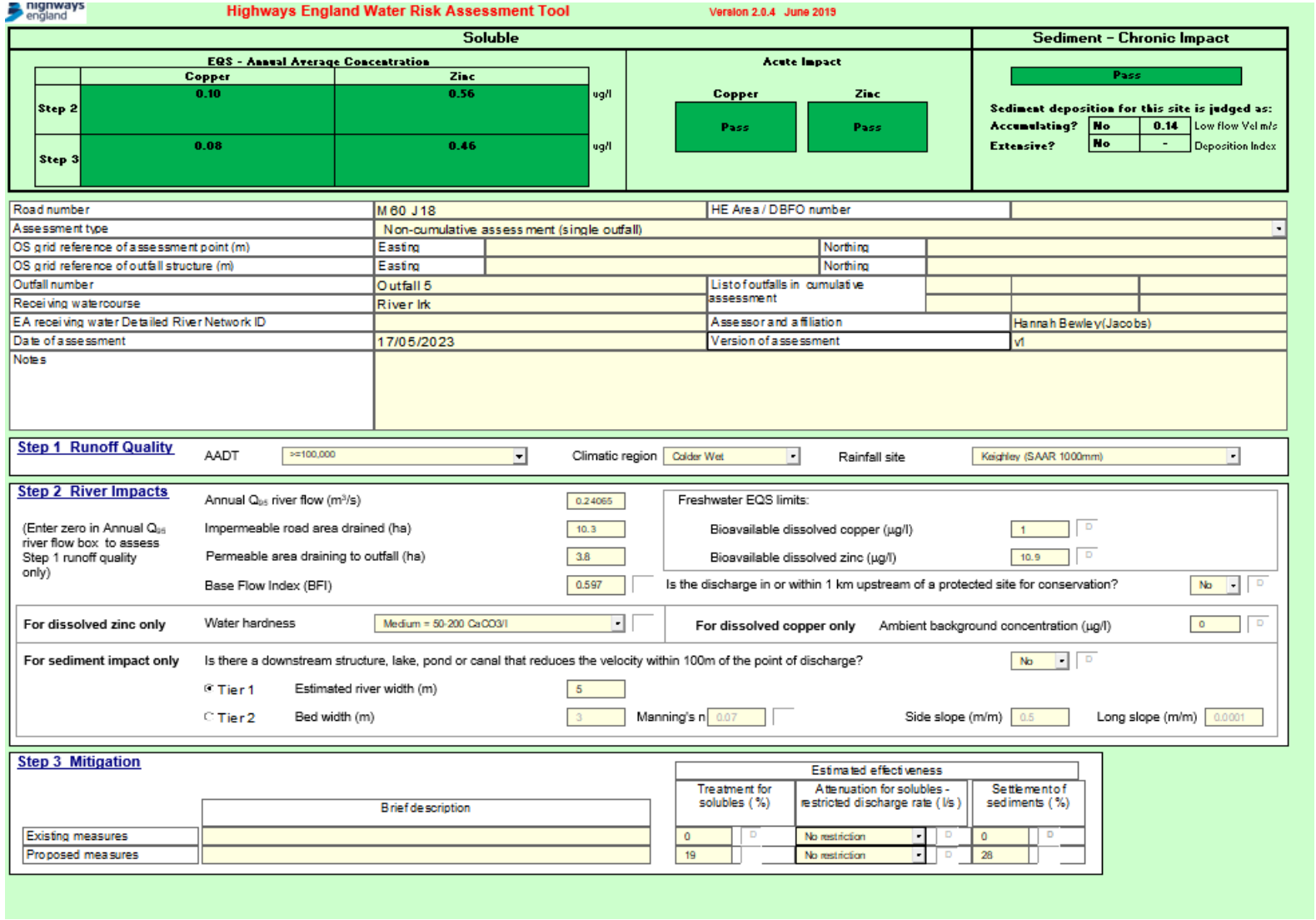
Tier 1 — Estimated river width (m): 0.5

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 | No restriction | 0 |
| Proposed measures | | 60 | No restriction | 88 |

## Plate D.7 Catchment 5 Step 3 (post-mitigation) HEWRAT Results (Copper)



Highways England Water Risk Assessment Tool — Version 2.0.4 June 2019

**Soluble**

EQS - Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.10 | 0.56 | ug/l |
| Step 3 | 0.08 | 0.46 | ug/l |

Acute Impact

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment – Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.14 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 5 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | River Irk | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.24065 |
| Impermeable road area drained (ha) | 10.3 |
| Permeable area draining to outfall (ha) | 3.8 |
| Base Flow Index (BFI) | 0.597 |

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: Medium = 50-200 CaCO3/l

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

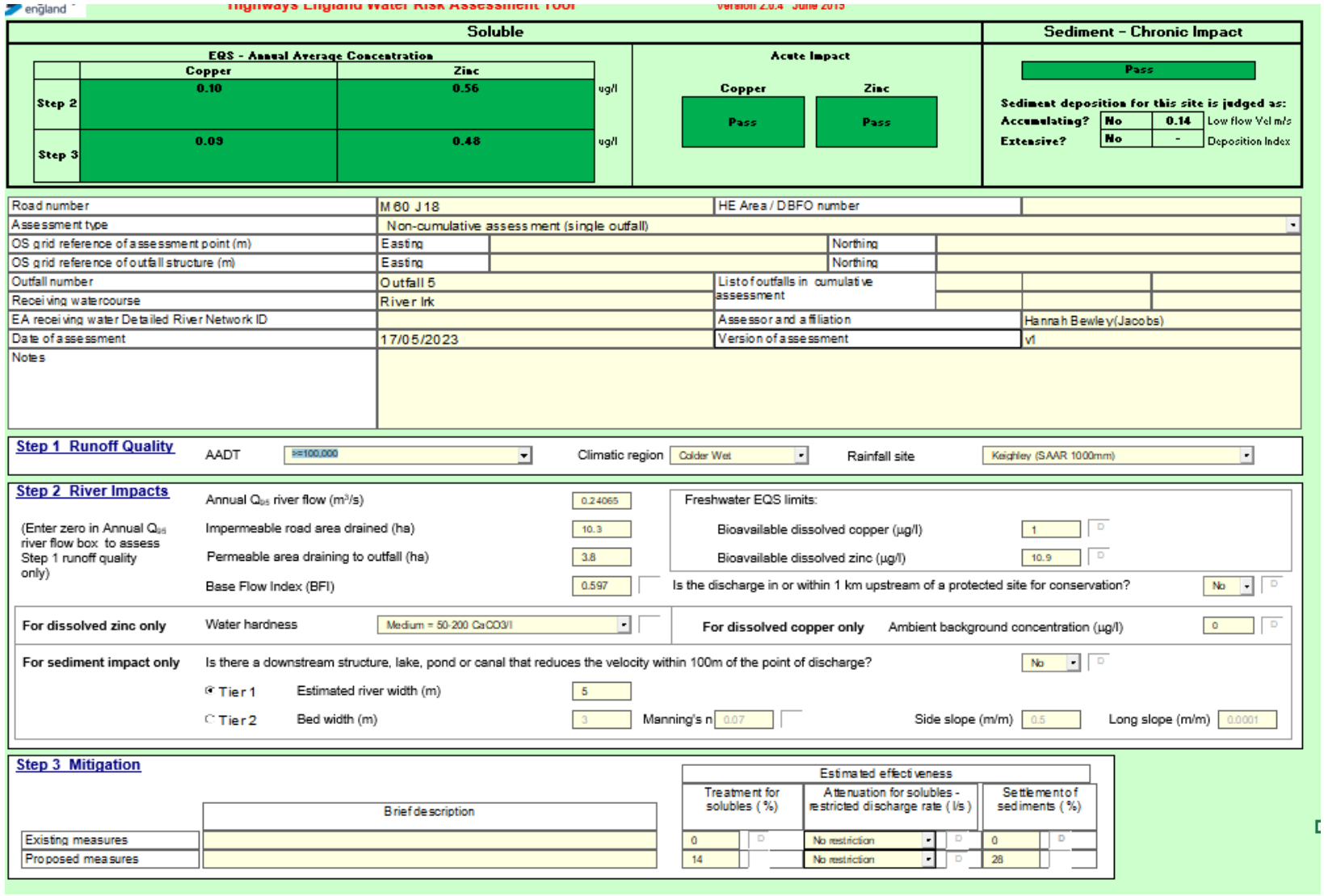
**For sediment impact only** — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- (•) Tier 1 — Estimated river width (m): 5
- ( ) Tier 2 — Bed width (m): 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 | No restriction | 0 |
| Proposed measures | | 19 | No restriction | 28 |

## Plate D.8 Catchment 5 Step 3 (post-mitigation) HEWRAT Results (Zinc)



england — Highways England Water Risk Assessment Tool — Version 2.0.4 June 2015

**Soluble**

EQS - Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.10 | 0.56 | ug/l |
| Step 3 | 0.09 | 0.48 | ug/l |

Acute Impact

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment – Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.14 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 5 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | River Irk | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 — Climatic region: Colder Wet — Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.24065 |
| Impermeable road area drained (ha) | 10.3 |
| Permeable area draining to outfall (ha) | 3.8 |
| Base Flow Index (BFI) | 0.597 |

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: Medium = 50-200 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): 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 | No restriction | 0 |
| Proposed measures | | 14 | No restriction | 28 |

## Plate D.9 Catchment 6 Step 3 (post-mitigation) HEWRAT Results (Copper & Zinc)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

**Soluble**

EQS - Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.01 | 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? | No | 0.35 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 6 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | River Irwell | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley(Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 3.645 |
| Impermeable road area drained (ha) | 21.8 |
| Permeable area draining to outfall (ha) | 1 |
| Base Flow Index (BFI) | 0.47 |

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: Medium = 50-200 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): 15

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 | No restriction | 0 |
| Proposed measures | | 0 | No restriction | 0 |

## Plate D.10 Catchment 7 Step 3 (post-mitigation) HEWRAT Results (Copper)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

**Soluble**

**EQS - Annual Average Concentration**

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.15 | 0.56 | ug/l |
| Step 3 | 0.09 | 0.34 | ug/l |

**Acute Impact**

| Copper | Zinc |
|---|---|
| Pass | Pass |

**Sediment - Chronic Impact**

Pass

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | No | 0.38 | Low flow Vel m/s |
| Extensive? | No | - | Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 7 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Parr Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley (Jacobs) | |
| Date of assessment | 22/05/2023 | | Version of assessment | v2 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 | | Freshwater EQS limits: | |
| Impermeable road area drained (ha) | 1.5 | | Bioavailable dissolved copper (µg/l) | 1 D |
| Permeable area draining to outfall (ha) | 1.5 | | Bioavailable dissolved zinc (µg/l) | 10.9 D |
| Base Flow Index (BFI) | 0.78 | | Is the discharge in or within 1 km upstream of a protected site for conservation? | No D |

**For dissolved zinc only** — Water hardness: Medium = 50-200 CaCO3/l

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

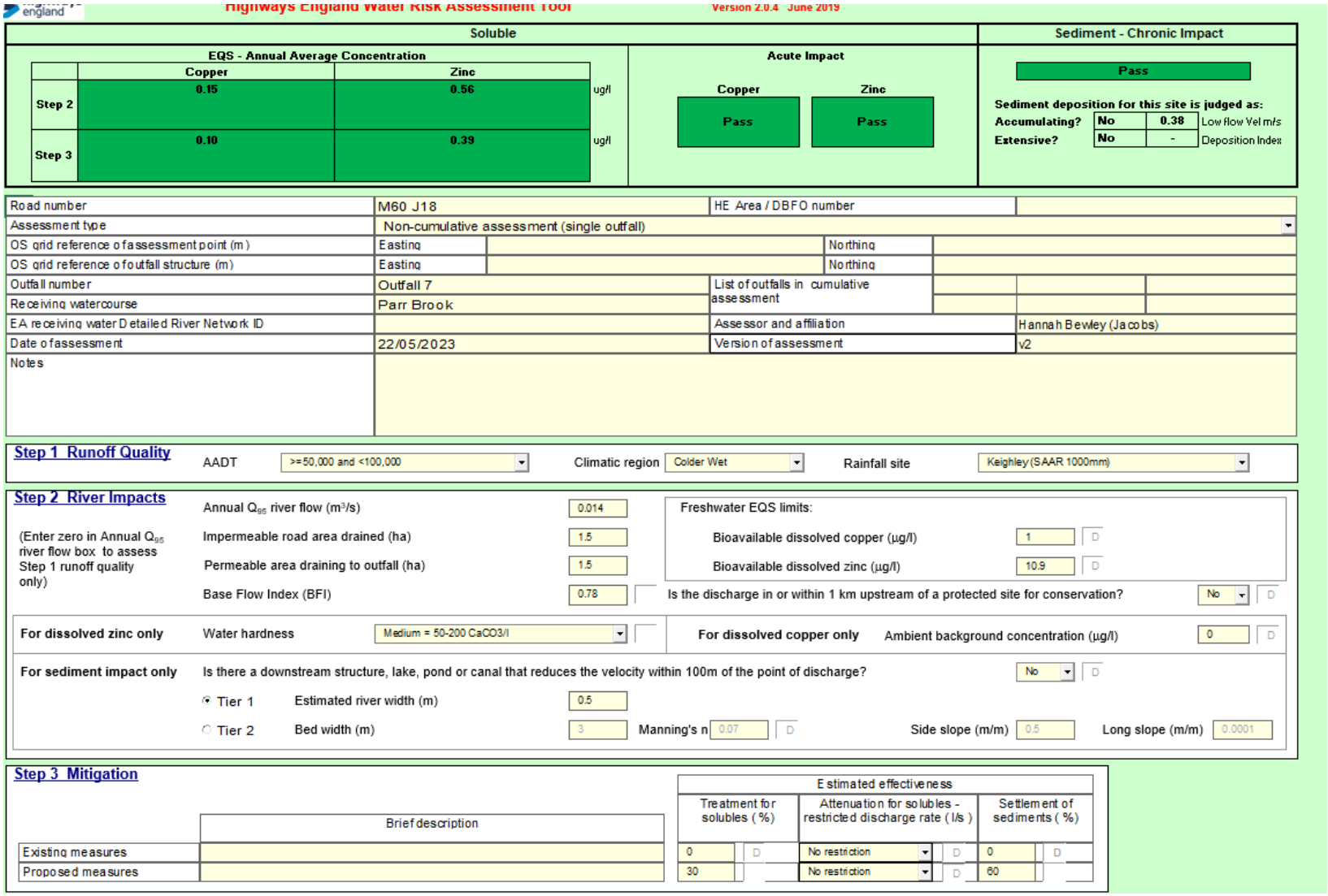
**For sediment impact only** — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

- Tier 1: Estimated river width (m): 0.5
- Tier 2: Bed width (m): 3 | Manning's n: 0.07 D | 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 | | 40 | No restriction D | 60 |

## Plate D.11 Catchment 7 Step 3 (post-mitigation) HEWRAT Results (Zinc)



Highways England Water Risk Assessment Tool — Version 2.0.4 June 2019

| Soluble | | | | Sediment - Chronic Impact |
|---|---|---|---|---|
| EQS - Annual Average Concentration | | | Acute Impact | Pass |
| | Copper | Zinc | Copper / Zinc | Sediment deposition for this site is judged as: |
| Step 2 | 0.15 ug/l | 0.56 ug/l | Pass / Pass | Accumulating? No 0.38 Low flow Vel m/s |
| Step 3 | 0.10 ug/l | 0.39 ug/l | | Extensive? No - Deposition Index |

| | | | |
|---|---|---|---|
| Road number | M60 J18 | HE Area / DBFO number | |
| Assessment type | Non-cumulative assessment (single outfall) | | |
| OS grid reference of assessment point (m) | Easting | Northing | |
| OS grid reference of outfall structure (m) | Easting | Northing | |
| Outfall number | Outfall 7 | List of outfalls in cumulative assessment | |
| Receiving watercourse | Parr Brook | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | Hannah Bewley (Jacobs) |
| Date of assessment | 22/05/2023 | Version of assessment | v2 |
| Notes | | | |

**Step 1 Runoff Quality**

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 | Freshwater EQS limits: | |
| Impermeable road area drained (ha) | 1.5 | Bioavailable dissolved copper (µg/l) | 1 D |
| Permeable area draining to outfall (ha) | 1.5 | Bioavailable dissolved zinc (µg/l) | 10.9 D |
| Base Flow Index (BFI) | 0.78 | Is the discharge in or within 1 km upstream of a protected site for conservation? | No D |

**For dissolved zinc only** — Water hardness: Medium = 50-200 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): 0.5

Tier 2 — Bed width (m): 3 | Manning's n: 0.07 D | 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 | | 30 | No restriction D | 60 |

## Plate D.12 Catchment 4+7 Step 3 (post-mitigation) HEWRAT Results (Copper)

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**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

| Soluble | | | | Sediment - Chronic Impact |
|---|---|---|---|---|
| EQS - Annual Average Concentration | | | Acute Impact | Pass |
| | Copper | Zinc | Copper / Zinc | Sediment deposition for this site is judged as: |
| Step 2 | 0.98 ug/l | 5.27 ug/l | Pass / Pass | Accumulating? No 0.38 Low flow Vel m/s |
| Step 3 | 0.44 ug/l | 2.37 ug/l | | Extensive? No - Deposition Index |

| | | | | |
|---|---|---|---|---|
| Road number | M60 J18 | HE Area / DBFO number | | |
| Assessment type | Cumulative assessment including sediments (outfalls within 100m) | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | |
| OS grid reference of outfall structure (m) | Easting | | Northing | |
| Outfall number | Outfall 7 | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Parr Brook | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | Hannah Bewley (Jacobs) | |
| Date of assessment | 17/05/2023 | Version of assessment | v1 | |
| Notes | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 | Freshwater EQS limits: | |
| Impermeable road area drained (ha) | 6.9 | Bioavailable dissolved copper (µg/l) | 1 D |
| Permeable area draining to outfall (ha) | 8.1 | Bioavailable dissolved zinc (µg/l) | 10.9 D |
| Base Flow Index (BFI) | 0.78 | Is the discharge in or within 1 km upstream of a protected site for conservation? | No D |

**For dissolved zinc only** — Water hardness: Medium = 50-200 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): 0.5
- Tier 2: Bed width (m): 3 | Manning's n: 0.07 D | 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 | | 55 | No restriction D | 75 |

## Plate D.13 Catchment 4+7 Step 3 (post-mitigation) HEWRAT Results (Zinc)

**Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

| Soluble | | | | Sediment - Chronic Impact |
|---|---|---|---|---|
| EQS - Annual Average Concentration | | | Acute Impact | Pass |
| | Copper | Zinc | Copper / Zinc | Sediment deposition for this site is judged as: |
| Step 2 | 0.98 ug/l | 5.27 ug/l | Pass / Pass | Accumulating? No 0.38 Low flow Vel m/s |
| Step 3 | 0.51 ug/l | 2.74 ug/l | | Extensive? No - Deposition Index |

| | | | | | |
|---|---|---|---|---|---|
| Road number | M60 J18 | | HE Area / DBFO number | | |
| Assessment type | Cumulative assessment including sediments (outfalls within 100m) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Outfall 7 | | List of outfalls in cumulative assessment | | |
| Receiving watercourse | Parr Brook | | | | |
| EA receiving water Detailed River Network ID | | | Assessor and affiliation | Hannah Bewley (Jacobs) | |
| Date of assessment | 17/05/2023 | | Version of assessment | v1 | |
| Notes | | | | | |

**Step 1 Runoff Quality**

AADT: >=100,000 | Climatic region: Colder Wet | Rainfall site: Keighley (SAAR 1000mm)

**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 ($m^3/s$) | 0.014 | Freshwater EQS limits: | |
| Impermeable road area drained (ha) | 6.9 | Bioavailable dissolved copper (µg/l) | 1 D |
| Permeable area draining to outfall (ha) | 8.1 | Bioavailable dissolved zinc (µg/l) | 10.9 D |
| Base Flow Index (BFI) | 0.78 | Is the discharge in or within 1 km upstream of a protected site for conservation? | No D |
| For dissolved zinc only: Water hardness | Medium = 50-200 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) | 0.5 | | |
| Tier 2: Bed width (m) | 3 | Manning's n 0.07 D; 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 | | 48 | No restriction D | 75 |

# Annex E Spillage risk assessment

### Table E.1 Spillage Risk Assessment Parameters

| Section Description | Risk Weighting | Length within catchment (km) | Annual Average Daily Traffic (vpd) | %HGV | Probability Score ($P_{POL}$) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) | Probability of Incident ($P_{INC}$)% | Return Period (Years) | Within Acceptable Limits?* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Catchment 1 (1A+1B)** | | | | | | | | | | |
| 2936_12831 Mainline M66 northbound | 0.36 | 0.809 | 35,750 | 5.00 | 0.45 | 0.0002 | 0.0001 | 0.0086 | 11,695 | Yes |
| 50005_2935 Mainline M60 southbound | 0.36 | 0.084 | 70,064 | 7.00 | 0.45 | 0.0001 | 0.0000 | 0.0024 | 41,051 | Yes |
| 12807_50005 Mainline M60 southbound | 0.36 | 0.299 | 70,064 | 7.00 | 0.45 | 0.0002 | 0.0001 | 0.0087 | 11,533 | Yes |
| 2997_12807 Mainline southbound | 0.36 | 0.355 | 39,562 | 5.00 | 0.45 | 0.0001 | 0.0000 | 0.0042 | 24,083 | Yes |
| 14434_12831 Slip Road from M60 | 0.43 | 0.334 | 4,729 | 10.00 | 0.45 | 0.0000 | 0.0000 | 0.0011 | 89,642 | Yes |
| 2716_50001 Flyover / Overbridge | 0.43 | 0.193 | 30,521 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0033 | 30,046 | Yes |
| 50001_50002 Flyover / Overbridge | 0.43 | 0.207 | 30,521 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0036 | 28,013 | Yes |
| 50002_12807 Flyover / Overbridge | 0.43 | 0.07 | 30,521 | 7.00 | 0.45 | 0.0000 | 0.0000 | 0.0011 | 94,674 | Yes |
| 2997_50004 Junction 4 slip road | 0.43 | 0.201 | 27,659 | 5.00 | 0.45 | 0.0000 | 0.0000 | 0.0020 | 50,936 | Yes |
| 50004_4902 Junction 4 slip road | 0.43 | 0.248 | 27,659 | 5.00 | 0.45 | 0.0001 | 0.0000 | 0.0024 | 41,283 | Yes |
| 4902_14435 Junction 4 slip road | 0.43 | 0.193 | 11,040 | 6.00 | 0.45 | 0.0000 | 0.0000 | 0.0009 | 110,751 | Yes |
| 14435_14436 Juntion 4 slip road | 0.43 | 0.113 | 14,822 | 4.00 | 0.45 | 0.0000 | 0.0000 | 0.0005 | 211,340 | Yes |

| Section Description | Risk Weighting | Length within catchment (km) | Annual Average Daily Traffic (vpd) | %HGV | Probability Score ($P_{POL}$) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) | Probability of Incident ($P_{INC}$)% | Return Period (Years) | Within Acceptable Limits?* |
|---|---|---|---|---|---|---|---|---|---|---|
| 4903_2715 Roundabout exit mainline | 0.36 | 0.22 | 11,498 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0012 | 83,571 | Yes |
| 4903_2715 Roundabout exit | 3.09 | 0.1 | 11,498 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0047 | 21,420 | Yes |
| 4904_4903 Roundabout | 3.09 | 0.031 | 15,275 | 6.00 | 0.45 | 0.0000 | 0.0000 | 0.0014 | 69,349 | Yes |
| 4904_4900 Roundabout | 3.09 | 0.114 | 16,620 | 4.00 | 0.45 | 0.0001 | 0.0000 | 0.0038 | 25,998 | Yes |
| 12806_4900 Roundabout approach | 3.09 | 0.054 | 5,961 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0013 | 76,513 | Yes |
| 4000_12806 Roundabout approach | 3.09 | 0.052 | 16,193 | 10.00 | 0.45 | 0.0001 | 0.0000 | 0.0043 | 23,399 | Yes |
| 2716_4000 Roundabout approach mainline | 0.36 | 0.2 | 16,193 | 10.00 | 0.45 | 0.0000 | 0.0000 | 0.0019 | 52,220 | Yes |
| 12806_2935 Slip Road to M60 southbound | 0.43 | 0.112 | 10,232 | 5.00 | 0.45 | 0.0000 | 0.0000 | 0.0004 | 247,103 | Yes |
| 4900_4908 Roundabout | 3.09 | 0.045 | 22,587 | 5.00 | 0.45 | 0.0001 | 0.0000 | 0.0026 | 38,770 | Yes |
| 4908_4901 Roundabout | 3.09 | 0.116 | 22,857 | 5.00 | 0.45 | 0.0001 | 0.0001 | 0.0067 | 14,862 | Yes |
| 4901_4907 Roundabout | 3.09 | 0.036 | 21,079 | 7.00 | 0.45 | 0.0001 | 0.0000 | 0.0027 | 37,092 | Yes |
| 4907_4898 Roundabout | 3.09 | 0.111 | 21,079 | 7.00 | 0.45 | 0.0002 | 0.0001 | 0.0083 | 12,030 | Yes |
| 4898_50010 Roundabout | 3.09 | 0.022 | 5,805 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0005 | 192,851 | Yes |
| 50010_4909 Roundabout | 3.09 | 0.016 | 5,805 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0004 | 265,170 | Yes |
| 4909_4899 Roundabout | 3.09 | 0.112 | 15,275 | 6.00 | 0.45 | 0.0001 | 0.0001 | 0.0052 | 19,195 | Yes |
| 4899_50009 Roundabout | 3.09 | 0.013 | 15,275 | 6.00 | 0.45 | 0.0000 | 0.0000 | 0.0006 | 165,371 | Yes |
| 50009_4904 Roundabout | 3.09 | 0.018 | 15,275 | 6.00 | 0.45 | 0.0000 | 0.0000 | 0.0008 | 119,435 | Yes |

| Section Description | Risk Weighting | Length within catchment (km) | Annual Average Daily Traffic (vpd) | %HGV | Probability Score ($P_{POL}$) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) | Probability of Incident ($P_{INC}$)% | Return Period (Years) | Within Acceptable Limits?* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | **4.478** | | | | **0.0019** | **0.0009** | **0.0856** | **1169** | **Yes** |
| **Catchment 2** | | | | | | | | | | |
| 12831_12832 Mainline northbound | 0.36 | 0.325 | 40,482 | 6.00 | 0.45 | 0.0001 | 0.0000 | 0.0047 | 21,424 | Yes |
| 2997_12807 Mainline southbound | 0.36 | 0.3 | 39,562 | 5.00 | 0.45 | 0.0001 | 0.0000 | 0.0035 | 28,499 | Yes |
| 50004_4902 Slip Road | 0.43 | 0.24 | 27,659 | 5.00 | 0.45 | 0.0001 | 0.0000 | 0.0023 | 42,659 | Yes |
| **Total** | | **0.865** | | | | **0.0002** | **0.0001** | **0.0105** | **9505** | **Yes** |
| **Catchment 4** | | | | | | | | | | |
| 2173_50001 Flyover / Overbridge | 0.43 | 0.229 | 30,521 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0039 | 25,322 | Yes |
| 2713_4910 Mainline eastbound | 0.36 | 0.193 | 88,500 | 13.00 | 0.45 | 0.0003 | 0.0001 | 0.0131 | 7,616 | Yes |
| 4910_2715 Mainline eastbound | 0.36 | 0.507 | 68,642 | 14.00 | 0.45 | 0.0006 | 0.0003 | 0.0288 | 3,471 | Yes |
| 2716_2714 Mainline westbound | 0.36 | 0.527 | 73,860 | 11.00 | 0.45 | 0.0006 | 0.0003 | 0.0253 | 3,950 | Yes |
| 2714_50003 Mainline westbound | 0.36 | 0.183 | 79,437 | 11.00 | 0.45 | 0.0002 | 0.0001 | 0.0095 | 10,576 | Yes |
| 4905_4901 Slip Road (slip off M60) | 0.43 | 0.098 | 15,165 | 6.00 | 0.45 | 0.0000 | 0.0000 | 0.0006 | 158,784 | Yes |
| 4901_4907 Slip Road to M62 | 0.43 | 0.036 | 21,097 | 7.00 | 0.45 | 0.0000 | 0.0000 | 0.0004 | 266,321 | Yes |
| 4907_4906 Slip Road to M62 | 0.43 | 0.072 | 16,679 | 4.00 | 0.45 | 0.0000 | 0.0000 | 0.0003 | 294,757 | Yes |
| 4906_60879 Slip Road to M62 | 0.43 | 0.153 | 11,102 | 4.00 | 0.45 | 0.0000 | 0.0000 | 0.0005 | 208,388 | Yes |
| 62879_12828 Slip Road to M62 | 0.43 | 0.152 | 34,301 | 7.00 | 0.45 | 0.0001 | 0.0000 | 0.0026 | 38,795 | Yes |
| 12828_50003 Slip road to M62 | 0.43 | 0.175 | 41,485 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0041 | 24,379 | Yes |

| Section Description | Risk Weighting | Length within catchment (km) | Annual Average Daily Traffic (vpd) | %HGV | Probability Score ($P_{POL}$) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) | Probability of Incident ($P_{INC}$)% | Return Period (Years) | Within Acceptable Limits?* |
|---|---|---|---|---|---|---|---|---|---|---|
| 4906_2714 Slip Road to M62 | 0.43 | 0.296 | 5,577 | 5.00 | 0.45 | 0.0000 | 0.0000 | 0.0006 | 171,539 | Yes |
| **Total** | | **2.621** | | | | **0.0020** | **0.0009** | **0.0897** | **1114** | **Yes** |
| **Catchment 5** | | | | | | | | | | |
| 12827_2936 Mainline northbound | 0.36 | 0.398 | 81,310 | 7.00 | 0.45 | 0.0003 | 0.0001 | 0.0134 | 7,466 | Yes |
| 2935_26825 Mainline southbound | 0.36 | 0.302 | 80,308 | 7.00 | 0.45 | 0.0002 | 0.0001 | 0.0100 | 9,962 | Yes |
| 2936_4905 Slip Road approach | 0.43 | 0.153 | 45,561 | 8.00 | 0.45 | 0.0001 | 0.0000 | 0.0039 | 25,389 | Yes |
| 12806_2935 Slip Road exit | 0.43 | 0.335 | 10,232 | 10.00 | 0.45 | 0.0001 | 0.0000 | 0.0024 | 41,307 | Yes |
| **Total** | | **1.188** | | | | **0.0007** | **0.0003** | **0.0298** | **3357** | **Yes** |
| **Catchment 6** | | | | | | | | | | |
| 2709-26786 Mainline eastbound from J17 | 0.36 | 0.316 | 119,021 | 12.00 | 0.45 | 0.0006 | 0.0003 | 0.0267 | 3,747 | Yes |
| 26786-12713 Mainline eastbound | 0.36 | 0.656 | 119,021 | 12.00 | 0.45 | 0.0012 | 0.0006 | 0.0554 | 1,805 | Yes |
| 50003-26787 Mainline westbound | 0.36 | 0.575 | 120,958 | 10.00 | 0.45 | 0.0009 | 0.0004 | 0.0411 | 2,432 | Yes |
| 26787_2710 Mainline westbound to J17 | 0.36 | 0.488 | 120,958 | 10.00 | 0.45 | 0.0008 | 0.0003 | 0.0349 | 2,865 | Yes |
| 2709-26786 Slip Road eastbound from J17 | 0.43 | 0.316 | 119,021 | 12.00 | 0.45 | 0.0007 | 0.0003 | 0.0319 | 3,137 | Yes |
| 26787_2710 Slip Road westbound to J17 | 0.43 | 0.488 | 120,958 | 10.00 | 0.45 | 0.0009 | 0.0004 | 0.0417 | 2,399 | Yes |
| **Total** | | **2.839** | | | | **0.0051** | **0.0023** | **0.2317** | **432** | **Yes** |

| Section Description | Risk Weighting | Length within catchment (km) | Annual Average Daily Traffic (vpd) | %HGV | Probability Score ($P_{POL}$) | Probability of Spillage ($P_{SPL}$) | Probability of Incident ($P_{INC}$) | Probability of Incident ($P_{INC}$)% | Return Period (Years) | Within Acceptable Limits?* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Catchment 7** | | | | | | | | | | |
| 2713_50001 Flyover / Overbridge | 0.43 | 0.595 | 30,521 | 8.00 | 0.45 | 0.0002 | 0.0001 | 0.0103 | 9,746 | Yes |
| 4910_50000 Slip Road | 0.43 | 0.333 | 19,858 | 10.00 | 0.45 | 0.0001 | 0.0000 | 0.0047 | 21,411 | Yes |
| 50000_4911 Slip Road | 0.43 | 0.129 | 19,858 | 10.00 | 0.45 | 0.0000 | 0.0000 | 0.0018 | 55,271 | Yes |
| 4910_50000 Roundabout approach | 3.09 | 0.333 | 19,858 | 10.00 | 0.45 | 0.0007 | 0.0003 | 0.0336 | 2,980 | Yes |
| 4898_50010 Roundabout | 3.09 | 0.022 | 5,085 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0005 | 220,157 | Yes |
| 50010_4909 Roundabout | 3.09 | 0.016 | 5,085 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0003 | 302,716 | Yes |
| 4909_14434 Roundabout Exit | 3.09 | 0.072 | 5,085 | 8.00 | 0.45 | 0.0000 | 0.0000 | 0.0015 | 67,270 | Yes |
| 14434_12831 Roundabout Exit | 3.09 | 0.05 | 4,729 | 10.00 | 0.45 | 0.0000 | 0.0000 | 0.0012 | 83,329 | Yes |
| **Total** | | **1.55** | | | | **0.0012** | **0.0005** | **0.0538** | **1860** | **Yes** |